IF YOU WISH TO ADDRESS THE CITY COUNCIL,
PLEASE COMPLETE FORM LOCATED ON DESK AT ENTRANCE AND PASS TO MAYOR.

AGENDA – CITY COUNCIL MEETING

October 25, 2016
6:30 p.m.

1. **CALL TO ORDER.**

2. **PLEDGE OF ALLEGIANCE** – Invocation by Daniel P. Greer, 3rd Ward City Councilmember.

3. **ROLL CALL**.

4. **ADOPTION OF AGENDA**.

5. **CITIZEN COMMENTS** (3-Minute Limit).

6. **PRESENTATIONS/PROCLAMATIONS**.

   A. **Kelli Hoover, Director of Parks, Recreation, and Cemeteries** (10 Minutes)
   Presentation of the City of Jackson Weed Management Investigation for the City of Jackson 25 Parks, Trails and Two (2) Cemeteries.

   Peter Bormuth, Citizen (10 Minutes)
   Presentation of the City of Jackson Weed Management Investigation.

7. **PETITIONS & COMMUNICATION (Accept & Place on File)**.

8. **CONSENT CALENDAR**.

   A. **Minutes of the Regular Meeting of October 11, 2016:**
   Approve the minutes of the regular City Council meeting of October 11, 2016.

   B. **Downtown Development Authority Appointment:**
   Mayor's recommendation to appoint Karen Bunnell to the Downtown Development Authority filling a current vacancy, beginning immediately and ending March 31, 2018.

C. Ella W. Sharp Museum Board of Trustees Resignation:
Receipt with regret the resignation of Joan Campau from the Ella W. Sharp Museum Board of Trustees.

D. Administrative Hearings Bureau Resignation:
Receipt with regret the resignation of Charles H. Aymond from the Administrative Hearings Bureau.

E. CDBG and HOME Financial Statements through September 30, 2016:
Receive the Community Development Block Grant (CDBG) and HOME Financial Summaries through September 30, 2016.

F. Christmas Parade:
Approve a request from the Downtown Jackson Christmas Parade to conduct their 26th annual Jackson Christmas Parade event on November 18, 2016, from 6:00 p.m. to 9:00 p.m. in downtown Jackson. (Event insurance is covered by the Downtown Development Authority.)

G. "Discover Downtown Again" Day (DDA Day):
Approve the request from the Downtown Development Authority to conduct their 8th annual "Discover Downtown Again" Day event (DDA Day) on November 19, 2016, at 10:00 a.m. to 2:30 p.m., in Horace Blackman Park. (This event is covered under the City insurance policy.)

9. PUBLIC HEARINGS.

Recess as a City Council and convene as a Board of Review.

A. Public Hearing on Special Assessment Roll No. 3384:
Hold a public hearing on Special Assessment Roll No. 3384 for street repaving Wisner Street from Argyle Street to Boardman Road.

1. Resolution confirming Roll No. 3384.

Adjourn as a Board of Review and reconvene as City Council.

B. Public Hearing on Amendments to Various Sections in Chapter 28 of the City Code of Ordinances.
Hold a public hearing on amendments to various sections in Chapter 28 of the City Code of Ordinances. (Introduction) (City Planning Commission recommends approval.)

10. OTHER BUSINESS.

A. Ordinance Amending Various Sections of Chapter 28 of the City Code of Ordinances.

Recommendation: Consider an ordinance amending various sections of Chapter 28 of the City Code in concurrence with the unanimous recommendation from the City Planning Commission on September 7, 2016. (Introduction of Ordinance.)

B. Ordinance Rezoning 707 Madison Street and 1216 Clinton Street (Second/Final Reading).

Recommendation: Final adoption of Ordinance No. 2016-28, amending Chapter 28, Section 28-32, City Code, to rezone 707 Madison Street and 1216 Clinton Street from R-4 (High Density Apartment and Office) to C-4 (General Commercial). (City Planning Commission recommends approval.)

C. Second Addendum to Development Agreement – Detroit Entrepreneur Development, LLC.

Recommendation: Approve execution of the Second Addendum to Development Agreement, authorize the City Manager to sign same, and authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the agreement.

D. Second Addendum to Purchase Agreement – Detroit Entrepreneur Development, LLC.

Recommendation: Approve execution of the Second Addendum to Purchase Agreement, authorize the City Manager to sign same, and authorize the City Attorney to make minor modifications and take all actions necessary to finalize the Agreement.

E. Execution of a Construction Access Easement – Detroit Entrepreneur Development, LLC.

Recommendation: Approve execution of a Construction Access Easement in favor of Detroit Entrepreneur Development, LLC, authorize the City Manager to sign same, and authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

11. NEW BUSINESS.

A. Local Share Cost of JACTS Unified Work Program for FY 2017.

Recommendation: Approve payment of the invoice from Region 2 Planning Commission for local share cost of Jackson Area Comprehensive Transportation Study (JACTS) Unified Work Program for FY 2017, in the amount of $19,493.50, in accordance with the recommendation of the City Engineer, and authorize the City Engineer to sign the Local Funding Resolution.

B. Revisions to Chapter 18, Section 31, City Code – Obstruction (First Reading).

Recommendation: Consider an ordinance amending Chapter 18, Section 31, Obstruction, City Code, by adding language that would help protect the health, safety, and welfare of the citizens of the City of Jackson, Michigan when on government-owned property.

C. Revisions to Chapter 19, Article I, City Code – Parks and Recreation, in General (First Reading).

Recommendation: Consider an ordinance amending revisions to Chapter 19, Article I, In General, by adding language that would help to protect the health, safety, and welfare of the citizens of the City of Jackson, Michigan, when in a City-owned park. Specifically, the proposed revision would allow designated City officials to temporarily ban disorderly individuals from the use of public parks if found to have used threatening, obscene, profane, or indecent language in a park with the intent to interfere with the proper use and enjoyment of other persons visiting such park.

D. Resolution Regarding Human Trafficking.

Recommendation: A Resolution requesting the City Manager to amend the City Personnel Policy to train appropriate City Staff to recognize human trafficking. (Agenda item will be available on Monday.)

E. Resolution in Support of SB 1061-1065.

Recommendation: A resolution supporting Senate Bills 1061, 1062, 1063, 1064, and 1065 – Transformational Brownfield Plan capturing part of the incremental sales tax and residential income tax generated from within the footprint of the project in order to make the development possible. (Agenda item will be available on Monday.)

12. CITY COUNCILMEMBERS' COMMENTS.

13. MANAGER'S COMMENTS.

14. ADJOURNMENT.

CITY OF JACKSON
Founded 1829

City Manager's Office

161 W. Michigan Ave. - Jackson, MI 49201
Phone: (517) 788-4035 • Facsimile: (517) 768-5820

MEMO TO: Mayor and City Councilmembers

FROM: Patrick H. Burtch, City Manager

DATE: October 25, 2016

SUBJECT: Roundup use in City Parks, Trails and Cemeteries

Presentation:

City of Jackson Parks, Recreation and Cemeteries Department weed management program.

Attached are a memo from Kelli Hoover, Director of Parks, Recreation and Cemeteries, regarding the Departments weed management program with in the City Park, Trails and Cemeteries.

Your consideration is appreciated.

PHB

DEPARTMENTAL REPORT

MEMO TO: Patrick Burtch, City Manager

FROM: Kelli Hoover, Director Parks, Recreation and Cemeteries

DATE: October 25, 2016

RECOMMENDATION: Investigation of the City of Jackson weed management program in two City Cemeteries, Trails and twenty-five City Parks.

SUMMARY

The City of Jackson Parks, Recreation and Cemeteries Department are currently using Roundup in the Cemeteries, Trails and Parks as weed control maintenance. Over the last few months the City has begun an investigation into the use of herbicide as a weed killing agent in its system. The use of Roundup and it subsequent chemical Glyphosate has come up for public conversation. The investigation included a survey of Roundup and line trimming use within other Townships, City, State and National Cemeteries and Parks.

BUDGETARY CONSIDERATIONS

Currently the City of Jackson uses liquid Roundup weed killer to eliminate weeds in the Parks, Trails and Cemeteries. The following are contracted costs associated with the use of Roundup and line trimming. (Line trimming consists of weed whipping around fences, buildings, trees, cemetery markers and athletic fields);

	Annual Cost
Woodland Cemetery	
Roundup:	$8,534
Line Trimming:	$23,520
Mt Evergreen Cemetery	
Roundup:	$4,266
Line Trimming:	$10,920
Parks	
Roundup	$2,250
Line Trimming	$7,630
Current: Roundup Cost	$15,050
Proposed Line Trim Costs	$42,070
Total Difference	**$27,020**

The City Parks and Cemetery Staff are certified in herbicide application and is one of the requirements for the Maintenance Worker III position in the Parks and Cemeteries Department.

HISTORY, BACKGROUND and DISCUSSION

The City of Jackson Parks, Recreation and Cemeteries Department have used Roundup weed control for over 20 years within the Department. The investigation included cost, a survey of Roundup and line trimming use within other Townships, City, State and National Cemeteries and Parks, non-herbicide treatment, and health risks.

DISCUSSION OF THE ISSUE

The first part of the investigation was the financial cost of Roundup and line trimming as a weed maintenance program which is noted under Budgetary Considerations.

The second part of the investigation was a survey of Departments to see if they use Roundup or line trimming (weed whipping) in their parks and cemeteries. The survey then focused on Historical Cemeteries and Fort Custer National Cemetery in Battle Creek, Michigan. They use both line trimming and Roundup for weed control. The Manager of Fort Custer maintenance said this would be the preferred weed management program in all the National Cemeteries.

The third part of the investigation was Roundup Herbicide and any health hazards that would come along with the use of this product. Information from the United States Environmental Protection Agency (EPA) discussed the main ingredient in Roundup which is Glyphosate. Glyphosate is a widely used herbicide that controls broadleaf weeds and grasses and has been used as pesticide since the 1970's. Glyphosate acid and several related glyphosate salt compounds are also registered pesticides.

The EPA noted the following about glyphosates used in such products as Roundup to control weeds in many places including:

- A wide variety of fruit, vegetable, and other food crops.
- Ornamental plantings, lawns, turf, greenhouse, aquatic areas, forest plantings and roadsides for total vegetation control.

Products are sold in liquid, solid and ready-to-use formulation, and applied using ground or aerial equipment and small hand-held sprayers.

According to the EPA glyphosate products can be safely used by following label directions and has low toxicity for humans. The EPA also noted that all pesticide is on a 15 year cycle for review.

The fourth part of the investigation was research of the Historic Cemeteries and a Preservation Guide that is supported by the Michigan State Historic Preservation Office and information in this document was compiled by the Charter Township of Canton, Michigan. In this document on page 131 under Herbicide and Insecticides states the following "The routine use of herbicides is discouraged. Their use should be restricted to eradicate noxious plants such as poison oak and poison ivy. Insecticides should be used only in the case of serious infestations. Indiscriminate application of any chemical in a historic cemetery should be avoided. The probability of damage to the markers is much greater than the benefit gleaned from the chemical application".

ATTACHMENTS

Survey of the Parks and Recreation and Cemetery Department's Weed Management Programs

LOCATION	CEMETERY LINE TRIM	CEMETERY ROUND UP	PARKS LINE TRIM	PARKS ROUND UP
ALMA CITY CEMETERY		X		
CITY OF CLARE			X	
CITY OF LANSING	X			X
CITY OF ST. JOE		X		X
FORT CUSTER NATIONAL CEM.	X	X		
HILLCREST CEMETERY	X			
HOLLAND				X
HUNTINGTON WOODS			X	
HURON VALLEY			X	
INGHAM COUNTY				X
KALAMAZOO				X
LAPEER	X	X	X	X
OAKLAND COUNTY			X	
ROMEO-WASHINGTON-BRUCE				X
ROSELAND CEMETERY	X			
ROYAL OAK				X
SAGINAW				X
SOUTHGATE				X
SPRINGFIELD TOWNSHIP			X	
ST. CLAIR COUNTY				X
ST. JOHNS CEMETERIES		X		

*Line Trimming= Weed whipping around fences, buildings, and headstones

*X= Preferred weed maintenance program(s)

241-425-71995: ROUNDUP READY-TO-USE WEED & GRASS KILLER PLUS EXTENDED WEED CONTROL

npic
Product
Research
Online

Status: **Active** (2004-05-03) **View Federal label PDF**

Registrant:

MONSANTO COMPANY
600 13TH ST.NW, SUITE 660
WASHINGTON, DC 20005

Toxicity Signal Word: CAUTION

Formulation: Ready-to-Use Solution

Ingredients (2): (click to view ingredient details in ChemSearch)

0.0170% 3-Pyridinecarboxylic acid, 2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl)-5-methyl-, monoammonium salt, (.+-.)- (PC:128943 CAS:104098-49-9)

Pests (68):

BAHIAGRASS
BENTGRASS
BERMUDAGRASS

Use Sites (14):

CURBS (FOLIAR TREATMENT)
DRIVEWAYS (FOLIAR TREATMENT)

Types (1):

HERBICIDE TERRESTRIAL

[Editorial Notes: Bracketed text [ ] is for internal use or serves as a 'place holder' for graphics. Parenthetical text ( ) denotes optional wording.]

[Refer to APPENDIX 1 for consolidated list of label claims.]

[Refer to APPENDIX 2 for packaging related claims.]

[Refer to APPENDIX 3 for packaging assembly and use instructions.]

Glyphosate Residual RTU

Alternate Brand Name: Roundup Ready-To-Use Extended Control Weed & Grass Killer Plus Weed Preventer

ACCEPTED
MAY 18 2006
Under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended for the pesticide registered under EPA Reg. No. 241-425

Active Ingredients:

Glyphosate, isopropylamine salt	1.000%
Imazapic, ammonium salt	0.017%
Other Ingredients	98.983%

KEEP OUT OF REACH OF CHILDREN
CAUTION
See back panel (booklet) for additional precautionary statements.

NET [ ]

Open (booklet for details)
Resealable Label for Directions and Precautions

[OPTIONAL SECTION]
[Insert product claims from Appendix 1]

HOW IT WORKS *[OPTIONAL SECTION]*

[Optional graphics- person applying product to patio]
IMPORTANT!
To prevent new weeds and grasses from growing **YOU MUST SPRAY THE ENTIRE AREA** you want to control (keep free of weeds), **NOT JUST** the emerged (existing) weeds.

DUAL-ACTION FORMULA WORKS TWO WAYS

1. Kills existing weeds and grasses, roots and all. *[Optional graphics - cutaway weed seed/tap root underground*
2. Prevents new weeds from growing for up to 4 months by creating an invisible barrier. *[Optional graphics – weed free patio]*

WHERE AND HOW TO USE *[OPTIONAL SECTION]*

Apply Roundup Extended Control to both existing weeds and weed-prone areas where weeds have not yet appeared.

[OPTIONAL TEXT]
Yellow color represents area to be sprayed to receive 4 month weed-free control.

- *[Optional graphic]* Driveway & Sidewalk Cracks
- *[Optional graphic]* Patios & Paths
- *[Optional graphic]* Along Fence Lines
- *[Optional graphic]* Tree Rings & Mulched Areas
- *[Optional graphic]* Gravel Areas

[OPTIONAL TEXT] **NOTE:** Product goes on clear and will not stain. Yellow highlight shown for illustration purposes only.

WHERE NOT TO USE *[OPTIONAL SECTION]*

- In areas that will be planted or seeded within 4 months
- Around un-established plants, shrubs, or trees

(See inside booklet for details)

☎	**Questions, Comments or Information** call *[Insert contact telephone number]*	*[insert computer icon]* www.roundup.com

Product Facts Container treats more than [ ] weeds [24 oz treats approximate 200 weeds] Treats up to [ ] sq ft (approx. size of [ ] tennis courts) *[See Appendix 2 for calculations]*	
WHAT IT DOES	*[Optional illustration of grassy, broadleaf and woody weeds]* **Kills & prevents all types of (tough) weeds & grasses**
HOW IT WORKS	**IMPORTANT: To prevent new weeds and grasses from growing YOU MUST SPRAY THE ENTIRE AREA you want to control (keep free of weeds), NOT JUST the emerged (existing) weeds.** Roundup Extended Control works two ways: 1. One ingredient enters plants through foliage and moves systemically to the roots, killing weeds by stopping the function of a substance found in plants (but not in humans or animals). Weeds begin to (yellow and) wilt within hours (24 hours) with complete kill in 1 to 2 weeks. 2. The other ingredient provides an invisible barrier in the soil that prevents growth of sprouting (new) weeds (weed seeds) and grasses for up to 4 (2, 3) months/
WHERE TO USE	Apply (spray) Roundup Extended Control to BOTH existing weeds and weed-prone areas where weeds have not yet appeared. • On cracks and crevices in driveways, sidewalks, walkways (tennis courts) and patios • Along fences, foundations, curbs, retaining walls, and edge of lawns • Around the base or in mulched beds of well-established (at least 6 months old) (ornamental) plants, shrubs or trees • On gravel areas • *[OPTIONAL TEXT]* Decorative rock (mulch) or bark landscapes • *[OPTIONAL TEXT]* On walkways, driveways, gravel pathways, (RV and boat) parking areas, and brick patios
WHERE NOT TO USE	• DO NOT SPRAY plants or grasses you like - they will die. • DO NOT USE in lawns or for lawn renovation as Roundup Extended Control prevents desirable grasses from growing too. • DO NOT USE for vegetable garden preparation or in and around fruits and vegetables. • DO NOT SPRAY around young plants or in an area that will be planted or seeded within 4 (1, 2, 3) months. **Note**: For weed control in these areas use Roundup Weed & Grass Killer Ready-To-Use (Roundup Weed & Grass Killer Ready-To-Use Plus).
[Re-entry Icon]	To prevent tracking product to unintended areas such as your yard, keep people and pets out of treated areas until spray has dried. *[ALTERNATE TEXT]* People and pets may enter treated area after spray

	has dried.

DIRECTIONS FOR USE	
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.	
[Sprayer-specific assembly/use instructions]]	*[Insert instructions from Appendix 3]*
HOW TO APPLY	• *[Trigger Sprayers only]* Adjust nozzle to the desired spray setting (FOAM or SPRAY). • *[OPTIONAL TEXT]* Point sprayer at unwanted weeds, grasses and weed-prone areas where weeds typically emerge and press sprayer button to begin spraying, hold for continuous spray. • Spray the existing weeds AND the entire surrounding weed-prone area you want to keep free of weeds (weed free) (for up to 4 (2, 3) months). Spray the area until **THOROUGHLY WET** (or covered with foam). • When spraying around the base of **well-established** (at least 6 months old) ornamental plants, shrubs or trees, shield desirable plants from drift with a sheet of cardboard or plastic. If desirable plant is accidentally sprayed, rinse off immediately with water or cut off the treated area. • *[OPTIONAL TEXT]* When making applications around desirable trees or ornamental plants, wait until desirable plants have become well established and deeply rooted.
WHEN TO APPLY	• Spray (apply) when air is calm to prevent drift to desirable plants. • For fastest visual (best) results, apply during warm, sunny weather (above 60 °F) (to accelerate systemic movement from foliage to root). • RAINPROOF (PROTECTION): Rain or watering (10, 30, 45, 60, or 90 minutes; 2 hours;1 hour; less than 1 hour; less than 60 minutes; less than 30 minutes; minutes) after application will NOT wash away effectiveness. • *[OPTIONAL TEXT]* Wait (at least) (1, 2, 3) months between applications of *[insert brand name]* (or apply when new weeds are present) • *[OPTIONAL TEXT]* Weeds usually yellow and wilt within hours (1-3 days) with complete kill in 1 to 2 weeks.
WHEN TO REPLANT	All ornamental bedding plants (annuals and perennials), trees, shrubs, sod and seed (flowers and grasses) may be planted 4 (1, 2, 3) months after application.
(HOW TO) REFILL	*[OPTIONAL TEXT]* This container and sprayer can be reused. Use *[insert brand name for Reg. No. 71995-40]* to refill the container. Follow the instructions below: ***[24 fl oz container]*** To this empty container add 1 oz (3 Tbs) of *[Insert brand name for Reg. No. 71995-40]* then fill with water very slowly to avoid foaming.

	[½ Gallon] To this empty container add 3 fl oz of *[Insert brand name for Reg. No. 71995-40]* then fill with water very slowly to avoid foaming. ***[Gallon]*** To this empty container add 6 oz of *[Insert brand name for Reg. No. 71995-40]* then fill with water very slowly to avoid foaming. ***[1.33 Gallon]*** To this empty container add 8 fl oz of *[Insert brand name for Reg. No. 71995-40]* then fill with water very slowly to avoid foaming. ***[1.5 Gallon]*** To this empty container add 9 fl oz of *[Insert brand name for Reg. No. 71995-40]* then fill with water very slowly to avoid foaming. ***[6L]*** To this empty container add 10 fl oz of *[Insert brand name for Reg. No. 71995-40]* then fill with water very slowly to avoid foaming. ***[2 Gallon]*** To this empty container add 12 fl oz of *[Insert brand name for Reg. No. 71995-40]* then fill with water very slowly to avoid foaming. ***[Battery Operated Sprayer Device]*** The sprayer may also be used with *[Insert Brand Name of refill pack]*. Follow instructions on refill pack for assembly.
HOW TO CLEAN *[OPTIONAL SECTION - Battery Operated Sprayer ONLY]*	*[Battery operated sprayer head may be used with other Roundup products, it will replace any sprayer fitted with a quick-connect cap]* • Before using the *[Insert name of sprayer device]* with other Roundup products, the sprayer must be thoroughly cleaned (the sprayer must be purged of remaining product). • Disconnect sprayer unit from the quick-connect cap (Disconnect sprayer unit from the bottle cap) • Place ONLY the end of the hose (the hose end) into a bucket of water and spray continuously for 30 seconds onto bare soil or gravel. *[ALTERNATE TEXT]* Rinse sprayer and sprayer parts (hose) with water 3 times. Spray rinse water on bare soil or gravel. Discard sprayer bottle as instructed in DISPOSAL section. *[ALTERNATE TEXT]* Rinse sprayer with water 3 times and then spray (clean) water through sprayer for 30 seconds. All rinse water should be applied to bare soil or gravel. • Connect sprayer head to any Roundup quick-connect cap (adaptor) (any Roundup bottle compatible with the *[Insert brand name of sprayer]* • Failure to properly clean sprayer before using with other Roundup

	products may cause damage to your plants.

KILLS ALL TYPES OF WEEDS & GRASSES *[OPTIONAL SECTION]*

Bahiagrass	Bentgrass	Bermudagrass
Bindweed	Black Medic	Blue Toadflax
Bluegrass	Brassbuttons	Broadleaf Plantain
Bromegrass	Bur Clover	Canada Thistle
Chickweed	Common Plantain	Common Groundsel
Crabgrass	Creeping Bentgrass	Creeping Charlie
Creeping Beggarweed	Curly Dock	Dandelion
Diffuse Lovegrass	Dog Fennel	Evening Primrose
False Dandelion	Fennel	Fescue
Fiddleneck	Filaree	Florida Pusley
Garden Spurge	Henbit	Johnsongrass
Knotweed	Lambsquarters	Little Bitter Cress
London Rocket	Maiden Cane	Mallow
Mayweed	Mouseear Chickweed	Nimblewill
Oldenlandia	Orchardgrass	Oxalis
Pennsylvania Smartweed	Pennywort	Perennial Ryegrass
Primrose	Prostrate Spurge	Puncture Vine
Quackgrass	Ragweed	Sandspur
Shepherdspurse	Smooth Cat's Ear	Sowthistle
Spotted Spurge	St. Augustinegrass	Tall Fescue
Tansy Ragwort	Torpedograss	White Clover
Whitetop	Wild Morning Glory	Wild Barley
Yellow Nutgrass	Zoysia	

NOTE: Heavy lawn grass or well established difficult to control weeds, such as Bermudagrass, Nimblewill, Dandelion, or Canada Thistle may require a repeat application.

STORAGE AND DISPOSAL *[trash can illustration]*

[Trigger Sprayer]
PESTICIDE STORAGE: Rotate nozzle to closed position. Store product in original container in a safe place away from direct sunlight. Keep from freezing.

[Quick Connect Sprayer]
PESTICIDE STORAGE: Flip down spout to close. **NO NEED TO DISCONNECT TRIGGER SPRAYER.** Close nozzle on trigger sprayer. Snap sprayer back in place. Store product in original container in a safe place away from direct sunlight. Keep from freezing.

[Pull 'N Spray I]
PESTICIDE STORAGE: Completely dispense product in sprayer prior to storage. Slide white (or other color) strip on cap back to closed position. LEAVE WAND PLUG CONNECTED TO 'T-HANDLE'. Snap wand back into place on side of container. Store product in original container in a safe place away from direct sunlight. Keep from freezing.

[Pull 'N Spray II]
PESTICIDE STORAGE :
Completely dispense product in sprayer prior to storage. Rotate nozzle to the OFF position. Flip down (color of spout) spout on cap. NO NEED TO DISCONNECT SPRAYER HOSE FROM CAP. Place sprayer back inside carrier on bottle with the nozzle facing down. Store product in original container in a safe place away from direct sunlight. Keep from freezing.

[Battery Operated Sprayer]
PESTICIDE STORAGE :
Rotate (twist) (sprayer) nozzle to the closed (OFF) position. Flip down (color of spout) spout on cap. NO NEED TO DISCONNECT SPRAYER HOSE FROM CAP. Place sprayer back inside carrier *[insert location]* with the nozzle facing down. Store product in original container in a safe place away from direct sunlight. Keep from freezing.

[Pump N Spray (EZ) Sprayer]
PESTICIDE STORAGE :
Push the yellow button and retract the wand until the yellow button snaps back into the original storage position. Place wand back onto the bottle with nozzle facing down. Push pump handle all the way down and turn pump handle and cap counter-clockwise to relieve pressure, then retighten to store. Store product in original container in a safe place away from direct sunlight. Keep from freezing.

[Pull 'N Spray I Device only]
DISPOSAL: DO NOT REUSE THIS CONTAINER. Place in trash or offer for recycling if available.

[All packaging types except for Pull 'N Spray]
DISPOSAL: This container can only be reused according to the directions contained in the (HOW TO) REFILL section.

[ALL Packaging Types]
If Empty: Place in trash or offer for recycling if available. **If Partly Filled:** Call your local solid waste agency or 1-800-CLEANUP for disposal instructions. Never place unused product down any indoor or outdoor drain.

PRECAUTIONARY STATEMENTS *[optional illustration]*	
HAZARDS TO HUMANS & DOMESTIC ANIMALS **CAUTION:** Causes moderate eye irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling.	
FIRST AID	
IF IN EYES	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after first 5 minutes, then continue rinsing eyes. • Call a poison control center (insert contact telephone #) or doctor for treatment advice.
EMERGENCY MEDICAL INFORMATION	
• Have the product container or label with you when calling a poison control center or doctor, or going for treatment. • You may contact (insert contact telephone #) for emergency medical treatment information. • This product is identified as ***[Insert brand name]*, EPA Reg. No. 241-425**	
ENVIRONMENTAL HAZARDS	
Do not apply directly to water. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.	
NOTICE: Buyer assumes all responsibility for safety and use not in accordance with directions.	

[OPTIONAL TEXT] Roundup Family of Products: Visit the Roundup website to learn more about the Roundup family of products for the best solution to your toughest weed problems

[Insert graphic – Roundup product family photo]

This product is protected by U.S. patent No. *[Insert relevant patent number(s).]*. No license granted under any non-U.S. patent(s).

[Insert relevant trademark(s).]

© [____] MONSANTO COMPANY
Manufactured for / Distributed by
Monsanto Company, Lawn & Garden Products
PO Box 418
Marysville, OH 43041-0418
PPN _____
EPA Reg. No. 241-425
EPA Est. 239-IA-3[1]; 58996-MO-1[A]
Superscript is first letter of lot number
Made in USA

APPENDIX 1 – Consolidated List of Label Claims

- (Contains) (Now with) FastAct (II) Technology
- (One application) Kills (existing) weeds (& grasses) (roots & all) and prevents (new) weed(s) (seeds) (from sprouting, appearing, growing) for up to 3 (2, 4) months (60, 90, 120 days)
- 2 in 1 (kills and prevents)
- 30-50% faster (even when its cold) (even in the Spring) (even when it's dry) (even when it's cool)
- All-Season Formula (Delivers 12 hour results all year (even in cool and cloudy weather))
- All-temperature Roundup – Always (less than) 12 (4, 6, 9) hour results!
- Before [*weed graphics*] / After [*weed graphics*]
- Begins working in hours
- Consumer Guarantee: If for any reason you are not satisfied after using this product, simply send us original proof of purchase and we will replace the product or refund the purchase price.
- Contains FastAct™ (Technology) (with Foam)
- Controls tough weeds longer
- Dead in a day
- Dead Weeds Guaranteed *[qualify guarantee]*
- Delivers maximum performance: Kills tough weeds and grasses to the root, prevents new weeds and grasses for up to 4 (2,3) months, visible results in hours (24 hours), rain-proof protection in [__] minutes, great value – covers up to [__] sq ft.
- Dual (2-way) Action (kills and prevents)
- Dual (2-way) Action: Kills existing weeds (roots and all) and prevents new weeds from appearing for up to (30, 60, 90, 120 days) (1, 2, 3, 4 months)
- Easy (-ier) to use (convenient, handy, useful)
- Eliminate(s) weeds
- Even if it rains – Roundup won't lose its effectiveness
- Exclusive (Roundup) formula
- Experience the Roundup Advantage (peel back this panel for detail) (see details inside / underneath this booklet) (see details on back panel)
- Extended performance
- Extended weed control
- Fast acting (formula)
- Fast results
- FastAct™ (Technology)
- Fast-acting formula moves to the root faster (is absorbed fast)(more quickly)
- Great value – covers up to [__] sq ft
- Ideal for killing and preventing unwanted weeds and grasses throughout your yard. Use along fences, retaining walls; in cracks of walks, drives and patios; and around flower (landscape) beds, rings around trees and shrubs
- Keep yards (areas of your yard) weed free longer
- Keeps driveways, walkways, landscape borders, tree rings, and other areas weed-free for 1 (2, 3, 4, 1-2, 2-3, 2-4, 3-4 months) (seasonally) (all season long)
- Kills (the toughest weeds and grasses) to the root so weeds (they) don't come back
- Kills (to) the roots

- Kills and prevents
- Kills more weeds in more places.
- Kills over 100 weeds
- Kills the weeds (& grasses) you see (roots & all) and prevents (new) weed(s) (seeds) (from sprouting, appearing) for up to 3 (2, 4) months
- Kills tough weeds & grasses to the root
- Kills weeds dead
- Kills weeds, roots and all
- Longer lasting formula
- One application kills weeds (to the root) and prevents (new) weeds for up to (1, 2, 3, 4 months) (30, 60, 90, 120 days)
- NEW
- Next day results: Begins killing on contact, visible results in hours (less than 9, 12, 24 hours)
- No Root, No Weed, No Problem
- NOW
- One step protection
- Only Roundup's effectiveness (exclusive formula) won't be washed away by rain or watering 2 hours (30, 45, 60, 90 minutes; 1 hour; less than 1 hour; less than 60 minutes; less than 30 minutes) after treatment
- Patented FastAct (II) Technology
- Provides seasonal (extended) (1, 2, 3, 4, 1-2, 2-3, 2-4, 3-4 months) control of weeds in driveways, walkways, landscape borders, tree rings, and other areas.
- Quality that lasts
- Rainproof (Protection) in ((less than) 10, 30, 45, 60, 90 minutes; (less than) 1 hour; (less than) 2 hours) (for control that won't wash away)
- Ready-To-Use
- Results in (4,6,8,10,less than 12, 12) hours (even when it's cool) (even in the Spring)
- Results in 12 (4,6,8,10) hours (even when it's cool) (even in the Spring)
- Results that show
- Roundup's exclusive (patented) (FastAct) formula (technology) kills to the root so weeds don't come back
- Same day results
- Satisfaction guaranteed
- Season long weed control
- Seasonal weed control
- (See) (visible) Results in 24 hours 12 hours (1 day)
- (See) (visible) Results in hours
- (See) (Visible) Results in hours (less than 9, 12, 24 hours) – Prevents for up to (30, 60, 90, 120 days)(1, 2, 3, 4 months)
- Speedy results
- Spray today, dead tomorrow
- Starts to kill in hours (same day)
- Starts to kill overnight
- Starts working in (24) hours
- Starts working overnight
- The fast weed killer (starts working immediately)
- Tougher than the toughest weeds

- Trusted protection
- Use to trim and edge landscape areas
- Weeds start dying in 1 day

[Promotional options]
- Save up to $[x] on (your) next purchase
- Free weed guide inside
- Free [ ] with this purchase of Roundup Ready-To-Use (container size)
- FREE SAMPLE
- SAMPLE NOT FOR SALE
- Value sized

APPENDIX 2 – Packaging Related Claims

NET	12 FL OZ	24 FL OZ (1PT 8 FL OZ)
	30 FL OZ (1PT 14 FL OZ)	64 FL OZ (½ GAL)
	67.7 FL OZ (0.52 GAL) 2L	128 FL OZ (1 GAL)
	135.4 FL OZ (1.05 GAL) 4L	170 FL OZ (1.33 GAL) 5 L
	192 FL OZ (1.5 GAL)	202 FL OZ (1.58 GAL) 6 L
	256 FL OZ (2 GAL)	

Treats (covers) up to 'X' sq ft (approximate size of 'Y' tennis court)

[X = net contents (fl oz) ÷ 128 x 300 sq ft]

[Y = X ÷ 2808]

Quick-Connect Sprayer (QCS)

- New
- Now
- Quick connect sprayer
- Quick &(and) easy to use
- No leaks or mess
- Easy to store (see back for instructions)

Foaming Sprayer (Quick-connect or trigger type)

- Foam targets exactly (precisely) what (the weeds) you want to spray (kill)
- Targets exactly (precisely) what (the weeds) you want to spray (kill)
- Accurately targets what (the weeds) you want to spray (kill)
- Accurately targets precisely (exactly) what (the weeds) you want to spray (kill)
- Visible foam shows (targets) (let's you see) exactly (precisely) where (what) (the weeds) you've sprayed
- Visible foam
- Foam
- Foam targets exactly (precisely) what (the weeds) you want to spray (kill)
- Target only what you want to kill
- See (shows) where (the weeds) (what) (how much) you (you've) spray (sprayed) (applied)
- See (shows) exactly (precisely) where (the weeds) (what) (how much) you (you've) spray (sprayed) (applied) (treated)
- See (shows) (marks) area covered (treated) (sprayed).
- (Foam) Marks (shows) treated (sprayed) weeds
- (Foam) Marks (shows) treated (sprayed) weeds for up to 5 minutes
- (Foam) Marks (shows) the weeds you've sprayed (treated)
- (Foam) Marks (shows) the weeds you've sprayed (treated) for up to 5 minutes
- Visible foam marks weeds
- Visible foam marks (shows) weeds you've sprayed (treated)
- Visible foam marks (shows) weeds for up to 5 minutes
- Visible foam marks (shows) weeds you've sprayed (treated) for up to 5 minutes

- Easily (Easy to) see where (the weeds) (what) you've sprayed (treated) (applied)
- Easily (Easy to) see exactly (precisely) where (the weeds) (what) you've sprayed (treated) (applied)
- Visible foam makes it easy (easier) to see where (the weeds) (what) you've sprayed (treated) (applied)
- Visible foam makes it easy (easier) to see exactly (precisely) where (the weeds) (what) you've sprayed (treated) (applied)
- Foam makes it easy (easier) to see where (the weeds) (what) you've sprayed (treated) (applied)
- Foam makes it easy (easier) to see exactly (precisely) where (the weeds) (what) you've sprayed (treated) (applied)
- Treated (sprayed) weeds stay visible (marked) for up to 5 minutes
- Treated (sprayed) weeds can easily be seen for up to 5 minutes
- Choose foam or clear stream (no foam)
- See where you spray technology
- Marker (Foam) (Foaming) Technology
- Hit (spray) (target) precisely (exactly) what you want
- Foam marks the spot
- Foaming action
- New!
- Now!
- Accurate
- For Visible Results
- See what you've hit
- The more accurate way to spray
- The accurate way to spray
- Hit what you aim at
- VisiSpray (technology)
- VisiMark (technology)
- VisiFoam (technology)
- VisiTech (technology)
- AccuSpray (technology)
- AccuFoam (technology)
- AccuMark (technology)
- WeedMark (technology)

Pull 'N Spray I

- NEW
- NOW
- No more tired (achy) hands from (caused by) trigger sprayers
- No more hand fatigue (cramping from) caused by trigger sprayers
- Fast and(&) easy application
- Quickly covers large areas
- The ergonomic sprayer
- Larger (Bigger) size
- 33% larger than 1 gallon size

- Easy to use tank sprayer
- Adjustable sprayer
- 3-ft extension cord enclosed (in spray wand)
- No hand fatigue
- Continuous, adjustable spray
- No pumping
- Just pull

Pull 'N Spray II

- 33% more
- Quick & Easy to Use
- EASY-TO-USE
- The easy way to spray (Roundup)
- The easier way to spray (Roundup)
- No (More) Hand Fatigue
- No more squeeze, squeeze, squeeze
- No (constant) pumping
- No constant trigger squeezing (pulling)
- No more pumping
- No pumping just pull and spray
- (33%) More than 1 gallon size
- Precise control for maximum accuracy
- Consistent spray for maximum accuracy
- Continuous, adjustable spray
- Quickly covers large areas
- No more tired (aching) hands
- Fast and (&) easy application
- Easy to use tank sprayer
- Revolutionary (new) applicator
- Change the way you spray
- Ideal for large or small jobs (areas)
- Great for large or small jobs (areas)
- Precise control – sprays (targets) only what you want
- Adjustable spray (sprayer) nozzle for maximum control
- Adjustable spray pattern for maximum control
- You're always ready to spray
- It's always ready to spray
- The easier way to kill and prevent weeds
- Targets weeds in tight places
- Save (Saves) time and energy
- One pull = (equals) 34 trigger sprays
- One pull delivers 34 trigger sprays
- New!
- Now!
- Improved Applicator (Application)!

- Improved Applicator (Application) System!
- Improved Applicator (Application) Device!
- New and Improved!
- Improved!
- PNS (PNS II)
- Pull 'N Spray (Pull 'N Spray II)
- Give your hands a break
- Continuous spray
- Targeted spray
- Accurate
- Targets weeds
- Convenient

PUMP 'N GO (EZ) Sprayer

- (33%) More than 1 gallon size
- 33% more
- Accurate
- Adjustable spray (sprayer) nozzle for maximum control
- Adjustable spray pattern for maximum control
- Change the way you spray
- Consistent spray for maximum accuracy
- Continuous spray
- Continuous, adjustable spray
- Convenient
- Easy to use tank sprayer
- EASY-TO-USE
- Extendable wand provides greater accuracy without bending over
- Fast and easy application
- Give your hands a break
- Great for large or small jobs (areas)
- Ideal for large or small jobs (areas)
- Improved Applicator (Application) Device!
- Improved Applicator (Application) System!
- Improved Applicator (Application)!
- Improved!
- It's always ready to spray
- New and Improved!
- New!
- No (constant) pumping
- No (More) Hand Fatigue
- No (more) pumping, no (more) pulling, just spray
- No constant trigger squeezing (pulling)
- No more squeeze, squeeze, squeeze
- No more tired (aching) hands
- Now!

- Precise control – sprays (targets) only what you want
- Precise control for maximum accuracy
- Quick & Easy to Use
- Quickly covers large areas
- Revolutionary (new) applicator
- Save (Saves) time and energy
- Targeted spray
- Targets weeds
- Targets weeds in tight places
- The easier way to kill and prevent weeds
- The easier way to spray (Roundup)
- The easy way to spray (Roundup)
- The fast and easy way to kill and prevent weeds
- (Provides) Up to [__] minutes of continuous spray
- You're always ready to spray

Battery Operated Trigger Sprayer

- X % more
- Quick & Easy to Use
- EASY-TO-USE
- The easy way to spray (Roundup)
- The easier way to spray (Roundup)
- No (More) Hand Fatigue
- No more squeeze, squeeze, squeeze
- No (constant) pumping
- No constant trigger squeezing (pulling)
- No (more) pumping, no (more) pulling, just spray !
- (X %) More than 1 gallon size
- Precise control for maximum accuracy
- Power sprayer for large areas
- Consistent spray for maximum accuracy
- Continuous, adjustable spray
- Quickly covers large areas
- No more tired (aching) hands
- No more trigger sprayer
- Fast and (&) easy application
- Easy to use tank sprayer
- Revolutionary (new) applicator
- Change the way you spray
- Ideal for large or small jobs (areas)
- Great for large or small jobs (areas)
- Precise control – sprays (targets) only what you want
- Adjustable spray (sprayer) nozzle for maximum control
- Adjustable spray pattern for maximum control
- You're always ready to spray

- It's always ready to spray
- The easier way to kill and prevent weeds
- Targets weeds in tight places
- The fast way to spray
- The powerful way to spray
- Save (Saves) time and energy
- New!
- Now!
- Improved Applicator (Application)!
- Improved Applicator (Application) System!
- Improved Applicator (Application) Device!
- New and Improved!
- Improved!
- Give your hands a break
- Continuous spray
- Targeted spray
- Accurate
- Targets weeds
- Convenient

APPENDIX 3 – Packaging Related Instructions

QUICK CONNECT SPRAYER *[illustrations]*

1. Remove sprayer. Pull cord/tubing ALL THE WAY OUT.
2. Insert (color of plug) plug into spout on cap until it clicks.
3. Flip up spout. Open nozzle at end of sprayer.

[PULL 'N SPRAY illustrations]

1. Detach green (or other color) wand. Pull plug and tubing from bottom of wand. Insert plug firmly into 'T-handle' until it clicks. **ONCE CONNECTED, PLUG CANNOT BE REMOVED WITHOUT DAMAGING 'T-HANDLE'.**
2. Slide white (or other color) strip on cap, then grab 'T-handle' and pull all the way up. **JUST PULL UP – NO NEED TO PUMP.**
3. Point wand at unwanted weeds or grasses and push button to begin spraying. Twist nozzle at end of wand to adjust spray pattern.
4. Pull 'T-handle' again as needed to continue spraying. **JUST PULL UP – NO NEED TO PUMP.** When finished, push 'T-handle' gently down to cap and follow storage instructions.

[Instructions on PNS wand] IMPORTANT! Follow directions and illustrations on back of container to assemble and use Pull 'N Spray correctly.

[PULL 'N SPRAY II illustrations]

[Applicator Device Directions]

Illustration # 1

- Remove sprayer from side carrier and unwrap hose completely.
- Insert (color of plug) plug at end of hose into (color of spout) spout on cap until it clicks.
- Flip up spout.

Illustration #2

- Point sprayer away from body.
- Grasp sprayer by the handle.
- Slowly pull ring at bottom of sprayer handle until it stops (and hold for 2 seconds) to prime (ready the sprayer) and continue spraying.

Illustration #3

- Adjust nozzle (at end of sprayer) to the desired spray setting.
- Press and hold (trigger) button on sprayer to begin spraying (and hold down for continuous spray).
- Pull ring at sprayer bottom again as needed to prime sprayer and continue spraying.

[Optional Instructions on PNS handle] PULL OUT SLOWLY (AND HOLD FOR (X) SECOND(S)).

PUMP N' GO (EZ) SPRAYER *[illustrations]*

CUT *[illustration # 1]*

1. Carefully cut the two white zip ties securing the hose and pump handle with scissors. Use caution not to cut the white hose.

CONNECT *[Illustration # 2]*

2. Unwind hose and attach black hose connector to spout on pump. The white dust cap on spout must first be removed before connecting.

PUMP *[Illustration # 3]*

3. Pump container 10-20 times to pressurize bottle. A full bottle requires fewer pumps than an empty bottle. (Note: This bottle is designed to expand under pressure and cannot be over-pressurized.)

EXTEND WAND *[Illustration # 4]*

4. Lift sprayer wand off bottle. Push yellow button while pulling wand out. Fully extend wand until yellow button snaps into SPRAY position. White trigger will not function until wand is fully extended and yellow button is visible in the spray position.

SPRAY *[Illustration # 5]*

5. Aim wand. Spray by pushing down white trigger with thumb. Adjust spray pattern by rotating white nozzle tip. Spray weeds (and grasses) until thoroughly wet.

STORE *[Illustration # 6]*

6. When finished spraying, push yellow button while retracting wand to storage position, yellow button will snap into place. Place wand back onto bottle with nozzle facing down. Turn pump handle counter-clockwise and relieve pressure, then retighten prior to storing.

BATTERY OPERATED SPRAYER DEVICE *[Illustrations]*

Illustration # 1

- Remove sprayer from [insert location] and unwrap hose completely
- *[Optional Text]* Locate battery compartment (on sprayer) *[insert optional location of battery compartment]*. (With nozzle in OFF position) (remove battery door) (open battery cover by lifting tab)). Install batteries (insert batteries as shown) (remove plastic wrap from each battery (and reinstall)) (remove plastic terminal shield) and close battery compartment door (replace battery cover until it clicks into place).
- Insert (color of plug) plug at end of hose into (color of spout) spout on cap until it clicks. (Attach coupler to the cap).
- *[Optional text]* Flip up spout.
- *[Optional text]* Spout must remain up or applicator will not spray.

Illustration # 2

- Twist (rotate) (adjust) nozzle (at end of sprayer) to (the) desired spray setting (pattern) (foam or spray).
  [Alternate text] Twist (turn) (pull out) nozzle at end of sprayer to adjust spray pattern (to coarse spray).

Illustration # 3

- To prime sprayer, position sprayer level with bottle.

Reg. No. 241-425 Master Label Amendment Submission Dated 22-Mar-2006
Previous EPA Stamped Label Dated 16-Sep-2006

Glyphosate Issue Paper:
Evaluation of Carcinogenic Potential

EPA's Office of Pesticide Programs
September 12, 2016

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List of Acronyms

ADME: Absorption, Distribution, Metabolism, and Excretion
AHS: Agricultural Health Study
AOP: Adverse Outcome Pathway
AMPA: Aminomethylphosphonic Acid
BrdU: Bromodeoxyuridine
CA: Chromosomal Aberration
CARC: Cancer Assessment Review Committee
CBPI: Cytokinesis Block Proliferation Index
CHL: Chinese Hamster Lung
CHO: Chinese Hamster Ovary
CPRC: Carcinogenicity Peer Review Committee
EFSA: European Food Safety Authority
EPSPS: 5-enolpyruvylshikimate-3-phosphate synthase
FAO: Food and Agriculture Organization
FIFRA: Federal Insecticide, Fungicide, and Rodenticide Act
FISH: Fluorescence *in situ* Hybridization
GC-MS: Gas Chromatography-Mass Spectrometry
HL: Hodgkin Lymphoma
HPLC: High-Performance Liquid Chromatography
HPRT: Hypoxanthine-Guanine Phosphoribosyl Transferase
IARC: International Agency for Research on Cancer
JMPR: Joint Meeting Pesticide Residues
MGUS: Monoclonal Gammopathy of Undetermined Significance
MN: Micronuclei
MOA: Mode of Action
MPCE: Micronucleated Polychromatic Erythrocytes
MRID: Master Record Identifier (a unique number assigned to each study submitted to EPA)
MTD: Maximum Tolerated Dose
NB: Nuclear Bud
NCR: National Research Council
NHL: Non-Hodgkin Lymphoma
NPB: Nucleoplasmic Bridges
NTP: National Toxicology Program
OCSPP: Office of Chemical Safety and Pollution Prevention
OECD: Organization for Economic Cooperation and Development
OPP: Office of Pesticides Program
PCE: Polychromatic Erythrocytes
PK: Pharmacokinetic
PPE: Personal Protective Equipment
PWG: Pathology Work Group
RED: Registration Eligibility Decision
ROS: Reactive Oxygen Species
SAP: Scientific Advisory Panel
SCE: Sister Chromatid Exchange

SCGE: Single Cell Gel Electrophoresis
TAC: Total Antioxidant Capacity
TK: Thymidine Kinase
UDS: Unscheduled DNA Synthesis
USGS: United States Geological Survey
UV: Ultraviolet
WHO: World Health Organization
XPRT: Xanthine-Guanine Phosphoribosyl Transferase

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1.0 Introduction

1.1 Background

Glyphosate is a non-selective, phosphonomethyl amino acid herbicide registered to control weeds in various agricultural and non-agricultural settings. The herbicide acts by inhibiting the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) enzyme, which is not present in mammalian systems. Glyphosate was initially registered in 1974. Since then, several human health analyses have been completed for glyphosate. In 1986, EPA issued the Glyphosate Registration Standard which updated the agency's toxicity database for this compound. In 1993, EPA issued the registration eligibility decision (RED) that indicated that glyphosate was eligible for re-registration.

Currently, glyphosate is undergoing Registration Review[1], a program where all registered pesticides are reviewed at least every 15 years as mandated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The initial docket opening for glyphosate occurred in 2009 with the publication of the human health scoping document and preliminary work plan[2]. As part of this process, the hazard and exposure of glyphosate are reevaluated to determine its potential risk to human and environmental health. Risks are assessed using current practices and policies to ensure pesticide products can still be used safely. Registration Review also allows the agency to incorporate new science. For human health risk assessment, both non-cancer and cancer effects are evaluated for glyphosate and its metabolites, aminomethylphosphonic acid (AMPA) and *N*-acetyl-glyphosate; however, this document will focus on the cancer effects only. EPA expects to complete its complete human health risk assessment in 2017 that will include an assessment of risk from anticipated exposures resulting from registered uses of glyphosate in residential and occupational settings.

1.2 Evaluation of Carcinogenic Potential

Since its registration, the carcinogenic potential of glyphosate has been evaluated by EPA several times. In 1985, the initial peer review of glyphosate was conducted in accordance with the Proposed Guidelines for Carcinogen Risk Assessment. The agency classified glyphosate as a Group C chemical (Possible Human Carcinogen), based on the presence of kidney tumors in male mice. In 1986, the agency requested that the FIFRA Scientific Advisory Panel (SAP) evaluate the carcinogenic potential of glyphosate. The panel determined that the data on renal tumors in male mice were equivocal (only an increase in adenomas was observed and the increase did not reach statistical significance). As a result, the panel recommended a Group D chemical classification (Not Classifiable as to Human Carcinogenicity) for glyphosate and advised the agency to issue a data call-in notice for further studies in rats and/or mice to clarify the unresolved questions (FIFRA SAP Report, 1986)[3].

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[1] Additional information on the Registration Review process can be found at: https://www.epa.gov/pesticide-reevaluation/registration-review-process

[2] Documents of the Registration Review can be found in the public docket at: EPA-HQ-OPP-2009-0361, accessible at www.regulations.gov.

[3] Review available at: http://www.epa.gov/pesticides/chem_search/cleared_reviews/csr_PC-103601_24-Feb-86_209.pdf

With the submission of two rat carcinogenicity studies following this data call-in, a second peer review was conducted in 1991 by the agency's Carcinogenicity Peer Review Committee (CPRC) to incorporate the new data. In accordance with the agency's 1986 Draft Guidelines for Carcinogen Risk Assessment, the CPRC classified glyphosate as a Group E Chemical: "Evidence of Non-Carcinogenicity for Humans" based upon lack of evidence for carcinogenicity in mice and rats and the lack of concern for mutagenicity (TXR# 0008897).

Most recently, in September 2015, a third review was done by the Cancer Assessment Review Committee (CARC). Relevant glyphosate data available to EPA at that time for glyphosate were reevaluated, including studies submitted by the registrant and studies published in the open literature. The agency performed this evaluation in support of Registration Review in accordance with the 2005 Guidelines for Carcinogen Risk Assessment, classified glyphosate as "Not Likely to be Carcinogenic to Humans" (CARC, 2015; TXR #0057299).

Recently, several international agencies have evaluated the carcinogenic potential of glyphosate. In March 2015, the International Agency for Research on Cancer (IARC), a subdivision of the World Health Organization (WHO), determined that glyphosate was a probable carcinogen (group 2A) (IARC, 2015). Later, in November 2015, the European Food Safety Authority (EFSA) determined that glyphosate was unlikely to pose a carcinogenic hazard to humans (EFSA, 2015). In May 2016, the Joint Food and Agriculture Organization (FAO)/WHO Meeting on Pesticide Residues (JMPR), another subdivision of the WHO, concluded that glyphosate was unlikely to pose a carcinogenic risk to humans from exposure through the diet (JMPR, 2016). Some individual countries (e.g., France, Sweden) have been moving to ban glyphosate based on the IARC decision, while other countries (e.g., Japan, Canada) have continued to support their conclusion that glyphosate is unlikely to pose a carcinogenic risk to humans.

The recent peer review performed by CARC served as an initial analysis to update the data evaluation for glyphosate at that time. Based on an evaluation of the studies included in the recent analyses by IARC, JMPR, and EFSA, the agency then became aware of additional relevant studies not available to EPA. As a result, EPA also requested information from registrants about studies that existed, but had never been submitted to the agency. The current evaluation incorporates these additional studies. In addition, the Agency conducted a systematic review of the open literature and toxicological databases for glyphosate by using a draft "Framework for Incorporating Human Epidemiologic & Incident Data in Health Risk Assessment". As such, the current evaluation also provides a more thorough evaluation than the 2015 CARC review.

1.3 Overview of Draft "Framework for Incorporating Human Epidemiologic & Incident Data in Health Risk Assessment"

In 2010, OPP developed a draft "Framework for Incorporating Human Epidemiologic & Incident Data in Health Risk Assessment" which provides the foundation for evaluating multiple lines of scientific evidence in the context of understanding of the mode of action (MOA)/adverse outcome pathway (AOP) (U.S. EPA, 2010). The draft framework, which includes two key components, problem formulation and use of the MOA/AOP pathway frameworks, was reviewed

favorably by the FIFRA SAP in 2010 (FIFRA SAP, 2010). Recently, EPA has applied this framework to the evaluation of atrazine and chlorpyrifos[4].

OPP's draft framework is consistent with updates to the World Health Organization/International Programme on Chemical Safety MOA/human relevance framework, which highlights the importance of problem formulation and the need to integrate information at different levels of biological organization (Meek *et al.*, 2014). Consistent with recommendations by the National Research Council (NRC) in its 2009 report on *Science and Decisions*, OPP's draft framework describes the importance of using problem formulation at the beginning of a complex scientific analysis. The problem formulation stage starts with planning dialogue with risk managers to identify goals for the analysis and possible risk management strategies. This initial dialogue provides the regulatory context for the scientific analysis and helps define the scope of such an analysis. The problem formulation stage also involves consideration of the available information regarding the pesticide use/usage, toxicological effects of concern, and exposure pathways and duration along with key gaps in data or scientific information. Specific to glyphosate, the scoping document prepared for Registration Review (J. Langsdale *et al.*, 2009) along with the review conducted by the CARC (CARC, 2015) represent the problem formulation analyses for the weight-of-evidence evaluation for carcinogenic potential. A summary of the US exposure profile is provided in Section 1.4 below to provide context for interpreting the various lines of evidence.

One of the key components of the agency's draft framework is the use of the MOA framework/AOP concept (Figure 1.1) as a tool for organizing and integrating information from different sources to inform the causal nature of links observed in both experimental and observational studies. Specifically, the modified Bradford Hill Criteria (Hill, 1965) are used to evaluate strength, consistency, dose response, temporal concordance and biological plausibility of multiple lines of evidence in a weight-of-evidence analysis.

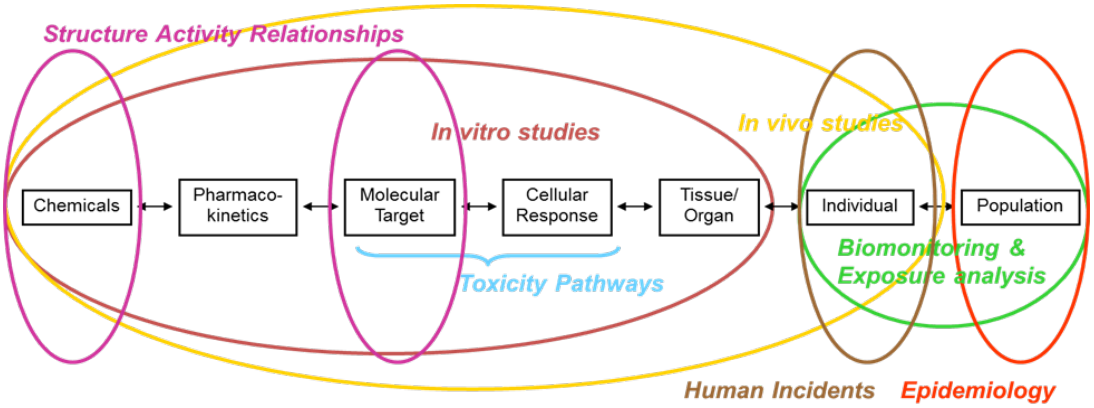

Figure 1.1. Source to outcome pathway (adapted from NRC, 2007).

[4] Chlorpyrifos Revised Human Health Risk Assessment for Registration Review; 29-DEC-2014; D424485. U.S. EPA 2010 SAP Background White Paper – Re-evaluation of Human Health Effects of Atrazine: Review of Experimental Animal and In Vitro Studies and Drinking Water Monitoring Frequency. EPA-HQ-OPP-2010-0125. U.S. EPA 2011 SAP Issue Paper – Re-evaluation of Human Health Effects of Atrazine: Review of Cancer Epidemiology, Non-cancer Experimental Animal and In Vitro Studies and Drinking Water Monitoring Frequency. EPA-HQ-OPP-2011-0399.

1.4 Summary of the Exposure Profile in the United States

All pesticide products provide critical information about how to safely and legally handle and use pesticide products. Pesticide labels are legally enforceable and all carry the statement "it is a violation of Federal law to use this product in a manner inconsistent with its labeling." In other words, the label is law. As a result, a key function of the pesticide product label is to manage the potential risk from pesticides.

Labeled uses of glyphosate include over 100 terrestrial food crops as well as other non-agricultural sites, such as greenhouses, aquatic areas, and residential areas. It is also registered for use on glyphosate-resistant (transgenic) crop varieties such as corn, soybean, canola, cotton, sugar beets, and wheat. Registered tolerances in the United States include residues of the parent compound glyphosate and *N*-acetyl-glyphosate, a metabolite found in/on glyphosate-tolerant crops[5].

Dietary (food and water) exposures are anticipated from applications to crops. Since there are registered uses of glyphosate that may be used in residential settings, residential handlers may be exposed to glyphosate during applications. Exposures may also occur from entering non-occupational areas that have been previously treated with glyphosate. Occupational/commercial workers may be exposed to glyphosate while handling the pesticide prior to application (mixing and/or loading), during application, or when entering treated sites. The agency considers all of the anticipated exposure pathways as part of their evaluation for human health.

Oral exposure is considered the primary route of concern for glyphosate. Oral absorption has been shown to be relatively low for glyphosate (~30% of administered doses) with negligible accumulation in tissues and rapid excretion (primarily unchanged parent) via the urine. Due to its low vapor pressure, inhalation exposure to glyphosate is expected to be minimal. Dermal penetration has also been shown to be relatively low for human skin (<1%) indicating dermal exposure will only contribute slightly to a systemic biological dose. Furthermore, in route-specific inhalation and dermal toxicity studies, no adverse effects were observed. This all suggests that there is low potential for a sustainable biological dose following glyphosate exposure.

In residential/non-occupational settings, children 1-2 years old are considered the most highly exposed subpopulation with oral exposures from dietary (food and water) ingestion and incidental oral ingestion (e.g., hand-to-mouth activities) in treated areas. There is also potential for dermal exposures in previously treated areas. Using HED's standard exposure assessment methodologies which are based on peer-reviewed and validated exposure data and models[6], a high-end estimate of combined exposure for children 1-2 years old is 0.47 mg/kg/day (see Appendix E).

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[5] All currently registered tolerances for residues of glyphosate can be found in the Code of Federal Regulations (40 CFR §180.364).

[6] Available: http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

At the time of initial registration (1974), total use of glyphosate in the United States was approximately 1.4 million pounds (Benbrook, 2016). In 1995, total use of glyphosate increased to approximately 40 million pounds with agriculture accounting for 70% of use. With the introduction of transgenic crop varieties in the United States circa 1996, (such as soybean, cotton, and corn) use of glyphosate increased dramatically (Green and Owen, 2011), and in 2000 the total use of glyphosate in the United States was approximately 98.5 million pounds. By 2014, total annual use of glyphosate was approximately 280-290 million pounds (based on Benbrook, 2016 and industry proprietary data accessible to EPA) with agriculture accounting for 90% of use. Although glyphosate use has continuously increased up to 2012, the stabilization of glyphosate usage in recent years is due to the increase in a number of glyphosate-resistant weed species, starting with rigid ryegrass identified in California in 1998 and currently totaling 16 different weed species in the United States as of March 2016. Figure 1.2 below provides a visual representation of the increased agricultural use of glyphosate in the United States using proprietary market research data from 1987-2014.

The increased use of glyphosate may be partly attributed to an increase in the number of farmers using glyphosate; however, it is more likely that individuals already using glyphosate increased their use and subsequent exposure. With the introduction of transgenic crop varieties, glyphosate use shifted from pre-emergent to a combination of pre- and post-emergent applications. Additionally, application rates increased in some instances and more applications were allowed per year (2-3 times/year). Maps from the United States Geological Survey (USGS) displaying glyphosate use in the United States indicate that although use has drastically increased since 1994, areas treated with glyphosate for agricultural purposes appear to be approximately the same over time (Figures 1.3-1.4). The introduction of transgenic crops in some cases led to a shift in crops grown on individual farms, such that more acreage within the farm would be dedicated to growing the glyphosate-tolerant crops replacing other crops. In addition, during the 2000s there was also an increase in growing corn for ethanol production, which could also have resulted in increased acreage dedicated glyphosate-tolerant corn.

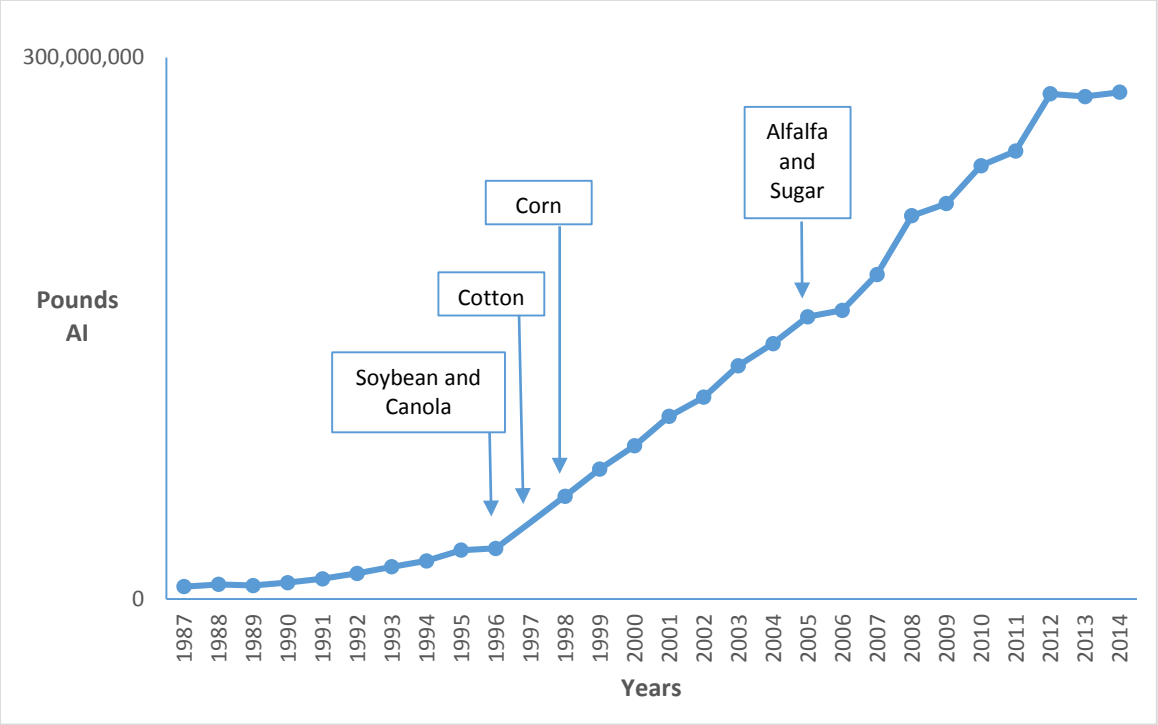

Figure 1.2. Glyphosate agricultural usage (pounds applied annually) from 1987- 2014. Boxes indicate years when glyphosate-resistant crops were introduced. Source: Proprietary Market Research Data (1987 – 2014).

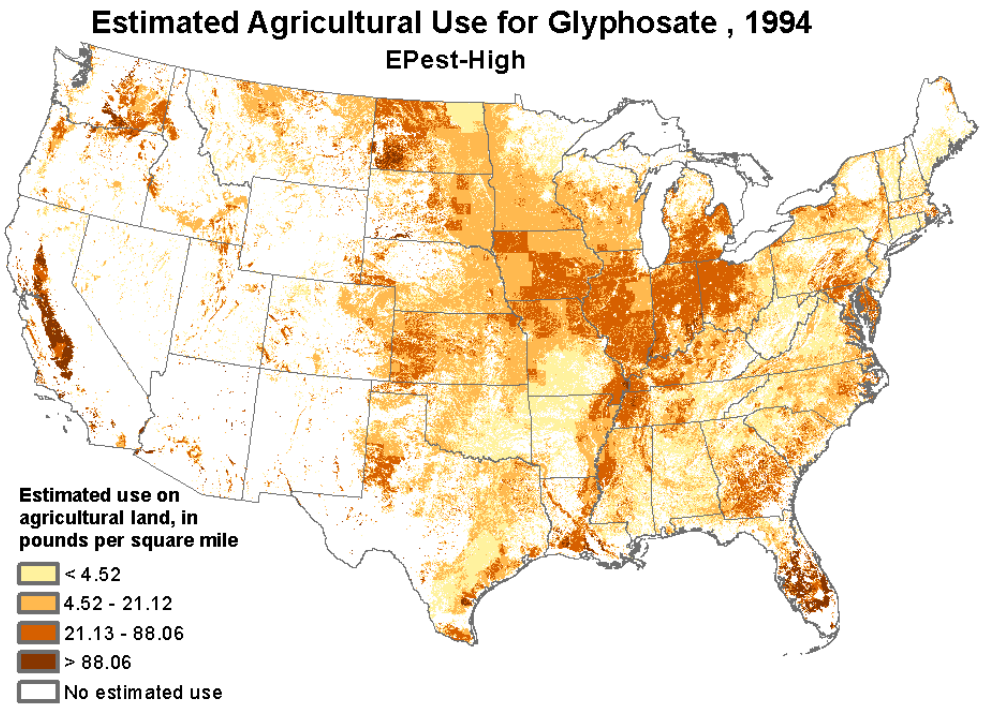

Figure 1.3. Map of estimated agricultural use for glyphosate in 1994 from USGS (http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=1994&map=GLYPHOSATE&hilo=H)

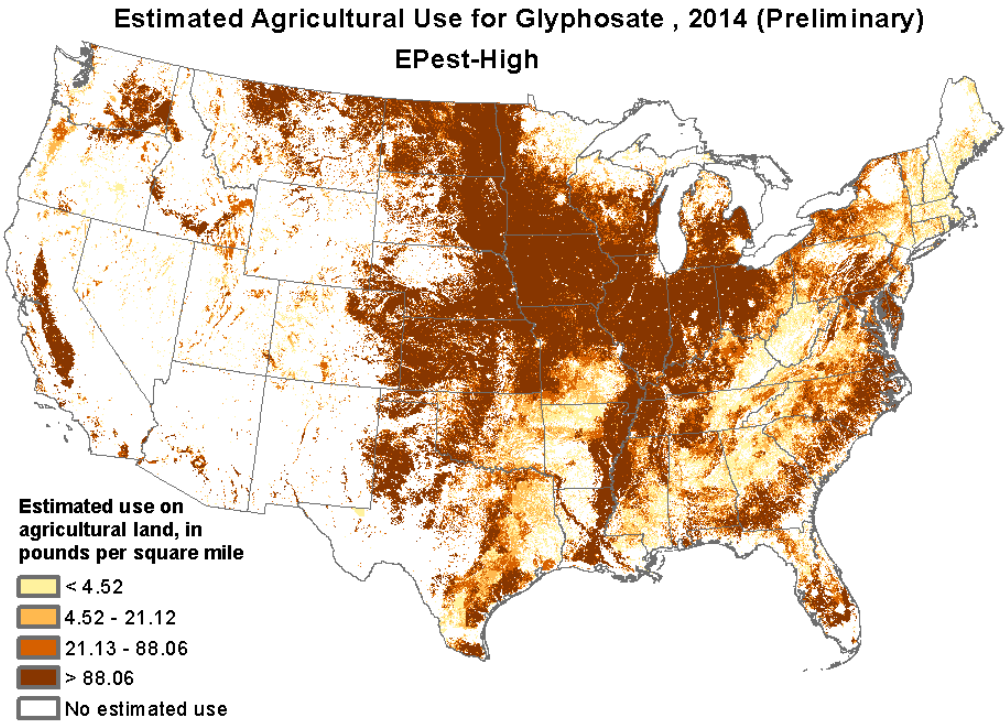

Figure 1.4. Map of estimated agricultural use for glyphosate in 2014 from USGS (http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2014&map=GLYPHOSATE&hilo=H)

The potential exposure to occupational handlers is dependent on the formulation, specific task (mixer, loader, and/or applicator), rate of application, and acreage treated. Using HED's standard occupational exposure assessment methodologies which are based on peer-reviewed and validated exposure data and models[7], mixer/loaders result in the highest potential exposure estimates. Assuming no personal protective equipment (PPE), exposure estimates for mixer/loaders range from 0.03-7 mg/kg/day using the maximum application rate for high acreage agricultural crops (6 lb ai/acre)[8]. For applicators, exposure would be lower with estimates ranging from 0.02-0.03 mg/kg/day using the same application rate and acreage.

The maximum potential exposures from currently registered uses of glyphosate in residential and occupational settings in the United States are used in the current evaluation to aid in the determination of whether findings in laboratory studies are relevant for human health risk assessment. In Sections 4.0 and 5.0, descriptions are provided for animal carcinogenicity and genotoxicity studies, respectively. Results from these studies, particularly those administering high doses, are put into context with the human exposure potential in the United States.

[7] Available: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data

[8] Based on use information provided by the Joint Glyphosate Task Force for the following end-use products: EPA Registration Nos.: 100-1182, 228-713, 524-343, 524-475, 524-537, 524-549, 524-579, 4787-23, and 62719-556.

1.5 Organization of this Document

In this analysis of the human carcinogenic potential of the active ingredient glyphosate, the agency has performed a comprehensive analysis of available data from submitted guideline studies and the open literature. This includes epidemiological, animal carcinogenicity, and genotoxicity studies. Consistent with the 2010 draft framework, the agency has evaluated these multiple lines of evidence and conducted a weight-of-evidence analysis. Although there are studies available on glyphosate-based pesticide formulations, the agency is soliciting advice from the FIFRA SAP on this evaluation of human carcinogenic potential for the active ingredient glyphosate only at this time. The remainder of this document is organized by the following:

- *Section 2.0 Systematic Review & Data Collection Methods* provides a description of methods used to compile all relevant studies used in the current evaluation.
- *Section 3.0 Data Evaluation of Epidemiology* describes the available epidemiological studies, evaluates relevant studies for study quality, and discusses reported effect estimates.
- *Section 4.0 Data Evaluation of Animal Carcinogenicity Studies* provides a description and evaluation of the available animal carcinogenicity studies for glyphosate.
- *Section 5.0 Data Evaluation of Genetic Toxicity* summarizes and discusses the various genotoxicity assays that have been tested with glyphosate.
- *Section 6.0 Data Integration & Weight of Evidence Analysis Across Multiple Lines of Evidence* integrates available data discussed in Sections 3.0-5.0 to consider concepts, such as strength, consistency, dose response, temporal concordance and biological plausibility in a weight-of-evidence analysis. This section also provides discussion of the data in the context of cancer descriptors provided in the 2005 Guidelines for Carcinogen Risk Assessment.
- *Section 7.0 Collaborative Research Plan for Glyphosate and Glyphosate Formulations* provides a discussion of planned research that is intended to evaluate the role of glyphosate in product formulations and the differences in formulation toxicity.

2.0 Systematic Review & Data Collection

In recent years, the National Academy of Sciences National Research Council (NRC) has encouraged the agency to move towards systematic review processes to enhance the transparency of scientific literature reviews that support chemical-specific risk assessments to inform regulatory decision making (NRC, 2011). The NRC defines systematic review as “a scientific investigation that focuses on a specific question and uses explicit, pre-specified scientific methods to identify, select, assess, and summarize the findings of similar but separate studies" (NRC, 2014). Consistent with NRC’s recommendations, EPA’s Office of Chemical Safety and Pollution Prevention (OCSPP) is currently developing systematic review policies and procedures. In short, OCSPP employs “fit for purpose” systematic reviews that rely on standard methods for ***collecting, evaluating, and integrating*** the scientific data supporting the agency’s decisions. The concept of fit for purpose implies that a particular activity or method is suitable for its intended use. Inherent in this definition is the concept that one size does not fit all situations and thus flexibility is allowed. However, it is notable that with flexibility comes the

importance of transparency of documented processes; including the importance of transparency and clarity in approaches to data collection, evaluation, and integration. These are described throughout the document with data collection in Sections 2.1.1-2.1.2, evaluation in Sections 3-5, and integration in Section 6.

As a result, more recent evaluations are starting to reflect this progression in the agency's process. Similar to the draft framework for incorporating human epidemiologic and incident data, systematic review begins with a problem formulation to determine the scope and purpose of the search. Studies are considered based on their relevance to answer specific questions and those studies deemed relevant are then further considered for their usefulness in risk assessment.

The agency strives to use high-quality studies when evaluating the hazard potential of pesticidal chemicals and considers a broad set of data during this process. This includes registrant generated studies required under FIFRA, as well as peer-reviewed scientific journals and other sources, such as other governments and academia. A wide range of potential adverse effects are assessed using acute, subchronic, chronic, and route-specific studies; predominately from studies with laboratory animals, in addition to epidemiologic and human incident data. All studies are thoroughly reviewed to ensure appropriate conduct and methodologies are utilized, and that sufficient data and details are provided. In this way, hazards are identified and potential risks characterized to ensure that decisions are informed by the best science available.

2.1 Data Collection: Methods & Sources

Data were collected by searching the open literature (Section 2.1.1) and other publicly available sources (e.g., recent internal reviews, evaluations by other organizations) (Section 2.1.2). Internal databases were also searched for submitted studies conducted according to Organization for Economic Cooperation and Development (OECD) test guidelines, OCSPP harmonized test guidelines, and other pesticide test guidelines (OPP guidelines) (Section 2.1.2).

It should be noted that glyphosate is primarily manufactured as various salts with cations, such as isopropylamine, ammonium, or sodium. These salts are derivatives of the active substance glyphosate and increase the solubility of technical-grade glyphosate acid in water. All of these forms were considered for the current evaluation.

2.1.1 Open Literature Search

As part of the evaluation of the human carcinogenic potential of glyphosate, the literature review described here uses concepts consistent with fit for purpose systematic review, such as detailed tracking of search terms and which literature have been included or excluded. The primary goal of the literature search was to identify relevant and appropriate open literature studies that had the potential to inform the agency on the <u>human</u> carcinogenic potential of glyphosate. Therefore, non-mammalian studies were not considered, and several terms were used in the search string in an attempt to exclude non-mammalian studies.

To obtain literature studies, OPP worked with EPA librarians to conduct searches in PubMed, Web of Science, and Science Direct. A search was conducted on May 6, 2016 in PubMed and Web of Science using the following search string to yield 141 and 225 results, respectively:

((glyphosate OR "1071-83-6" OR roundup OR "N-(Phosphonomethyl)glycine") AND (aneuploid* OR chromosom* OR clastogenic* OR "DNA damag*" OR "DNA adduct*" OR genome* OR genotoxic* OR micronucle* OR cancer* OR carcinogen* OR oncogenic* OR mutagen* OR cytotoxic* OR tumor* OR tumour* OR malignanc* OR neoplasm* OR *oma)) NOT (fish* OR frog* OR tadpole* OR insect* OR eco* OR amphibian* OR reptil* OR invertebrate* OR fly OR flies OR aquatic OR bird* OR aqueous OR water OR yeast* OR worm* OR earthworm* OR bacteria* OR lichen OR resist* OR "herbicide resist")

Due to differences with using Science Direct, the search string was slightly changed. This search was also conducted on May 6, 2016 and yielded 459 results:

((glyphosate OR "1071-83-6" OR roundup OR "N-(Phosphonomethyl)glycine") AND (aneuploid* OR chromosom* OR clastogenic* OR (DNA pre/2 (damag* OR adduct*)) OR genome* OR genotoxic* OR micronucle* OR cancer* OR carcinogen* OR oncogenic* OR mutagen* OR cytotoxic* OR tumor* OR tumour* OR malignanc* OR neoplasm* OR *oma)) AND NOT (eco* OR fish* OR frog* OR tadpole* OR invertebrate* OR bird* OR insect* OR fly OR flies OR amphibian* OR reptil* OR yeast* OR aquatic OR aqueous OR water OR worm* OR earthworm* OR bacteria* OR lichen OR resist* OR "herbicide resist”)

After cross-referencing the results obtained from the three open literature searches for duplicates, a total of 735 individual articles were obtained (Appendix A) and one additional study (Alvarez-Moya et al., 2014) not identified in the search was added to this list for a total of 736 individual articles. All of the studies were evaluated to determine if the study would be considered relevant to the issue of concern (i.e., human carcinogenic potential of glyphosate). Many of the articles were not considered to be within the scope of the search or not considered relevant in general (658 articles). Additionally, 27 articles were not appropriate due to the type of article (i.e., correspondence, abstract only, not available in English, retraction). Of the 51relevant articles, 42 were used in the current evaluation (31 genotoxicity, 9 epidemiological, and 2 animal carcinogenicity). Three articles also reported on the potential of glyphosate and its metabolites to be developed into therapeutic drugs for cancer treatment. The remaining 6 articles evaluated effects on glyphosate or glyphosate formulations on cellular processes, mostly focusing on epidermal cells, and were not considered informative for the current evaluation.

2.1.2 Studies Submitted to the Agency

For all pesticides, there are toxicology data requirements that must be submitted to the agency for registration. These studies, defined under the 40 CFR Part 158 Toxicology Data Requirements, provide information on a wide range of adverse health outcomes, routes of exposure, exposure durations, species, and lifestages. They typically follow OECD, OCSPP, or OPP accepted protocols and guidelines, which ease comparisons across studies and chemicals. The toxicological databases for glyphosate[9] were reviewed and all relevant animal, genotoxicity, and metabolism studies were collected for consideration.

[9] Glyphosate pesticide chemical (PC) codes: 103601, 103603, 103604, 103605, 103607, 103608, 103613, 128501, and 417300.

Several resources were used to ensure all relevant studies were included in the current evaluation. The list of studies obtained from the toxicological database and the open literature search were cross-referenced with recent internal reviews (CARC, 2015; S. Recore *et al.*, 2014). This list was also cross-referenced with review articles from the open literature [Chang and Delzell (2016), Greim et al. (2015), Kier and Kirkland (2013), Kier (2015), Mink *et al.* (2012), Schinasi and Leon (2014), and Williams *et al.* (2000)][10]. EPA requested studies from registrants that were not previously available to the EPA. As a result, numerous studies were subsequently submitted to the agency. Study reports for one animal carcinogenicity study and 17 genotoxicity studies, were not available to the agency and have been noted in the relevant sections below. For these studies, data and study summaries provided in Greim et al. (2015) and Kier and Kirkland (2013) were relied upon for the current evaluation.

2.2 Evaluation of Relevant Studies

Studies submitted to the agency are evaluating based on OECD, OCSPP, or OPP test guideline requirements to determine whether studies are acceptable for use in risk assessment. In the current evaluation, animal carcinogenicity, genotoxicity, and metabolism studies located in the internal databases with access to full study reports were evaluated in this manner. Those classified as unacceptable were noted and subsequently excluded from the current evaluation.

In order to evaluate open literature studies, criteria described in the OPP guidance for considering and using open literature toxicity studies to support human health risk assessment was utilized (U.S. EPA, 2012). This guidance assists OPP scientists in their judgement of the scientific quality of open literature publications. More specifically, the document discusses how to screen open literature studies for journal articles/publications that are relevant to risk assessment, how to review potentially useful journal articles/publications and categorize them as to their usefulness in risk assessment, and how the studies may be used in the risk assessment. As with submitted studies, those deemed unacceptable were noted and subsequently excluded from the current evaluation.

3.0 Data Evaluation of Epidemiology

3.1 Introduction

Epidemiological studies are valuable for risk assessment since they may provide direct evidence on whether human exposure to a chemical may cause cancer. Studies of high quality and adequate statistical power are preferable and remove the need to account for extrapolation from animals to humans or extrapolation from high to low doses. Epidemiological studies can also be integrated with experimental evidence when determining or clarifying the carcinogenic potential of a chemical for risk assessment. The key considerations in evaluating epidemiologic studies are study design, exposure assessment, outcome assessment, confounding control, statistical analyses, and risk of other bias.

[10] All review articles, except Schinasi and Leon (2014), were funded and/or linked to Monsanto Co. or other registrants.

OPP routinely evaluates the available epidemiological literature. As part of Registration Review of glyphosate, an evaluation was initially conducted in 2014 (S. Recore *et al.*, 2014) and subsequently another evaluation was performed in 2015 (CARC, 2015). The 2015 evaluation began with the epidemiological studies previously identified in the 2014 evaluation and included three additional studies that were not included in the 2014 evaluation. These studies were identified in review articles, included in the evaluation by IARC (2015), or were published since the 2014 OPP evaluation. Both the 2014 and 2015 OPP evaluations considered the design and overall quality of the epidemiological studies; however, formal study quality evaluations and rankings were not conducted. In the current review, all of the studies in the 2015 report, as well as additional epidemiological articles identified from a comprehensive search and cross-referencing with available resources as described under Section 2.0, were considered in the current evaluation, which totaled 58 epidemiological studies. The following sections provide a description of how epidemiological studies were evaluated for study quality and subsequent overall rankings, a summary of relevant studies, and a discussion of the overall results.

3.2 Considerations for Study Quality Evaluation and Scope of Assessment

This section summarizes how specific study characteristics were factored into the determination of a study's overall quality category. It should be noted that these study quality considerations are specific to the issue of concern (i.e., carcinogenic potential of glyphosate). These considerations are considered 'fit-for-purpose' under this context and could differ in another regulatory or scientific context. Although the basic concepts apply broadly, the study quality considerations are tailored specifically to studies investigating the association between glyphosate exposure and cancer outcomes. As with all research studies, the design elements of an epidemiological study have potential impacts on study quality and relevance to the research question under investigation. Each study was, therefore, judged to be of high, moderate, or low quality in each of the following six domains affecting study quality: study design, exposure assessment, outcome assessment, confounder control, statistical analysis, and susceptibility to bias (See Section 3.2.1 for general considerations under each domain). A similar approach was recently used by OPP for the evaluation of epidemiological studies for organophosphate pesticides (A. Lowit *et al.*, 2015).

Primary literature and associated meta-analyses evaluating the association between glyphosate exposure and a cancer outcome were the focus of this analysis. Reviews were only used to identify individual studies that should be considered for study evaluation. Commentaries, correspondence, and letters to the editor without original data were excluded. Of the relevant studies identified, studies with the most complete analyses utilizing the greatest number of cases and controls (e.g., pooled case-control studies) were evaluated for ranking (see Appendix B for visual representation of these studies). If studies did not collect exposure information on glyphosate from individual subjects, did not assess an outcome (e.g., biomonitoring studies), and/or did not provide a quantitative measure of an association between glyphosate and a cancer outcome, then these studies were assigned a low quality ranking and were not further evaluated in detail (see Figure 3.1). A similar process was used by JMPR for their identification of epidemiological studies for evaluating the carcinogenic potential of glyphosate and two other pesticides (JMPR, 2016).

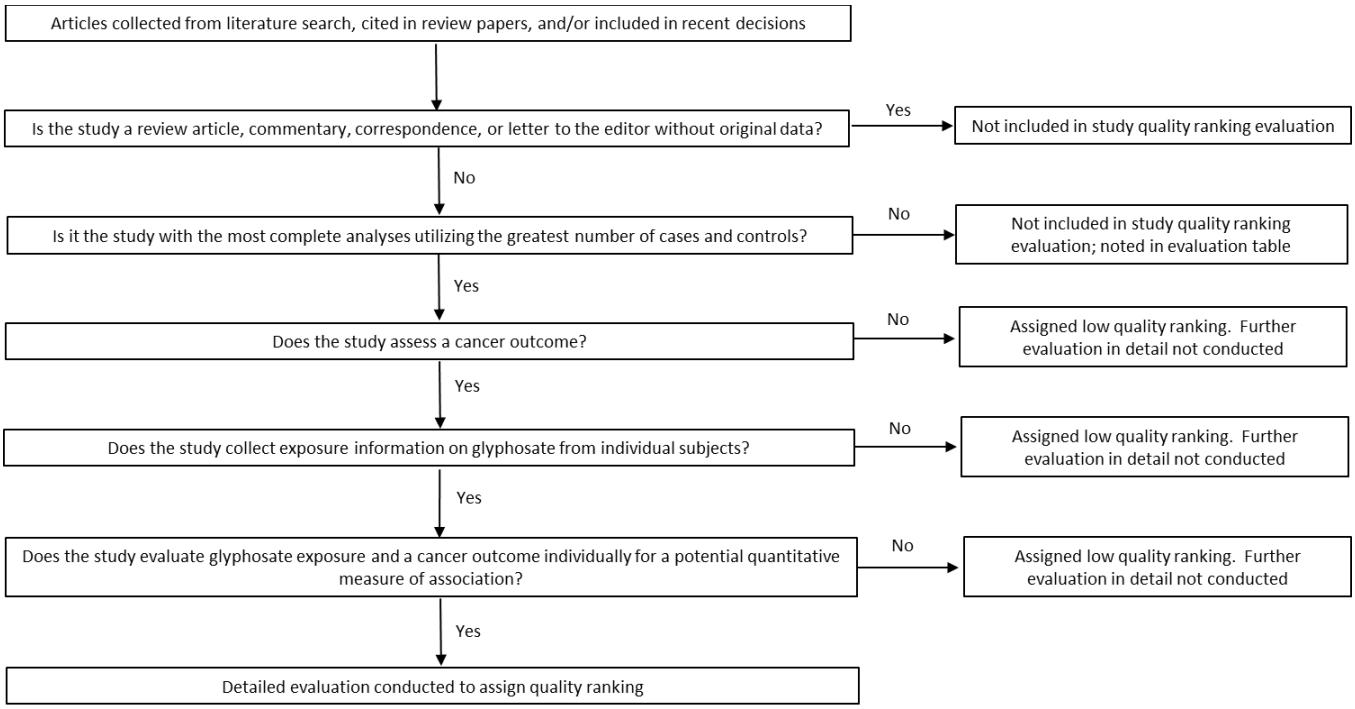

Figure 3.1. Study evaluation process for epidemiological studies.

3.2.1 Study Designs

In judging an individual study's contribution to the strength of evidence in the epidemiologic literature base, the following general hierarchy of observational study designs was considered (from most to least preferred): prospective cohort study (including nested case-control studies), case-control study, and cross-sectional study. It is important to note, however, that this hierarchy of study designs reflects the *potential* for the collection of high quality information (related to exposure, outcome, confounders, and effect modifiers) and *potential* for efficient and valid estimation of the true association. Thus, in deliberating on quality, care has been taken to consider the circumstances and particulars of each individual study to consider whether the study was well conducted independent of the type of study design.

The study designs used in the epidemiological literature reviewed were analytical and descriptive studies. Cohort and case-control study designs are analytical studies used to evaluate relative incidence of health and disease outcomes by exposure status. Cross-sectional and ecological studies are generally considered descriptive or hypothesis-generating study designs; however, they can also be used to test hypotheses regarding prevalence of health outcomes and, under certain conditions, incidence as well.

Table 3.1. Epidemiological Study Quality Considerations[a].

Parameter	High Score	Moderate Score	Low Score
Study Design	Cohort	Case-control	Cross-sectional/Ecological

Table 3.1. Epidemiological Study Quality Considerations[a].			
Parameter	**High Score**	**Moderate Score**	**Low Score**
Exposure Assessment	Questionnaire and/or interview answered by subjects for chemical-specific exposure	Questionnaire and/or interview for chemical-specific exposure answered by subjects or proxy individuals	Low-quality questionnaire and/or interview; information collected for groups of chemicals rather than chemical-specific; no chemical-specific exposure information collected; ever/never use of pesticides in general evaluated
Outcome Assessment	State or National registries, physicians, and/or special surveillance programs with cases verified by histopathological evaluation for tumors; appropriate consideration of prevalent vs. incident cases; analysis by valid method specific for biomarkers	State or National registries, physicians, and/or special surveillance programs without histopathological verification for tumors; analysis by assays that are less specific for biomarkers of interest	No outcome evaluated; unclear/no consideration for whether prevalent or incident cases are appropriate; biomarker methods not validated
Confounder Control	Good control for important confounders related to cancer, standard confounders, and known confounders for glyphosate and cancer outcomes (e.g., exposure to multiple pesticides) through study design or analytic control with well measured co-exposures (i.e., cumulative exposure)	Moderately good control for confounders related to cancer; standard variables accounted for and; attempt to control for known confounders via a less efficient measure of co-exposure (e.g., ever/never use)	No adjustments for confounders
Statistical Analyses	Appropriate to study question and design, supported by relatively adequate sample size, maximal use of data, reported well	Acceptable methods, lower/questionable study power	Minimal attention to statistical analyses, sample size evidently low, comparison not performed or described clearly
Risk of (Other) Bias	Major sources of other potential biases not likely present, present but analyzed, unlikely to influence magnitude and direction of effect estimate, no/low potential of selection bias	Other sources of bias present, acknowledged but not addressed in study, may influence magnitude but not direction of estimate, evidence of potential selection bias with low impact on effect estimate	Major study biases present, unacknowledged or unaddressed in study, cannot exclude other explanation for study findings, evidence of selection bias with high potential to impact effect estimate

[a] Overall study quality ranking based on comprehensive assessment across the parameters.

3.2.1.1 Analytical Studies

(1) Cohort Study

In a typical cohort study, such as the Agricultural Health Study (AHS), individuals are classified according to exposure status (i.e., presence, absence, or magnitude of exposure) and then followed over time to quantify and compare the development (i.e., incidence) of the health outcome of interest by exposure group. Conceptually, the non-exposed comparison group in a cohort study provides an estimate of the incidence of the outcome among the exposed, had they, counter-to-fact, not been exposed. Apart from chance variations, a valid cohort study comparing exposed individuals to non-exposed individuals provides an estimate of the relative risk (or rate) of the disease associated with exposure. Ideally, the exposed and non-exposed groups are exchangeable, in the sense that switching the exposed to non-exposed, and non-exposed to exposed would yield the same measure of association (e.g., relative risk). If this were the case then, apart from chance, a cohort study would yield a measure of association equivalent to that produced in a corresponding (intervention) study where exposure status was randomly assigned.

The chief advantage of the cohort study design is that it affords the investigator the opportunity to avoid and/or adjust for potential biases (i.e., selection bias, information bias, and confounding); however, these biases may also be avoided in other well-designed study designs, such as a case-control study. Cohort studies also allow for discernment of the chronological relationship between exposure and outcome, and can be particularly efficient for studying uncommon exposures. The primary disadvantage of the cohort study design is logistical inefficiency with respect to the necessary time, expense, and other resources needed to conduct them. Cohort studies are particularly inefficient for evaluating associations with rare outcomes and diseases with long induction or latency periods. Case-control studies that are nested within a cohort study (nested case-control studies) share the attributes of the cohort study and may be more efficient. However, when follow-up throughout the study period is incomplete, the potential for selection bias is increased, especially if follow-up rates are related to exposure status.

Two sub-categories of cohort studies – prospective and retrospective – are often applied to distinguish between studies in which the health outcome has occurred (retrospective study), or has not occurred (prospective study) at the time the investigators initiate the study. This distinction is important primarily as it pertains to the potential differences in the quality (e.g., completeness, accuracy, and precision) of information that can be ascertained by the investigators, and also as it relates to potential sources of bias. Although not always true, the prospective study design is considered the preferable of the two, as investigators can potentially have more choices in determining how exposure, outcome, and covariate information is collected. In a retrospective study conducted to evaluate the same hypothesis, by contrast, the investigators would have to rely on exposure information based on self-reporting or historical records. Such reporting is subject to (human) errors in recall, however when such errors are uncorrelated with disease state, there can be a bias towards the null due to random exposure measurement error (information bias) and only when such errors are correlated with the disease state can there be bias away from the null.

(2) Case-Control Study

In a typical case-control study, individuals are classified according to their outcome status (i.e., cases who have developed the outcome of interest, and controls who represent the population

from which the cases arise). The relative odds of exposure are then compared between cases and controls. The primary advantage of case-control studies is that they are logistically efficient relative to cohort studies, often being conducted at a fraction of the cost and in a fraction of the time as a corresponding cohort study. Case-control studies can be used to examine associations between multiple exposures and a given health outcome. They are particularly efficient for evaluating rare outcomes, but are inefficient for studying uncommon exposures. An important point to evaluate in each case-control study is the potential for selection bias, which arises if the exposure distribution among the control subjects is not representative of the exposure distribution among the population that gave rise to the cases. When participation rates between cases and controls are low or distinctly imbalanced, the potential for selection bias is increased, especially if participation rates are related to exposure status. Case-control studies that rely on self-reported exposure measures are also potentially susceptible to information bias which could result in bias towards the null or away from the null.

3.2.1.2 Descriptive Studies

Cross-sectional studies are used to evaluate associations between exposure and outcome prevalence in a population at a single point in (or period of) time. The primary advantage of a cross-sectional study is logistical efficiency. They are relatively quick and inexpensive to conduct, as a long period of follow-up is not required, and exposure and outcome assessments occur simultaneously. Cross-sectional studies have three primary *potential* disadvantages: 1) potential difficulty in discerning the temporal relationships (i.e., whether the exposure precedes the outcome); 2) estimating outcome prevalence rather than incidence of the outcome; and 3) the possible overrepresentation of cases of the outcome with long duration relative to the average in the population, and often with a better prognosis.

Ecological studies are used to evaluate associations between exposures and outcomes using population-level rather than individual-level data. The primary advantages of ecological studies are related to logistical efficiency, as they often rely on pre-existing data sources and require no individual-level exposure, outcome, or covariate assessments. The primary weakness of the ecologic study is the potential for confounding and resultant inappropriate extrapolation of associations observed on the aggregate-level to associations on an individual level. The discrepancy that associations observed at the population level are not observed at the individual level is referred to as the ecological fallacy. Semi-ecological studies are less susceptible to the ecological fallacy due to incorporation of individual-level data on outcomes and/or confounders. The quality of these studies depends on the ability of the group exposure data to represent individual exposure and the research question of interest.

3.2.2 Exposure Measures

As described in Section 3.2 and Figure 3.1, studies assigned a low quality ranking based on an initial evaluation were not further evaluated in detail. In all of the studies included in the analysis that were reviewed and ranked for study quality, exposure information was collected from subjects and/or proxy individuals via questionnaires and/or interviews. These exposure assessments typically include questions to determine the amount of direct pesticide use or to collect information on behaviors and conditions associated with pesticide use (e.g., occupation, tasks). This type of reporting likely misclassifies actual pesticide exposure. If conducted as part

of a prospective exposure assessment, these errors are likely to be non-differential with respect to the outcome(s) of interest. In a retrospective assessment, the subject or proxy has knowledge of the outcome; therefore, these errors may be differential or non-differential. Studies that exclusively used subjects rather than including proxy individuals were considered more reliable and given a higher weight given that the subjects would have a more accurate recollection of their own exposure.

3.2.3 Outcome Measures

All of the studies evaluated in detail, except one, utilized state or national cancer registries, physicians, and/or special surveillance programs to determine outcome status (i.e., subjects with or without a cancer of interest). In several studies, the cases were also verified by histopathological evaluation. Overall, outcome measures were relatively consistent across studies and these assessments are likely to have minimal errors. The remaining study evaluated in detail (Koureas et al., 2014) assessed oxidative DNA damage rather than a type of cancer. For this evaluation, the oxidation by-product 8-hydroxydeoxyguanosine (8-OHdG) was measured by enzyme immunoassay. This type of assay generally exhibits low specificity. More sensitive quantitative methods are available to analyze genomic DNA for 8-OHdG by high-performance liquid chromatography (HPLC) with electrochemical detection, gas chromatography-mass spectrometry (GC-MS), and HPLC tandem mass spectrometry. Consideration of incident or prevalent cases should also be carried out. By using only incident cases, there is greater confidence that exposures occurred prior to the development of the outcomes. Inclusion of prevalent cases can lead to an over-representation of cases with a long course of disease.

3.2.4 Confounding

The degree to which confounders were controlled varied across studies. Some studies adjusted for particular medical variables, while others did not. Some standard variables, such as age, geographical location, and sex, were either adjusted for analytically or by matching in case-control studies. Several studies collected information on potential confounders; however, not all of these variables were evaluated or results of the evaluation were not reported. The direction and magnitude for confounders are, in general, difficult to determine because they are dependent upon the relationship of each confounding factor with glyphosate and the cancer under investigation. Several studies considered the potential for confounding from co-exposure to other pesticides; however, only a few reported effect estimates between glyphosate exposure and cancer risk adjusted for the use of other pesticides. Given most people in the epidemiological studies who use pesticides occupationally will be exposed to multiple pesticides and, in some instances, those other pesticides were observed to be risk factors for the same cancer, this is a particularly important concern to address in either the study design or in the statistical analyses. Across numerous studies, co-exposures to other pesticides was found to be positively correlated with exposure to glyphosate and exposure to those other pesticides appear to increase the risk of some cancers. As a result, the direction of confounding would be to inflate any true effect of glyphosate in the absence of statistical control. This underlines the importance of controlling for co-exposures to other pesticides.

For NHL, other potential confounders, such as exposure to diesel exhaust fumes, solvents, ultraviolet radiation, livestock, and viruses, have been identified. Some of these are more

plausible than others. For example, occupational exposure to diesel exhaust fumes (e.g., McDuffie et al., 2002; Karunanayake et al. 2008; Baris et al. 2001; Maizlish et al. 1998) and solvents (Wang et al., 2009; Kato et al., 2005; Olsson and Brandt, 1988) are considered likely to increase the risk of NHL. Agricultural workers are exposed to diesel fumes when using agricultural vehicles when applying pesticides, such as glyphosate, and when using heavy equipment during mixing, loading, and/or applying pesticides. Agricultural workers are also exposed to solvents. Solvents are often used in pesticide products to aid the delivery of the active ingredient and enhance efficacy. Solvents are also used for cleaning and maintenance/repair of agricultural equipment used for mixing, loading, and/or applying pesticides. With an association between exposure and outcome of interest, it is reasonable to consider diesel exhaust fumes and solvents as probable confounders; however, neither of these factors were accounted for in any of the studies evaluated in detail. There is also evidence that ultraviolet (UV) radiation may increase the risk of NHL (Karipidis et al., 2007; Zhang et al., 2007). As a result, there is a support that UV radiation is also a potential confounder given the extended amount of time agricultural workers spend outside performing activities, including those associated with pesticide use. This was also not accounted for in any of the studies evaluated in detail.

3.2.5 Statistical Analyses

Statistical analyses that were appropriate to the study question and study design, supported by adequate sample size, maximized the use of available data, and were well characterized in the report were weighted most highly. Acceptable statistical methods, questionable study power, and analytical choices that resulted in the loss of information were given moderate weight. Reports with only minimal attention paid to the conduct and reporting of the statistical analyses were given the lowest weight.

3.2.6 Risk of Bias

The internal validity of the studies reviewed was judged by noting the design strategies and analytic methods used in each study to constrain or eliminate selection bias, information bias, and confounding. Selection bias can occur when the sampling of the population by the investigator yields a study population that is not representative of the exposure and outcome distributions in the population sampled. Put simply, selection bias occurs if selection of the study sample yields a different estimate of the measure of association than that which would have been obtained had the entire target population been evaluated. Although there are numerous sources of selection bias, there are several mechanisms that may have induced selection bias in the studies reviewed: low participation rates of eligible individuals due to non-responsiveness or refusal (self-selection bias); loss to follow-up (i.e., failure to retain all study participants initially enrolled in the study); and, in a case-control study, control selection bias arising because the exposure distribution in the control sample does not represent the exposure distribution of the study base (i.e., the population that gave rise to the cases or more formally, the person-time experience of that population).

Information bias (also referred to as observation bias) arises when study participants are incorrectly categorized with respect to their exposure or outcome status, or when errors arise in the measurement of exposure or outcome, in the case of continuously distributed measures.

Epidemiologists often distinguish between two mechanisms or types of misclassification – those that are non-differential (or random) and those that are differential (non-random). Non-differential misclassification of exposure (or non-differential exposure measurement error) occurs when the probability or magnitude of error in the classification or measurement of exposure is independent of the outcome status of the study participants. Non-differential exposure measurement error typically results in a bias towards the null which may obscure any true effect of the exposure of interest. Similarly, non-differential misclassification of outcome (or outcome measurement error) occurs when the probability or magnitude of error in the assignment of outcome status or level is independent of exposure status. Non-differential outcome measurement error typically does not cause bias but does decrease the precision of effect estimates and therein inflates the width of confidence intervals. In contrast, differential exposure misclassification (or measurement error) occurs when the error in the exposure assignment is not independent of the outcome status. The mechanisms that cause non-differential misclassification in the currently reviewed literature include random errors in exposure recall from subjects or proxy respondents. The mechanisms that could induce differential misclassification include recall bias and interviewer/observer bias. Note that mismeasurement of confounders can result in residual confounding of the association of interest, even when adjustment for that confounder has been conducted in the analysis.

Studies in which major sources of potential biases were not likely to be present, studies in which potential sources of bias were present, but effectively addressed and analyzed to maximize the study validity, and studies in which sources of bias were unlikely to influence the magnitude and direction of the effect estimate were given more weight than studies where sources of bias may be present, but not addressed in the study.

3.3 Review of Quality Results

Each study was judged to be of high, moderate, or low quality in each of the six domains affecting study quality, as discussed above and in Table 3.1. The results of the quality assessment are presented separately for each group below. The quality rankings presented are specific to the current evaluation of the carcinogenic potential of glyphosate. As noted above and in Table 3.2, several studies were not included in the ranking evaluation because they did not represent the most complete analysis. Rather, the subjects were included in a larger analysis (e.g., pooled case-control study) to produce a greater number of cases and controls (see Appendix B for visual representation of these studies). For example, Cantor *et al.* (1992) was not individually evaluated for ranking because the data from this study were pooled with data from other studies in De Roos *et al.* (2003), which was included.

3.3.1 "High" Quality Group

Three studies were given a high quality ranking: De Roos *et al.* (2005), Eriksson *et al.* (2008), and Koutros *et al.* (2013).

De Roos *et al.* (2005) was the only cohort study available for ranking. This prospective cohort study evaluated associations between various pesticide exposures, including glyphosate, and cancer incidence for numerous solid and non-solid tumors in the AHS. The aim of the AHS is to evaluate the role of agricultural exposures in the development of cancer and other diseases in the

farming community. AHS recruited 52,934 licensed private pesticide applicators along with 32,345 of their spouses between 1993 and 1997. In the first two phases of the study, the cohort also included 4,916 commercial pesticide applicators from Iowa. As a prospective analysis of the AHS cohort, information was obtained from exposed subjects at enrollment and no proxies were necessary. Exposure was evaluated as ever/never use, cumulative lifetime exposure, and intensity-weighted cumulative exposure. Due to the study design, the potential for many biases were reduced. Additionally, the study adjusted and/or considered numerous factors, including use of other pesticides. Study participants provided detailed pesticide exposure information prior to enrollment in the study and this information has been incorporated into the study evaluation by determining tertile cut points and calculating effect estimates by comparing to the lowest tertile. Additional evaluations with quartiles and quintiles were performed for cancers with elevated effect estimates in the study and for NHL.

Eriksson *et al.* (2008) was a population-based case-control study that recruited a consecutive series of incident cases of NHL in several regions of Sweden from physicians treating lymphoma within specified health service areas. Cases were verified pathologically and matched to randomly selected controls from the national population registry by age, sex and health service area. Exposure information was collected from exposed individuals (i.e., no use of proxy respondents) using a comprehensive questionnaire including a total work history with in depth questions about exposures to pesticides, solvents, and other chemicals. Interviewers were blinded to case/control status. The study only reported minimal demographic information on subjects (age and sex) and a table with subject characteristics (e.g., smoking status, alcohol intake, physical activity, education) that could potentially be used to adjust effect estimates was not provided. Glyphosate exposure was reported in 29 cases and 18 controls during the study period. Multivariate analyses were adjusted for co-exposure to different agents, including MCPA, “2,4,5-Y and/or 2,4-D”, mercurial seed dressing, arsenic, creosote, and tar. An analysis for a potential exposure-response relationship was also conducted; however, it was not clear whether this analysis controlled for co-exposure to other pesticides based on the statistical methods description. The number of cases and controls were also not reported for this analysis.

Koutros *et al.* (2013) was a nested case-control study within the AHS that evaluated the association between pesticide use and prostate cancer. Exposure information was collected from exposed subjects (no proxies necessary) through the enrollment questionnaires, as well as in a follow-up questionnaire administered 5 years after enrollment. This study evaluated the association between glyphosate and prostate cancer diagnoses from enrollment (1993-1997) through 2007 resulting in a longer follow-up time than many of the other case-control studies that utilized AHS subjects. The study used lifetime cumulative exposure and intensity-weighted cumulative exposure metrics. Analyses were also conducted using unlagged exposure and 15-year lagged exposure, which excluded the most recent 15 years of exposure for both exposure metrics. Although the effect estimate reported for glyphosate in this study was not adjusted for co-exposure to other pesticides, additional analyses were not considered necessary since there was no association observed.

3.3.2 “Moderate” Quality Group

Twenty-one case-control studies were assigned a moderate quality rating (Table 3.2). In general, these studies share many study design characteristics. Exposure information was collected from subjects and/or proxy individuals, the outcome measurement(s) utilized state/national registries and surveillance programs, appropriate statistical analyses were performed, some covariates but maybe not all relevant covariates were evaluated and/or considered, and risks of bias were minimized to some extent. Sample sizes varied across studies. Case-control studies investigating solid tumors included study populations in the United States and Canada. For non-solid tumors, study populations were located in the United States, Canada, Sweden, France, Germany, Italy, Ireland, Spain, and the Czech Republic. Although several nested case-control studies shared most of the characteristics of the AHS cohort study, these studies were primarily given a moderate quality ranking since co-exposure to other pesticides was not accounted for in the analyses.

3.3.3 "Low" Quality Group

Seven case-control and 27 cross-sectional/ecological studies were assigned a low quality ranking. All of these studies, except one case-control study (Cocco *et al.*, 2013) and one descriptive study (Koureas et al., 2014), were not subjected to a detailed evaluation because they did not report a quantitative measure of an association between glyphosate exposure and a cancer outcome, did not collect information on glyphosate exposure from all subjects, and/or did not evaluate risk to a cancer outcome (Appendix D). In many instances, effect estimates were reported only for total pesticide exposure. Additionally, exposure was assumed and glyphosate-specific exposure information was not collected. In other studies, the aim of the study was to assess exposure methods for epidemiological studies and/or to evaluate the impact of exposure misclassification; therefore, there was no evaluation of a cancer outcome.

It should be noted that some of the studies assigned a low quality ranking in the current evaluation were included in the recent evaluation by IARC. There were a number of descriptive studies that evaluated the genotoxicity in human populations; however, these studies did not meet the criteria for inclusion in the ranking as described in Section 3.2 and Figure 3.1. In most instances, these studies reported effect estimates for total pesticide exposure and/or assumed glyphosate exposure without collecting glyphosate-specific exposure information. For case-control studies, Cocco et al. (2013), Dennis et al. (2010) and Ruder et al. (2004) were included in the 2015 IARC evaluation, but were not considered informative in the current evaluation.

Detailed evaluations were not performed in the current evaluation for Dennis et al. (2010) and Ruder et al. (2004) because a quantitative measure of an association between glyphosate and a cancer outcome was not reported. Cocco et al. (2013) received a detailed evaluation and was assigned a low quality ranking. This case-control study, which evaluated lymphoma risk across six European countries, was not considered informative due to a combination of numerous limitations in the study. The power of the study was low with only four cases and two controls exposed to glyphosate. Control ascertainment was not consistent across countries, with a mix of hospital- and population-based controls used. The overall participation rate for population-based controls was found to be much lower than the overall participation rates of the cases or hospital-based controls. Lastly, the study was limited to ever/never use of glyphosate and did not control for confounders, in particular exposure to other pesticides. Although this study was included in

the IARC evaluation, IARC also stated that the study had very limited power to assess the effects of glyphosate on risk of NHL.

The other study subjected to a detailed evaluation and assigned a low quality ranking was Koureas *et al*. (2014). This cross-sectional study evaluated the association between glyphosate exposure and oxidative DNA damage in 80 Greek pesticide sprayers. Although the study reported a non-statistically significant effect estimate for glyphosate, it is limited in its ability to contribute to the overall evaluation of the carcinogenic potential of glyphosate. The effect estimate was not adjusted for any standard covariates or potential confounders, including co-exposure to other pesticides. The power of the study was questionable. There were 80 subjects, but the number exposed to glyphosate was not reported. The outcome is measured using an immunoassay that is less specific for measuring the biomarker of interest than other available analytical methods. Lastly, the study evaluates primary DNA damage, but does not measure the consequence of genetic damage. An increase in oxidative DNA damage may lead to cell death or initiate DNA repair rather than lead to a mutation.

Due to the limitations in the studies assigned a low quality ranking, they do not provide reliable information to evaluate associations between glyphosate exposure and cancer outcomes. Therefore, the remaining sections of this document do not further discuss these studies except to note when a study is included in meta-analyses.

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
Alavanja *et al.* (2003)	This study was not included in the study quality ranking because the data were used in the updated analysis by Koutros *et al.* (2013).						
Andreotti *et al.* (2009)	Nested Case-control	Questionnaire answered by subjects at study enrollment followed by take-home questionnaire; examined exposure for glyphosate as ever/never, and intensity-weighted cumulative exposure days; spouses either self-administered questionnaire (81%) or telephone interview (19%)	State cancer registries without histopathological verification; exclusion of subjects with prevalent cancer at enrollment; follow-up ~ 9 years	Adjusted for age, smoking, and diabetes for both exposure metrics as well as applicator type forever/never exposure metric No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Unconditional logistic regression to obtain OR and 95% CI	Exposure misclassification particularly for spouses, low response rate to take-home questionnaire (40%) but unclear if affected cases and controls differently, insufficient power for pesticide exposure interactions	Moderate
Band *et al.* (2011)	Population-based case-control Males only	Self-administered questionnaire answered by subjects or proxies for deceased subjects requesting work history and demographic information; use of a job exposure matrix to estimate exposure to pesticides	Cancer registry with histopathological verification; excluded farmers that worked all outside of British Columbia; included prostate cancer cases prior to the PSA era	Adjustment for alcohol consumption, cigarette years, education level, pipe years, and respondent type. Marital status and ethnicity not significant No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Conditional logistic regression to obtain ORs and 95% CIs	Recall bias, use of proxy for deceased, exposure misclassification, participation rates cited from another study, use of cancer patients as controls (excluding lung and unknown cancer)	Moderate
Brown *et al.* (1990)	Pooled population-based case-control Males only	In-person interviews using standardized questionnaire with subjects or proxies for deceased/incapacitated; supplementary questionnaire administered by telephone for Iowa subjects to obtain more	State cancer registry (Iowa) and special surveillance network including hospitals and pathology laboratories (Minnesota); cases ascertained retrospectively and prospectively (2 years after start of study);	Adjusted for vital status, age, state, ever used tobacco daily, close relative with lymphopoietic cancer, nonfarming job related to risk of leukemia in the study, exposure to substances related to risk in this study	Unconditional logistic models to obtain OR and 95% CI; questionable power (15 cases)	Recall bias; exposure misclassification, use of proxy respondents	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
		detailed information from those indicating pesticide use	~26% of cases deceased or too ill when identified and ~15% deceased or too ill at time of interview; histopathological verification by pathologists	(benzene, napthalene, hair dyes) No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)			
Brown *et al.* (1993)	Population-based case-control Males only	In person interviews with standardized questionnaire to obtain detailed information on farm activities and use of pesticides from subjects or proxies	State cancer registry (Iowa) ascertained retrospectively and prospectively (2 years after start of study); ~26% of cases deceased or too ill when identified and ~15% deceased or too ill at time of interview; histopathological verification by pathologists	Adjusted for vital status and age; smoking and education evaluated and not found to be significant No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Logistic models to obtain OR and 95% CI; questionable power (11 cases)	Recall bias; exposure misclassification, use of proxy respondents	Moderate
Cantor *et al*. (1992)	This study was not included in the study quality ranking because the data were used in the pooled analysis conducted by De Roos *et al.* (2003).						
Carreon *et al.* (2005)	This study was not included in the study quality ranking because the data were used in the pooled analysis conducted by Yiin *et al.* (2012).						
Cocco *et al*. (2013)	European multi-center case-control Hospital-based and population-based (mixed for 2 countries, only hospital-based for the rest)	Trained interviewers conducted in person interviews using structured questionnaire answered by subjects; those identified as agricultural worker on questionnaire given subsequent questions about pesticide use, crops, etc.	Surveillance centers, 20% of slides from each center reviewed by pathologist	Adjustment for age, sex, education, and center. No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Unconditional logistic regression to obtain ORs and 95% CIs; Low power (4 cases, 2 controls)	Recall bias, selection bias (low response rate for population-based controls and differed from cases), exposure misclassification, mix of hospital- and population-based controls,	Low
De Roos *et al*. (2003)	Population-based case-control Males only Pooled analysis of	Interviews with subjects or proxy for deceased subjects. Different interview techniques across states. One study collected information on	State cancer registries (one state chose a random sample, other states chose all cases), surveillance programs, and hospitals without	Adjustment for age, study site, and other pesticides. First degree relative with haematopoietic	Logistic regression and hierarchical regression to obtain ORs and 95% CIs	Recall bias, exposure misclassification, , use of proxy for deceased, , varying quality of questionnaire/interview techniques across studies	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
	Cantor *et al.*, 1992; Hoar *et al.*, 1986; Zahm *et al.*, 1990	pesticide use and then followed-up with questions on selected specific pesticides, another study had a direct question about a selected list of specific pesticides, and the last study used an open ended question without prompting for specific pesticides	histopathological verification	cancer, education, and smoking not found to be important confounders. No adjustment for other potential confounders (e.g., solvents, diesel fumes, UV radiation)			
De Roos *et al*. (2005)	Prospective cohort (licensed pesticide applicators)	Questionnaire answered by subjects at enrollment and with subsequent take-home questionnaire; examined exposure as ever/never, cumulative lifetime days, and intensity-weighted cumulative exposure days	State cancer registries without histopathological verification; follow-up ~7 years	Adjustment for state of residence, age, education, smoking history, alcohol consumption, family history of cancer, use of other common pesticides No adjustment for other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Poisson regression to obtain RRs and 95% CIs	Major sources of potential biases unlikely, potential exposure misclassification due to any changes in exposure since enrollment, follow-up period may be limited	High
Engel *et al.* (2005)	Nested case-control Females only	Take-home questionnaire from spouses of enrolled applicators used to obtain farm exposures, general health information, and reproductive health history; Information obtained from applicators used as measure of possible indirect exposure to spouses	State cancer registries identifying malignant breast cancer; ~5 years average follow-up time	Adjusted for age, race and state. Evaluated BMI, age at menarche, parity, age at first birth, menopausal status, age at menopause, family history of breast cancer, physical activity, smoking, alcohol consumption, fruit and vegetable consumption and education but none	Poisson regression to obtain RRs and 95% CIs	Exposure misclassification, exposure to other pesticides (however no association observed), lack of information on length of marriage could result in overestimating exposure based on husband	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
				found to be significant No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)			
Eriksson *et al*. (2008)	Population-based case-control	Questionnaire answered by subjects; follow-up by phone if incomplete answers; excluded exposures that occurred during the same calendar year and year before diagnosis (cases) or enrollment (controls); minimal demographic information reported	Physicians treating lymphoma within specified health service areas and verified by pathologists	Adjustment for age, sex, year of diagnosis/enrollment, as well as exposure to other pesticides in multivariate analyses. Not stated what adjustments were made for other pesticides in latency analyses. No adjustment other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Unconditional logistic regression and multivariate analyses to obtain ORs and 95% CIs; not clear how multivariate was performed; questionable power (29 cases, 18 controls); also included analysis of ≤10 vs. >10 years exposure	Recall bias, exposure misclassification, lack of subject demographics/ characteristics (e.g., smoking, alcohol consumption, race, etc)	High
Flower *et al.* (2004)	Nested case-control	Questionnaire answered by applicators at enrollment; spouses enrolled through a questionnaire brought home by applicator; females (applicators and spouses) were asked to complete a questionnaire on female and family health that collected information on children born during or after 1975	State cancer registry to identify childhood cancer cases (diagnosed from birth through 19 yrs of age) for children of parents enrolled; hybrid prospective/retrospective ascertainment; excluded female applicators	Child's age at parent's enrollment was included in model; parental age at child's birth, child's sex, child's birth weight, history of parental smoking, paternal history of cancer, and maternal history of miscarriage were evaluated but not found to be significant and not included in model No adjustment for co-	Logistic regression to obtain OR and 95% CI; calculated standardized incidence ratios to compare observed number of childhood cancer cases identified to the expected number; low/questionable power (6 parental cases, 13 maternal cases)	Exposure misclassification, lack of timing data to determine if exposure occurred prior to conception or during pregnancy, exposure to other pesticides (however no association observed and lack of power for adjustment)	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
				exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)			
Hardell and Eriksson (1999)	This study was not included in the study quality ranking because the data were used in the pooled analysis conducted by Hardell *et al.* (2002).						
Hardell *et al*. (2002)	Population-based case-control Males only Pooled analysis of Hardell and Eriksson 1999 and Nordstrom *et al.*, 1998	Questionnaire answered by subjects or proxy for deceased subjects to obtain complete working history and exposure to different chemicals; follow-up with interview for clarification	Registries with histopathological verification	Adjustment for age, vital status, and county (by matching). Exposure to other pesticides in multivariate analysis. No adjustment for other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Conditional logistic regression to obtain OR and 95% CI (univariate and multivariate analyses). Questionable power (8 cases/8 controls)	Recall bias, exposure misclassification, use of proxy for deceased	Moderate
Hohenadel *et al*. (2011)	This study was not included in the study quality ranking because a more complete analysis was conducted by McDuffie *et al*. (2001).						
Kachuri *et al.* (2013)	Population-based case-control Males only	Questionnaire answered by subjects or proxies; pesticide use collected via detailed telephone interview on all participants with 10+ hours of pesticide use during lifetime and 15% random sample of those who did not; exposure based on lifetime exposure to glyphosate	Cancer registries or hospitals in 6 Canadian provinces with histopathological verification for 36.55% of samples	Adjustment for age, province, selected medical conditions, family history of cancer, use of proxy respondent, smoking status No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Unconditional logistic regression to obtain OR and 95% CI; trends examined using multiple logistic regression	Recall bias, exposure misclassification, control selection based on three different sources depending on province of residence, low participation rates among controls, use of proxy respondents	Moderate
Karunanayake *et al.* (2012)	Population-based case-control Males only	Questionnaire answered by subjects; pesticide use collected via detailed telephone interview on all participants with 10+ hours of pesticide use during lifetime and 15%	Cancer registries or hospital in 6 Canadian provinces with histopathological verification for 49% of samples; difficulty recruiting control	Adjusted for age, province of residence, and significant medical history variables No adjustment for co-	Conditional logistic regression to obtain OR and 95% CI	Recall bias, exposure misclassification, control selection based on three different sources depending on province of residence, low participation rates among	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
		random sample of those who did not; exposure based on lifetime exposure to glyphosate	participants for older age groups	exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)		controls, unable to evaluate Epstein-barr virus exposure	
Koureas *et al*. (2014)	Cross-sectional	Questionnaire answered by pesticide sprayers	Genomic DNA extracted from peripheral blood samples and oxidation by-product 8-hydroxydeoxyguanosine (8-OHdG) was determined by enzyme immunoassay; more specific methods (HPLC, GC-MS) are available for measurement	No adjustments. In univariate, occupational exposure, sex and alcohol consumption were statistically significant while DAP concentrations and smoking were not.	For univariate, chi-square test used to obtain RR and 95% CI; 8-OHdG levels transformed into binary variables (categorized as high and low using the 75th percentile cut-off); unknown number of exposed and unexposed cases (questionable power possible given total number of subjects is only 80)	Recall bias, did not control for risk factors identified as statistically significant for univariate analysis, does not measure the consequence of genetic damage	Low
Koutros *et al.* (2013)	Nested case-control Males only	Questionnaire answered by subjects at study enrollment; examined exposure as cumulative lifetime days and intensity-weighted cumulative exposure days	State cancer registries with histopathological verification; total and aggressive prostate cancers evaluated	Adjustment for age, state, race, smoking, fruit servings, family history of prostate cancer, and leisure time physical activity in the winter. No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Poisson regression to obtain RRs and 95% CIs; also included unlagged vs. lagged analysis	Exposure misclassification	High
Landgren *et al*. (2009)	Nested case-control[a] Males only	Questionnaire answered by subjects at enrollment in AHS cohort and subsequent take-home questionnaire to collect	Venous blood collected from antecubital vein and analyzed for MGUS; same method as used for controls group in	Adjusted for age and education level Association with other pesticides examined	Logistic regression models to obtain OR and 95% CI comparing to population-based	Exposure misclassification, control group not from geographical area (used control group with	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
		information on 50 pesticides; occupational expoures, medical histories, and lifestyle factors updated with 5-year follow-up interview; subjects with prior history of lymphoproliferative malignancy excluded	Minnesota	and not found to be significant so no adjustment performed No adjustment for other potential confounders (e.g., solvents, diesel fumes, UV radiation)	screening study in Olmsted County, Minnesota; questionable power (27 cases; 11 controls)	similar demographics from Minnesota)	
Lee *et al*. (2004a)	This study was not included in the study quality ranking because the data were used in the pooled analysis conducted by De Roos *et al*. (2003).						
Lee *et al*. (2004b)	Population-based case-control White males and females only	Subjects or proxies were interviewed by telephone; those living/working on a farm asked for detailed history of pesticide use and farming information	State cancer registry or review of discharge diagnosis and pathology records at 14 hospitals; only newly diagnosed cases with confirmed adenocarcinoma of stomach or esophagus retained; controls randomly selected from a prior study conducted in geographical area	Adjusted for age and sex; evaluated BMI, smoking, alcohol consumption, educational level, family history of stomach or esophageal cancer, respondent type, dietary intake of particular vitamins and minerals, protein, and carbohydrates (included in model if changed value of OR by more than 10%) No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Unconditional logistic regression to obtain OR and 95% CI; questionable power (12 cases for stomach; 12 cases for esophagus)	Recall bias, exposure misclassification, use of proxy respondents, control selection	Moderate
Lee *et al*. (2005)	Population-based case-control	Questionnaire and/or interview with subject or proxy individuals to collect information on use of specific pesticides; telephone follow-up for unclear responses	Referral by hospitals or through state cancer registries with histopathological verification; controls selected from a previous study	Adjusted for age and respondent type; evaluated history of head injury, marital status, education level, alcohol consumption, medical history of diabetes mellitus,	Unconditional logistic regression to obtain OR and 95% CI	Recall bias, exposure misclassification, large number of proxy respondents, control selection (historical control group from another cancer evaluation, differences in	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
				dietary intake of α- and β-carotene, and dietary fiber (included in model if changed value of OR by more than 10%) No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)		exposure time period evaluated, needed to add younger controls, exposure information collected for different time periods for cases vs. controls)	
Lee *et al*. (2007)	Nested case-control	Questionnaire answered by subjects at enrollment in AHS cohort and subsequent take-home questionnaire to collect information on 50 pesticides	State cancer registries without histopathological verification; follow-up ~ 7 years	Adjustment for age, smoking, state, total days of pesticide application No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Unconditional multivariate logistic regression to obtain OR and 95% CI	Exposure misclassification, limited data on dietary factors, NSAID drug use and family cancer history	Moderate
McDuffie *et al*., 2001	Population based case-control Males only	Questionnaire answered by subjects; pesticide use collected via detailed telephone interview on all participants with 10+ hours of pesticide use during lifetime and 15% random sample of those who did not; exposure based on lifetime exposure to glyphosate	Cancer registries or hospital in 6 Canadian provinces with histopathological verification for 84% of samples; ascertainment of cases stopped in each province once target numbers were reached	Adjustment for age, province, and significant medical variables (including history of cancer in study participants and family history). No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Conditional logistic regression to obtain OR and 95% CI	Recall bias, exposure misclassification, control selection based on three different sources depending on province of residence, relatively low participation rates	Moderate
Nordstrom *et al*., 1998	This study was not included in the study quality ranking because the data were used in the pooled analysis conducted by Hardell *et al.* (2002).						
Orsi *et al*., 2009	Hospital-based case-control	Data collection in 2 stages: 1) self-	Hospital catchment area with histopathological/	Adjustment for age, center, and	Unconditional logistic regression	Recall bias, exposure misclassification,	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
	Males only (occupationally exposed)	administered questionnaire on socioeconomic characteristics, family medical history, and lifelong residential and occupational histories and more specific information for each job held for at least 6 months, and 2) face-to-face interview with trained staff (blinded) using standardized questionnaire	cytological verification Controls were hospital based with no prior history of lymphoid neoplasms, excluding patients with cancer or a disease directly related to occupation, smoking or alcohol abuse (but history of any of these did not prevent selection as a control)	socioeconomic category. Education and housing not found to impact results. Flu immunization, previous history of mononucleosis, skin type, smoking, and drinking did not change results. Evaluated particular crops and animal husbandry as well. No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	to obtain OR and 95% CI. Questionable power (12 cases/24 controls)	hospital-based controls	
Pahwa *et al*. (2011)	Population-based case-control Males only	Questionnaire answered by subjects; pesticide use collected via detailed telephone interview on all participants with 10+ hours of pesticide use during lifetime and 15% random sample of those who did not; exposure based on lifetime exposure to glyphosate	Cancer registries or hospitals in 6 Canadian provinces with histopathological verification for 30% of samples	Adjustment for age group, province of residence, and statistically significant medical history variables No adjustment for co-exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Conditional logistic regression to obtain OR and 95% CI; trends examined using multiple logistic regression	Recall bias, exposure misclassification, control selection based on three different sources depending on province of residence, low participation rates among controls	Moderate
Pahwa *et al*. (2012)	Population-based case-control Males only	Questionnaire answered by subjects; pesticide use collected via detailed telephone interview on all participants with 10+ hours of pesticide use during lifetime and 15% random sample of those	Cancer registries or hospitals in 6 Canadian provinces with histopathological verification for 36.5% of samples	Adjustment for age group, province of residence, and statistically significant medical history variables No adjustment for co-	Conditional logistic regression to obtain OR and 95% CI; trends examined using multiple logistic regression	Recall bias, exposure misclassification, control selection based on three different sources depending on province of residence, low participation rates among controls	Moderate

Table 3.2. Summary of Study Design Elements Impacting Study Quality Assignment and Overall Ranking.							
Journal Article	**Study Design**	**Exposure Assessment**	**Outcome Assessment**	**Confounder Control**	**Statistical Analyses**	**Risk of (Other) Bias**	**Overall Ranking**
		who did not; exposure based on lifetime exposure to glyphosate		exposure to other pesticides or other potential confounders (e.g., solvents, diesel fumes, UV radiation)			
Yiin *et al.* (2012)	Population-based case-control Pooled analysis of men with women analyzed in Carreon *et al*. (2005)	Questionnaire and/or interview for chemical-specific exposure answered by subjects or proxy individuals	Cases referred by physicians or through state cancer registries with histopathological verification; controls matched within state, but not county of residence	Adjustment for age, education, sex, and , sex, and farm pesticide exposure (yes/no) No adjustment for other potential confounders (e.g., solvents, diesel fumes, UV radiation)	Unconditional logistic regression to obtain ORs and 95% CIs	Acknowledge other sources of bias. Recall bias, exposure misclassification, control selection (low number of deceased controls obtained)	Moderate

[a] Mixed methods used in the Landgren et al (2009) study, with cross-sectional study design used to calculate prevalence rates comparing the AHS to a reference population MN. Pesticide risk estimates (including glyphosate) calculated using nested case-control approach, comparing AHS exposed/unexposed (ever/never) study participants.

3.4 Assessment of Epidemiological Studies for Relevance to Analysis

Using the criteria summarized in Section 3.2, a total of 58 individual literature studies were identified in the literature review and were judged as high, moderate, or low quality. Overall, 3 studies, 21 studies, and 34 studies were assigned high, moderate, or low rankings, respectively. All of the high and moderate quality studies were considered relevant to the current evaluation.

The majority of the studies were case-control studies evaluating a wide-range of cancers in the United States and Canada. There were several case-control studies from Canada that utilized the same study population (Kachuri *et al.*, 2013; Karunanayake *et al.*, 2012; McDuffie *et al.*, 2001; Pahwa *et al.*, 2011; Pahwa *et al.*, 2012). In a similar fashion, numerous studies in the United States were nested case-control studies, where the AHS cohort served as the source population for selecting cases and controls (Andreotti *et al*., 2009; Engel *et al*., 2005; Flower *et al*., 2004; Koutros *et al.*, 2013; Landgren *et al*., 2009; Lee *et al*., 2007). In these studies, a subset of the AHS cohort were selected based on their outcome status for a particular cancer and exposure information was used from the AHS enrollment questionnaire and/or during follow-up interviews. Nested case-control studies allow for testing of hypotheses not anticipated when the cohort was initially assembled. In the AHS prospective cohort study (De Roos *et al.*, 2005), exposure and demographic information were also obtained from the questionnaires at enrollment; however, subjects were enrolled prior to developing cancer outcomes of interest. Subjects were then followed from enrollment to a subsequent time point to determine if subjects developed cancer outcomes of interest. As such, all available subjects in the cohort are included in the evaluation of whether there was an association between a risk factor (e.g., glyphosate exposure) and outcome.

The moderate studies included a varying degree of control for confounding and biases across studies. As moderate studies, they encompass a combination of strengths and limitations. In particular, important factors that impacted the quality assessment for these studies included whether there was control for known confounders, identification of control selection issues, study power issues, and length of follow-up. As noted previously, most people in these epidemiological studies used pesticides occupationally and were exposed to multiple pesticides over their working lifetime. Therefore, exposure to other pesticides is a particularly important factor to control for and studies that made this adjustment were given more weight than those that did not. Similarly, control selection issues were noted in a few studies and were given less weighting than those without control selection issues. The issues ranged from concerns using hospital-based controls, using different population sources to ascertain controls within the same study, and appropriateness of using controls ascertained for another research question. Numerous studies had limited power due to small sample size, which results in large confidence intervals and reduces the reliability of the results to demonstrate a true association. Studies demonstrating low or questionable power were therefore given less weighting. Lastly, the length of follow-up time varied across studies.

3.5 Summary of Relevant Epidemiological Studies

A summary of the relevant studies evaluating the association between glyphosate exposure and cancer are discussed below. Results of the studies reporting data on glyphosate exposure and

solid tumors (non-lymphohematopoietic) at various anatomical sites are presented in Table 3.3. Results of the studies reporting data on glyphosate exposure and non-solid tumors (lymphohematopoietic) are presented in Table 3.4. For study details, see Table 3.2 above and Appendix C.

3.5.1 Solid Tumor Cancer Studies

(1) Cancer at Multiple Sites from the AHS Cohort

De Roos *et al*., (2005) evaluated associations between glyphosate exposure and cancer incidence of all cancers combined in the AHS cohort study and did not find an association [ever/never use relative risk ratio (RR) =1.0 with 95% confidence interval (CI) of 0.90–1.2) when adjusting for age, demographic and lifestyle factors, and exposure to other pesticides]. In addition, De Roos *et al*., 2005 evaluated cancer at specific anatomical sites. Along with several nested case-control studies, no statistical evidence of an association with glyphosate was observed at any specific anatomical site (Table 3.3). Specifically, AHS researchers reported no evidence of an association between glyphosate use and cancers of the oral cavity (De Roos *et al*., 2005), colon (De Roos *et al*., 2005; Lee *et al*., 2007), rectum (De Roos *et al*., 2005; Lee *et al*., 2007), lung (De Roos *et al*., 2005), kidney (De Roos *et al*., 2005), bladder (De Roos *et al*., 2005), pancreas (De Roos *et al*., 2005; Andreotti *et al*., 2009), breast (Engel *et al*., 2005), prostate (De Roos et al., 2005; Koutros *et al*., 2013) or melanoma (De Roos *et al*., 2005). The adjusted RR or odds ratio (OR) and 95% CI for these studies are provided in Table 3.3.

(2) Prostate Cancer

In a Canadian population-based study (Band *et al.*, 2011), researchers reported non-statistically significant elevated odds of prostate cancer in relation to glyphosate use (OR=1.36; 95% CI=0.83–2.25). There was no adjustment made for exposure to other pesticides. This study included prostate cancer cases from 1983-1990, prior to the prostate-specific antigen (PSA) era. Consequently, the study included more advanced tumors before diagnosis. The AHS related studies (De Roos et al., 2005; Koutros *et al*., 2013), reflect PSA-era cases (i.e., cases which are typically identified at an earlier stage in the progression of the disease) and also did not identify an association with prostate cancer.

(3) Brain (Glioma) Cancer

Lee *et al*. (2005) investigated the association between brain cancer with farming and agricultural pesticide use. Matching for age, sex, vital status, and region, study authors reported a non-significant elevated odds of glioma (OR=1.5; 95% CI=0.7–3.1) in relation to glyphosate use by male farmers; however, the results were significantly different between those who self-reported pesticide use (OR=0.4; 95% CI=0.1–1.6), and for those for whom a proxy respondent was used (OR=3.1; 95% CI=1.2–8.2), indicating recall bias was a potential factor in this study. Furthermore, there was no adjustment for co-exposure to other pesticides and issues noted with control selection.

A population-based case-control study evaluated the risk of brain cancer, specifically, glioma risk, among men and women participating in the Upper Midwest Health Study (Yiin *et al*.,

2012). Using a quantitative measure of pesticide exposure (in contrast to an ever-use metric), Yiin *et al*. (2012) observed no statistical evidence of an association with glyphosate with effect estimates roughly equal to the null value following adjustment for age, education, sex, and use of other pesticides (home and garden use: OR=0.98; 95% CI=0.67–1.43; non-farm jobs: OR=0.83; 95% CI=0.39–1.73).

(4) Stomach and Esophageal Cancer

In a population-based case-control study in eastern Nebraska, Lee *et al*. (2004b) investigated pesticide use and stomach and esophageal adenocarcinomas. There was no association observed between glyphosate exposure and either stomach cancer (OR=0.8; 95% CI=0.4–1.5) or esophageal cancer (OR=0.7; 95% CI=0.3–1.4) after adjustment for age and sex. No adjustment was made for exposure to other pesticides.

(5) Soft Tissue Sarcoma

A Canadian case-control study (Pahwa *et al*., 2011) examined exposure to pesticides and soft tissue sarcoma and found no relation with the use of glyphosate after adjustment for age, province of residence, and medical history variables (OR=0.90; 95% CI= 0.58–1.40); however, control selection issues were noted, including low response rate and selection from three different sources depending on the province of residence.

(6) Total Childhood Cancer

Flower *et al*. (2004), a nested case-control study in the AHS cohort, examined the relation between parental pesticide use and all pediatric cancers reported to state registries among children of AHS participants and did not observe a significant association with maternal use exposure to glyphosate (OR=0.61; 95% CI= 0.32–1.16) or paternal (prenatal) exposure to glyphosate (OR=0.84; 95% CI= 0.35–2.54). The models adjusted for the child's age at the time of parents' enrollment. There was no adjustment for exposure to other pesticides.

Table 3.3. Summary of Findings: Solid Tumor Cancer Studies					
Study	**Study Design**	**Study Location**	**Exposure Metric**	**Adjusted Effect Estimate: RR or OR (95% CI)[a]**	**Covariate Adjustments in Analyses**
All Cancers Combined					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.0 (0.9-1.2)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 1.0 (0.9-1.1) 1.0 (0.9-1.1)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 0.9 (0.8-1.0) 0.9 (0.8-1.1)	Age, demographic and lifestyle factors, and other pesticides[b]
Lung					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	0.9 (0.6-1.3)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 0.9 (0.5-1.5) 0.7 (0.4-1.2)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 1.1 (0.7-1.9) 0.6 (0.3-1.0)	Age, demographic and lifestyle factors, and other pesticides[b]
Oral Cavity					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.0 (0.5-1.8)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 0.8 (0.4-1.7) 0.8 (0.4-1.7)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5	1.0 1.1 (0.5-2.5)	Age, demographic and lifestyle factors, and other pesticides[b]

Table 3.3. Summary of Findings: Solid Tumor Cancer Studies					
Study	**Study Design**	**Study Location**	**Exposure Metric**	**Adjusted Effect Estimate: RR or OR (95% CI)[a]**	**Covariate Adjustments in Analyses**
			79.6-337.1 337.2-18,241	1.0 (0.5-2.3)	
Kidney					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.6 (0.7-3.8)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 0.6 (0.3-1.4) 0.7 (0.3-1.6)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 0.3 (0.1-0.7) 0.5 (0.2-1.0)	Age, demographic and lifestyle factors, and other pesticides[b]
Bladder					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.5 (0.7-3.2)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 1.0 (0.5-1.9) 1.2 (0.6-2.2)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 0.5 (0.2-1.3) 0.8 (0.3-1.8)	Age, demographic and lifestyle factors, and other pesticides[b]
Melanoma					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.6 (0.8-3.0)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 1.2 (0.7-2.3) 0.9 (0.5-1.8)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days		Age, demographic and lifestyle factors, and other pesticides[b]

Table 3.3. Summary of Findings: Solid Tumor Cancer Studies					
Study	**Study Design**	**Study Location**	**Exposure Metric**	**Adjusted Effect Estimate: RR or OR (95% CI)[a]**	**Covariate Adjustments in Analyses**
			(by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 0.6 (0.3-1.1) 0.7 (0.3-1.2)	
Colon					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.4 (0.8-2.2)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 1.4 (0.9-2.4) 0.9 (0.4-1.7)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 0.8 (0.5-1.5) 1.4 (0.8-2.5)	Age, demographic and lifestyle factors, and other pesticides[b]
Lee *et al.* (2007)	Nested Case-Control	USA: Iowa and North Carolina	Ever/never	1.0 (0.7-1.5)	Age, smoking, state, total days of pesticide application
Rectum					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.3 (0.7-2.3)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 1.3 (0.7-2.5) 1.1 (0.6-2.3)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 1.0 (0.5-2.0) 0.9 (0.5-1.9)	Age, demographic and lifestyle factors, and other pesticides[b]
Lee *et al.* (2007)	Nested Case-Control	USA: Iowa and North Carolina	Ever/never	1.6 (0.9-2.9)	Age, smoking, state, total days of pesticide application
Colorectal					
Lee *et al.* (2007)	Nested Case-Control	USA: Iowa and North Carolina	Ever/never	1.2 (0.9-1.6)	Age, smoking, state, total days of pesticide application
Pancreas					

Table 3.3. Summary of Findings: Solid Tumor Cancer Studies					
Study	**Study Design**	**Study Location**	**Exposure Metric**	**Adjusted Effect Estimate: RR or OR (95% CI)[a]**	**Covariate Adjustments in Analyses**
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	0.7 (0.3-2.0)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 1.6 (0.6-4.1) 1.3 (0.5-3.6)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 2.5 (1.0-6.3) 0.5 (0.1-1.9)	Age, demographic and lifestyle factors, and other pesticides[b]
Andreotti *et al.* (2009)	Nested Case-Control	USA: Iowa and North Carolina	Ever/never	1.1 (0.6-1.7)	Age group, cigarette smoking, diabetes, and applicator type
			Intensity-Weighted Exposure Days (by control median): ≤184 ≥185	1.4 (0.9-3.8) 0.5 (0.2-1.3)	Age group, cigarette smoking, and diabetes
Prostate					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.1 (0.9-1.3)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 0.9 (0.7-1.1) 1.1 (0.9-1.3)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 1.0 (0.8-1.2) 1.1 (0.9-1.3)	Age, demographic and lifestyle factors, and other pesticides[b]
Koutros *et al.* (2013)[c]	Nested Case-Control	USA: Iowa and North Carolina	Intensity-Weighted Cumulative Exposure Days (by quartile): Q1 Q2 Q3 Q4	Total prostate cancer: 0.91 (0.79-1.06) 0.96 (0.83-1.12) 1.01 (0.87-1.17) 0.99 (0.86-1.15)	Age, state, race, smoking, fruit servings, family history of prostate cancer, and leisure time physical activity in the winter

Table 3.3. Summary of Findings: Solid Tumor Cancer Studies					
Study	**Study Design**	**Study Location**	**Exposure Metric**	**Adjusted Effect Estimate: RR or OR (95% CI)[a]**	**Covariate Adjustments in Analyses**
			Intensity-Weighted Cumulative Exposure Days (by quartile): Q1 Q2 Q3 Q4	Aggressive prostate cancer: 0.93 (0.74-1.16) 0.91 (0.73-1.13) 1.01 (0.82-1.25) 0.94 (0.75-1.18)	Age, state, race, smoking, fruit servings, family history of prostate cancer, and leisure time physical activity in the winter
Band *et al.* (2011)	Case-Control	Canada: British Columbia	Ever/never	1.36 (0.83-2.25)	Alcohol consumption, cigarette years, education level, pipe years, and respondent type
Esophagus					
Lee *et al.* (2004b)	Case-Control	USA: Nebraska	Ever/never	0.7 (0.3-1.4)	Age and sex
Stomach					
Lee *et al.* (2004b)	Case-Control	USA: Nebraska	Ever/never	0.8 (0.4-1.5)	Age and sex
Breast					
Engel *et al.* (2005)	Nested Case-Control	USA: Iowa and North Carolina	Ever/never	Wives who apply pesticides: 0.9 (0.7-1.1) Wives who never used pesticides: 1.3 (0.8-1.9)	Age, race, and state of residence
Soft Tissue Sarcoma					
Pahwa *et al.* (2011)	Case-Control	Canada	Ever/never	0.90 (0.58-1.40)	Age group, province of residence, and statistically significant medical history variables
Brain (glioma)					
Lee *et al.* (2005)	Case-Control	USA: Nebraska	Ever/never	Overall: 1.5 (0.7-3.1) Self-reported: 0.4 (0.1-1.6) Proxy respondents: 3.1 (1.2-8.2)	Age for overall analysis; age and respondent type for other analyses
Yiin *et al.* (2012)	Case-Control	USA: Iowa, Michigan, Minnesota, and Wisconsin	Ever/never	House/garden use: 0.98 (0.67-1.43) Non-farm jobs: 0.83 (0.39-1.73)	Age, education, sex, and use of other pesticides
Total Childhood					

Table 3.3. Summary of Findings: Solid Tumor Cancer Studies					
Study	**Study Design**	**Study Location**	**Exposure Metric**	**Adjusted Effect Estimate: RR or OR (95% CI)[a]**	**Covariate Adjustments in Analyses**
Flower *et al.* (2004)	Nested Case-Control	USA: Iowa and North Carolina	Ever/never	Maternal use: 0.61 (0.32-1.16) Paternal use: 0.84 (0.35-2.34)	Child's age at enrollment

[a] Some studies report multiple quantitative risk measurements. This table reports the most highly adjusted quantitative measurements.
[b] De Roos *et al.* (2005) excluded subjects missing covariate data for demographic and lifestyle factors and exposure to other pesticides; therefore, the number of subjects included in each analysis varies.
[c] Effect estimates for glyphosate reported in the supplemental web material for Koutros *et al.* (2013).

3.5.2 Non-Solid Tumor Cancer Studies

(1) Leukemia

De Roos *et al*. (2005) reported no association between leukemia and glyphosate-exposed (ever/never used) pesticide applicators in the AHS cohort. For applicators with the full data set (54,315), the RR was 1.1 (95% CI=0.6–2.4) with only adjustment for age. In the fully adjusted model, the RR was similar (RR=1.0; 95% CI=0.5–1.9). The number of participants included in the adjusted analysis was lower (n=40,716) due to the exclusion of subjects with missing covariate data. Effect estimates using cumulative lifetime exposure and intensity-weighted cumulative exposure were also found to be non-statistically significant and did not demonstrate a trend with increasing exposure.

In a population-based case-control study in Iowa and Minnesota, Brown *et al*. (1990) did not observe an association with the ever-use of glyphosate (OR=0.9; 95% CI=0.5–1.6). A limitation in the study was the low number of cases exposed to glyphosate (n=15). Adjustments were made for several covariates, including vital status, age, tobacco use, family history of lymphopoietic cancer, high risk occupations, and high risk exposures; however, no adjustment was made for exposure to other pesticides.

Chang and Delzell (2016) conducted a meta-analysis exploring glyphosate exposure and leukemia using 3 studies (De Roos *et al*., 2005; Brown *et al*., 1990; and Kaufman *et al.,* 2009). I^2 values were reported, which represented the percentage of the total variance explained by study heterogeneity and measure inconsistency in results. Larger I^2 values indicate greater inconsistency. A meta-risk ratio of 1.0 (95% CI=0.6-1.5) was obtained with an I^2 value of 0.0%, indicating consistency across the data sets. It should be noted that this analysis included data from Kaufman *et al.* (2009), which is not considered in the current evaluation because it was assigned a low quality ranking because a quantitative measure of an association between glyphosate and a cancer outcome was not reported for that study.

(2) Multiple Myeloma

In a follow-up analysis of the study population from Iowa and Minnesota used in Brown *et al.* (1990), Brown *et al.* (1993) investigated whether pesticide use was related to multiple myeloma. Among men in Iowa, the authors observed a non-statistically significant elevated association with glyphosate use (OR=1.7; 95% CI=0.8–3.6; 11 exposed cases); however, no adjustment was made for exposure to other pesticides. The authors cautioned that while the study may lend support to the role of pesticides in general, the study limitations preclude use of the evidence as a definitive finding for any one compound.

De Roos *et al*. (2005) reported a suggestive association between multiple myeloma and glyphosate-exposed pesticide applicators based on 32 multiple myeloma cases observed in the AHS cohort. For applicators with the full data set, the RR was 1.1 (95% CI=0.5–2.4) with only adjustment for age. In the fully adjusted model excluding subjects with missing covariate data, there was a non-statistically significant elevated risk following adjustment for age, demographic and lifestyle factors, and exposure to other pesticides (RR=2.6; 95% CI=0.7–9.4). The authors

postulated that the increased myeloma risk could be due to bias resulting from a selection of subjects in adjusted analyses that differed from subjects included in unadjusted analyses or may be due to a confounder or effect modifier that is prevalent among the subgroup and has not been accounted for in the analyses. When exposure data were also stratified by tertiles with the lowest tertile of exposure as the referent category, trend analyses were not statistically significant. Non-statistically significant elevated RRs of 1.9 (95% CI: 0.6-6.3) and 2.1 (95% CI: 0.6-7.0) were estimated for the highest tertile of both cumulative and intensity-weighted exposure days, respectively. The study authors did note that small sample size precluded precise estimation (n=19 for adjusted analyses). When using never exposed as the referent category, the trend analysis was again non-statistically significant, but the RRs ranged from 2.3 (95% CI: 0.6-8.9) to 4.4 (95% CI: 1.0-20.2) from the lowest tertile to the highest tertile, respectively. When stratified by quartiles, a statistically significant trend is achieved and the RR increased to 6.6 (95% CI: 1.4-30.6); however, the authors noted that the cases were sparsely distributed for these analyses.

Sorahan (2015)[11] re-analyzed the AHS data reported by De Roos *et al*. (2005) to examine the reason for the disparate findings in relation to the use of a full data set versus the restricted data set. Using Poisson regression, risk ratios were calculated without excluding subjects with missing covariate data. When adjusted for age and sex, the RR for ever-use of glyphosate was 1.12 (95% CI of 0.5–2.49). Additional adjustment for lifestyle factors and use of other pesticides did not have a large impact (RR=1.24; 95% CI=0.52–2.94). The authors concluded that the disparate findings in De Roos *et al.* (2005) could be attributed to the use of a restricted dataset that was unrepresentative.

Landgren *et al*. (2009), within the AHS study population, also investigated the association between pesticide use and prevalence of monoclonal gammopathy of undetermined significance (MGUS). MGUS is considered a pre-clinical marker of multiple myeloma progression. The authors did not observe an association with glyphosate use and MGUS using subjects from the AHS cohort (OR=0.50; 95% CI=0.20–1.0). No adjustment was made for exposure to other pesticides.

In a population-based case-control study (Pahwa *et al*., 2012) among men in six Canadian provinces, a non-statistically significant elevated odds of multiple myeloma was reported in relation to glyphosate use (OR=1.22; 95% CI = 0.77–1.93), based upon 32 glyphosate exposed multiple myeloma cases and 133 controls. There was no adjustment for exposure to other pesticides. Kachuri *et al*. (2013), using the same Canadian study population, further explored multiple myeloma in relation to days per year that glyphosate was used. Adjustment for exposure to other pesticides was also not performed in this study. For ever-use, there was a slight non-statistically significant increased odds ratio (OR=1.19; 95% CI=0.76–1.87). For light users (>0 and ≤2 days/year), there was no association (OR=0.72; 95% CI = 0.39–1.32; 15 exposed cases); whereas, for heavy users (>2 days/ year), there was a non-statistically significant increased odds ratio (OR=2.04; 95% CI=0.98–4.23; 12 exposed cases). Similar results were obtained when proxy respondents were excluded from the analysis. The low number of cases and controls exposed to glyphosate, particularly when exposed subjects were divided into light and heavy users, was a limitation of the study. It would be expected that effect estimates would be reduced if adjustment for co-exposure to other pesticides had been performed.

[11] Funded by Monsanto

In a hospital-based case-control study conducted by Orsi *et al*. (2009) in France, 56 multiple myleoma cases and 313 age- and sex-matched controls were identified. A non-statistically significant elevated risk was observed (OR=2.4; 95% CI=0.8–7.3; 5 exposed cases and 18 exposed controls). The wide CI range can primarily be attributed to the low number of exposed cases indicating the analysis is underpowered. Additionally, the study did not adjust for exposure to multiple pesticides.

Chang and Delzell (2016) conducted a meta-analysis exploring glyphosate exposure and multiple myeloma using data from the 6 studies described above (Brown *et al.*, 1993; De Roos *et al*., 2005; Sorahan, 2015; Pahwa *et al*., 2012; Kachuri *et al*., 2013; Orsi *et al*., 2009). Meta-risk ratios were obtained using data from each of the 4 independent study populations, such that if a study population was already represented in the analysis by one study, then the same population analyzed by another study would not be included (e.g., Sorahan, 2015 and De Roos *et al.*, 2005 could not be used simultaneously in a meta-analysis). The combined meta-risk ratio based on data from prioritized studies (Brown *et al.*, 1993; Kachuri *et al.*, 2013; Orsi *et al.*, 2009; and Sorahan, 2015) was 1.4 (95% CI=1.0-1.9) using random-effects and fixed-effects models and the I^2 value = 0.0% indicating consistency across data sets. There was relatively no impact on the meta-risk ratio and associated 95% CI when secondary analyses were conducted using alternative estimates for a study population (e.g., substituting the data from Sorahan, 2015 for De Roos *et al.*, 2005).

(3) Hodgkin Lymphoma

In a Canadian case-control study, Karunanayake *et al.*, (2012) evaluated Hodgkin lymphoma (HL) and observed no association with glyphosate exposure following adjustment for age, province of residence, and medical history variables (OR=0.99; 95% CI=0.62-1.56; 38 cases). No adjustment was made for exposure to other pesticides.

In a hospital-based case-control study conducted by Orsi *et al*. (2009) in France, authors identified 87 HL cases and 265 age-and sex-matched controls. There was a non-statistically significant elevated odds ratio observed (OR=1.7; 95% CI=0.6–5.0; 6 exposed cases and 15 exposed controls). The wide CI range can primarily be attributed to the low number of exposed cases indicating the analysis is underpowered. Also, as noted earlier, this study did not adjust for exposure to multiple pesticides.

Chang and Delzell (2016) conducted a meta-analysis exploring glyphosate exposure and HL using data from both of these studies. A meta-risk ratio of 1.1 (95% CI=0.7-1.6) was obtained with a I^2 value of 0.0%, indicating consistency across the data sets.

(4) Non-Hodgkin Lymphoma

NHL has about 60 subtypes classified by the WHO, which may have etiological differences (Morton *et al.*, 2014). There are analyses available for particular subtypes of NHL; however, these are particularly limited by the small sample sizes. As a result, this evaluation only presents results for total NHL.

There were six studies available that investigated the association between glyphosate exposure and NHL, which was the most for any type of cancer. As discussed in Section 3.4, these studies encompass a combination of strengths and limitations. These studies are therefore discussed in more detail in this section as compared to discussions of other cancer types in order to highlight the strengths and identify the limitations for each study.

De Roos *et al*. (2005) was the only prospective cohort study available; therefore, subjects were enrolled prior to developing cancer outcomes. Disease status was determined through state cancer registries. Exposure information was obtained from a large number of licensed pesticide applicators and no proxies were used. Exposure was evaluated as ever/never use, cumulative lifetime exposure, and intensity-weighted cumulative exposure. Due to the study design, the potential for many biases were reduced. Additionally, the study adjusted and/or considered numerous factors, including use of other pesticides. Median follow-up time was approximately 7 years and a longer follow-up would increase the ability of the study to detect subjects developing cancer outcomes; however, as discussed in Section 3.3.1, study participants provided exposure information prior to enrollment and this information was incorporated into the cumulative lifetime and intensity-weighted cumulative exposure metrics. As a result, the amount of time exposed was longer than just the follow-up time since enrollment. For applicators with the full data set, the RR for ever/never use was 1.2 (95% CI=0.7–1.9; 92 cases) with only adjustment for age. In the fully adjusted model excluding subjects with missing covariate data, the RR was similar following adjustment for age, demographic and lifestyle factors, and exposure to other pesticides (RR=1.1; 95% CI=0.7-1.9). Effect estimates obtained using cumulative lifetime exposure and intensity-weighted cumulative exposure were below 1 (RR = 0.6-0.9 when comparing to the lowest tertile).

De Roos *et al.* (2003) used pooled data from three case-controls studies evaluating NHL in white males from Nebraska, Kansas, and in Iowa and Minnesota (Cantor *et al.*, 1992; Hoar *et al.*, 1986; Zahm *et al.*, 1990; Appendix B). Exposure information was obtained from exposed individuals or their next of kin (i.e., proxy respondents) if the subjects were dead or incapacitated; however, techniques varied across the three studies. There is potential for selection bias due to exclusion of observations with missing covariate data, but only if the lack of the covariate data was associated with glyphosate exposure. The effect estimates for the association between glyphosate exposure and NHL was significant (OR=2.1; 95% CI=1.1–4.0) in the logistic regression analyses controlling for co-exposure to other pesticides. However, utilizing alternative hierarchical regression techniques to adjust for co-exposure to other pesticide exposures, the odds ratio was still elevated, but the increase was not statistically significant (OR=1.6; 95% CI=0.90–2.8).

Eriksson *et al.* (2008) is a Swedish case-control study that used detailed exposure information from exposed individuals (i.e., no use of proxy respondents), but only minimal demographic information was provided on subjects (age and sex) and a table with subject characteristics (e.g., smoking status, alcohol intake, physical activity, education) was not provided. Cases were identified through physicians and verified histopathologically. Glyphosate exposure, which was reported in 29 cases and 18 controls between 1999 and 2003, produced a statistically significant increased OR in the univariate analysis (OR=2.02; 95% CI=1.10–3.71); however, in the

multivariate analysis adjustments were conducted for co-exposure to different agents including MCPA, "2,4,5-Y and/or 2,4-D", mercurial seed dressing, arsenic, creosote, and tar and the OR reduced to 1.51 (95% CI=0.77–2.94) and was not statistically significant. Additional analyses were conducted to investigate the impact of various exposure times. When exposure was for more than 10 cumulative days (the median number of days among exposed controls), the OR was 2.36 (95% CI=1.04–5.37; 17 exposed cases) and for exposure less than 10 cumulative days, the OR was 1.69 (95% CI=0.7–4.07; 12 exposed cases). By dividing the exposed cases and controls using this exposure metric, wider CIs were observed indicating reduced power from the smaller sample sizes. Additionally, these analyses did not account for co-exposure to other pesticides. Similarly, wider CIs were also observed when exposed cases and controls were divided by a longer exposure metric. ORs of 1.11 (95% CI=0.24-5.08) and 2.26 (95% CI=1.16-4.40) were obtained for 1-10 years and >10 years, respectively. It was not clear whether this analysis controlled for co-exposure to other pesticides based on the statistical methods description and the subjects for each exposure group were not reported. This finding, while limited to a single study, suggests that cohort studies without sufficient follow-up time or other case-control studies which did not stratify by time since first exposure may be less sensitive in detecting risk.

Hardell *et al.* (2002) used pooled data from two case-control studies in Sweden (Hardell and Eriksson, 1999; Nordstrom *et al*., 1998; Appendix B) that examined hairy cell leukemia, a subtype of NHL, and NHL (not including hairy cell leukemia). Exposure information was collected from individuals or proxy respondents based on a working history with specific questions on exposures to different chemicals. Cases were identified from regional cancer registries and verified histopathologically. In the univariate analysis, risk of NHL associated with glyphosate exposure was found to be significantly increased (OR=3.04; 95% CI=1.08–8.52), but when study site, vital status, and co-exposure to other pesticides were considered in the multivariate analysis, the OR noticeably attenuated and was found to be non-statistically significant (OR=1.85; 95% CI=0.55–6.20). The wide range of the CI suggests that the analysis is underpowered (only 8 glyphosate-exposed cases and 8 glyphosate-controls).

McDuffie *et al.* (2001) is a multicenter population-based study among men of six Canadian provinces. This case-control study utilized a well-conducted exposure assessment and cases were ascertained from cancer registries or hospitals in six provinces with histopathological verification for 84% of the samples. There are concerns with control selection. There was low control participation (48%) and different sources were used for selecting controls depending on the province of residence. Effect estimates were obtained using a considerable number of exposed cases and controls (51 cases and 133 controls); however, the study did not assess co-exposure to other pesticides. There was a non-statistically significant increased risk of NHL from glyphosate exposure when adjusting for age and province (OR=1.26; 95% CI=0.87–1.80) and when adjusting for age, province and medical variables (OR=1.20; 95% CI=0.83–1.74). Medical variables found to be statistically significant included history of measles, mumps, previous cancer, skin-prick allergy tests, allergy desensitization shots, and a positive family history of cancer in a first-degree relative. It would be expected that effect estimates would attenuate if control for co-exposure to other pesticides had been performed. Additional analyses were conducted to investigate differences in exposure time. When exposure was for more than 2 days/year, the OR was 2.12 (95% CI=1.20-3.73; 23 exposed cases and 36 exposed controls) compared to unexposed subjects and for exposure more than 0 and ≤ 2 days/year, the OR was

1.00 (95% CI=0.63–1.57; 28 exposed cases and 97 exposed controls) compared to unexposed subjects.

Orsi *et al.* (2009) is a French hospital-based case-control study that obtained exposure information from subjects (no proxies used) using a detailed questionnaire with lifelong residential and occupational histories followed by a discussion with a trained interviewer who was blinded to case status. No issues regarding exposure or outcome assessment were identified; however, there is potential for selection bias given the study utilized hospital-based controls. The study evaluated several potential confounders; however, it did not assess co-exposure to other pesticides. There was no association observed between NHL and glyphosate use (OR=1.0; 95% CI=0.5-2.2; 12 exposed cases and 24 exposed controls). The low number of cases and controls exposed to glyphosate and lack of adjustment for exposure to multiple pesticides were limitations of the study.

Schinasi and Leon (2014) conducted a meta-analysis exploring occupational glyphosate exposure and NHL using data from six of the above mentioned studies (McDuffie *et al*., 2001; Hardell *et al*., 2002; De Roos *et al*., 2003; De Roos *et al*., 2005; Eriksson *et al*., 2008; and Orsi *et al*., 2009). Since the authors identified a variety of sources of heterogeneity between publications, they decided a priori to calculate meta-risk ratio estimates and 95% CIs using random effect models, allowing between study heterogeneity to contribute to the variance. I^2 values were reported as a measure of inconsistency in results. For glyphosate, the meta-risk ratio was 1.5 with a 95% CI of 1.1–2.0 and the I^2 value was 32.7% indicating relatively low levels of heterogeneity among these studies. This study combined multiple smaller studies that on their own were very limited in statistical power.

The 2015 IARC evaluation noted that fully adjusted effect estimates in two of the Swedish studies (Hardell *et al*., 2002 and Eriksson *et al*., 2008) were not used in the analysis conducted by Schinasi and Leon (2014). Consequently, the IARC Working Group conducted a reexamination of the results of these studies (IARC 2015). For an association between glyphosate exposure and NHL, the IARC estimated a meta-risk ratio of 1.3 (95% CI=1.03–1.65, I^2 =0%; p=0.589 for heterogeneity).

Chang and Delzell (2016) conducted their own meta-analysis exploring glyphosate exposure and NHL using six independent studies (De Roos *et al.*, 2003; De Roos *et al.*, 2005; Eriksson *et al.*, 2008; Hardell *et al.*, 2002; McDuffie *et al.*, 2001; and Orsi *et al.*, 2009). A meta-risk ratio of 1.3 (95% CI=1.0-1.6) was obtained with an I^2 value of 0.0%. In a secondary analysis, the De Roos *et al.* (2003) OR using hierarchical regression was replaced by the logistic regression OR. This change had no impact on the meta-risk ratio and associated confidence interval (meta-risk ratio=1.3; 95% CI=1.0-1.6). In another secondary analysis, the OR from McDuffie *et al.* (2001) was replaced by the OR from Hohenadel *et al.* (2011), which evaluated the same study population (minus four previously misclassified NHL cases). This analysis also yielded similar results (meta-risk ratio=1.3; 95% CI=1.0-1.7). A final analysis was performed with the replacements for both secondary analyses [i.e., logistic regression OR from De Roos *et al.* (2003) and OR from Hohenadel *et al.* (2011)]. The results were relatively the same as the other meta-analyses (meta-risk ratio=1.4; 95% CI=1.0-1.8). Chang and Delzell (2016) also tested for publication bias using Egger's linear regression approach to evaluating funnel plot asymmetry,

and found no significant asymmetry indicating little evidence of publication bias; however, given the small sample size (n=6), this analysis would lack power and the results are not considered meaningful.

Table 3.4. Summary of Findings: Non-Solid Tumor Cancer Studies.

Study	Study Design	Study Location	Exposure Metric	Adjusted Effec Estimate: RR or OR (95% CI)[a]	Covariate Adjustments in Analyses
Leukemia					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.0 (0.5-1.9)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	 1.0 1.9 (0.8-4.5) 1.0 (0.4-2.9)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	 1.0 1.9 (0.8-4.7) 0.7 (0.2-2.1)	Age, demographic and lifestyle factors, and other pesticides[b]
Brown *et al.* (1990)	Case-Control	USA: Iowa and Minnesota	Ever/never	0.9 (0.5-1.6)	Vital status, age, tobacco use, family history of lymphopoietic cancer, high occupations, and high risk exposures
Multiple Myeloma					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	2.6 (0.7-9.4)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	 1.0 1.1 (0.4-3.5) 1.9 (0.6-6.3)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	 1.0 1.2 (0.4-3.8) 2.1 (0.6-7.0)	Age, demographic and lifestyle factors, and other pesticides[b]
Brown *et al.* (1993)	Case-Control	USA: Iowa	Ever/never	1.7 (0.8-3.6)	Age and vital status
Kachuri *et al.* (2013)	Case-Control	Canada	Ever/never	1.19 (0.76-1.87)	Age, province of residence, smoking status, selected medical conditions, family history of cancer, and use of a proxy respondent
			Days per year of use: 0 to ≤2 days/year >2 days/year	 0.72 (0.39-1.32) 2.04 (0.98-4.23)	Age, province of residence, smoking status, selected medical conditions, family history of cancer, and use of a proxy respondent
Pahwa *et al.* (2012)	Case-Control	Canada	Ever/never	1.22 (0.77-1.93)	Age group, province of residence, and statistically significant medical history variables

Table 3.4. Summary of Findings: Non-Solid Tumor Cancer Studies.

Study	Study Design	Study Location	Exposure Metric	Adjusted Effec Estimate: RR or OR (95% CI)[a]	Covariate Adjustments in Analyses
Orsi *et al.* (2009)	Case-Control	France	Ever/never	2.4 (0.8-7.3)	Age, centre, and socioeconomic category
Monoclonal Gammopathy of Undetermined Significance (MGUS)					
Landgren *et al.* (2009)	Nested Case-Control	USA: Iowa and North Carolina	Ever/never	0.5 (0.2-1.0)	Age and education
Hodgkin Lymphoma (HL)					
Karunanayake *et al.* (2012)	Case-Control	Canada	Ever/never	0.99 (0.62-1.56)	Age group, province of residence, and statistically significant medical history variables
Orsi *et al.* (2009)	Case-Control	France	Ever/never	1.7 (0.6-5.0)	Age, centre, and socioeconomic category
Non-Hodgkin Lymphoma (NHL)					
De Roos *et al.* (2005)	Prospective Cohort	USA: Iowa and North Carolina	Ever/never	1.1 (0.7-1.9)	Age, demographic and lifestyle factors, and other pesticides[b]
			Cumulative Exposure Days (by tertile cut points): 1-20 21-56 57-2,678	1.0 0.7 (0.4-1.4) 0.9 (0.5-1.6)	Age, demographic and lifestyle factors, and other pesticides[b]
			Intensity-Weighted Cumulative Exposure Days (by tertile cut points): 0.1-79.5 79.6-337.1 337.2-18,241	1.0 0.6 (0.3-1.1) 0.8 (0.5-1.4)	Age, demographic and lifestyle factors, and other pesticides[b]
De Roos *et al.* (2003)	Case-Control	USA: Iowa, Nebraska, Minnesota, and Kansas	Ever/never	1.6 (0.9-2.8)	Age, study site, and use of other pesticides
Eriksson *et al.* (2008)	Case-Control	Sweden	Ever/never	Multivariate: 1.51 (0.77-2.94)	Age, sex, year of diagnosis or enrollment, and exposure to other pesticides
			Days per year of use: ≤ 10 days >10 days	1.69 (0.70-4.07) 2.36 (1.04-5.37)	Age, sex, and year of diagnosis or enrollment
			Years of use: 1-10 years >10 years	1.11 (0.24-5.08) 2.26 (1.16-4.40)	Unknown
Hardell *et al.* (2002)	Case-Control	Sweden	Ever/never	Multivariate: 1.85 (0.55-6.20)	Study, study area, vital status, and exposure to other pesticides
McDuffie *et al.* (2001)	Case-Control	Canada	Ever/never	1.20 (0.83-1.74)	Age, province of residence, and statistically significant medical variables
			Days per year of use: >0 and ≤ 2 days	1.00 (0.63-1.57)	Age and province of residence

Table 3.4. Summary of Findings: Non-Solid Tumor Cancer Studies.

Study	Study Design	Study Location	Exposure Metric	Adjusted Effec Estimate: RR or OR (95% CI)[a]	Covariate Adjustments in Analyses
			>2 days	2.12 (1.20 -3.73)	
Orsi *et al.* (2009)	Case-Control	France	Ever/never	1.0 (0.5-2.2)	Age, centre, and socioeconomic category

[a] Some studies report multiple quantitative risk measurements. This table reports the most highly adjusted quantitative measurements.
[b] De Roos *et al.* (2005) excluded subjects missing covariate data for demographic and lifestyle factors and exposure to other pesticides; therefore, the number of subjects included in each analysis varies.

3.6 Discussion

A total of 24 epidemiological studies from the open literature were identified as appropriate for detailed evaluation. Of these, 23 studies were considered informative with regard to the carcinogenic potential of glyphosate. There was no evidence of an association between glyphosate exposure and solid tumors. There was also no evidence of an association between glyphosate exposure and leukemia, or HL. This conclusion is consistent with those recently conducted by IARC, EFSA, and JMPR who also concluded there is no evidence of an association for these tumors at this time. The data should be considered limited though with only one or two studies available for almost all of the cancer types investigated. Additionally, with the increased use of glyphosate following the introduction of glyphosate-tolerant crops in 1996, there is a need for more recent studies since a large number of studies were conducted prior to 1996. As described in Section 1.1, the use pattern changed following the introduction of transgenic crops, which may impact overall effect estimates. The remainder of this discussion focuses on multiple myeloma and NHL. Study elements for the available studies and their potential to impact effect estimates are examined; however, the discussion is applicable in most cases to all of the epidemiological studies used in this evaluation.

Multiple Myeloma

Five studies were available evaluating the association between glyphosate exposure and risk of multiple myeloma (Brown et al., 1993; De Roos et al., 2005; Kachuri et al., 2013; Orsi et al., 2009; Pahwa et al., 2012). The effect estimates for ever/never use ranged from 1.19 to 2.6 although none were found to be statistically significant. Only one study (De Roos et al., 2005) controlled for co-exposures to other pesticides; therefore, potential confounding was not addressed in the other studies. There was an indication of a possible exposure-response relationship; however, this was the only study that evaluated the exposure-response relationship for multiple myeloma. Furthermore, reanalysis of the full dataset by Sorahan (2015) raised concerns about whether the restricted dataset used for these analyses was representative of the whole cohort. There was a single study of MGUS, a precursor to multiple myeloma, which showed decreased risk with exposure to glyphosate; however, the study did not control for exposure to other pesticides. Overall, the available epidemiologic evidence for an association between glyphosate and risk of multiple myeloma is inadequate to assess the carcinogenic potential at this time due to the potential for confounding in three of the four studies, the limited observation of a possible exposure-response relationship in a single study, and concerns whether restricted datasets were representative of the whole cohort.

NHL

Six studies were available evaluating the association between glyphosate exposure and risk of NHL. Effect estimates for ever/never use ranged from 1.0-1.85 in adjusted analyses with none reaching statistical significance (Figure 3.2). Two of these studies did not adjust for co-exposures to other pesticides (McDuffie et al., 2001; Orsi et al., 2009). Many of the evaluated studies had limited power due to small sample sizes, which resulted in large confidence intervals and reduced the reliability of the results to demonstrate a true association. Meta-analyses were performed by IARC (2015) and Chang and Delzell (2016) using these results for the ever/never

use metric. Both analyses reported similar meta-risk ratios ranging from 1.3-1.5, depending on the effect estimates and studies included in the analyses. All meta-analysis estimates reported were non-statistically significant except the meta-risk ratio reported by IARC (2015), which was borderline significant with the lower limit of the 95% CI at 1.03. It should also be noted that publication bias may play a role in this evaluation given there is a tendency to only publish positive results and potential concerns regarding glyphosate have only been raised in recent years.

With respect to meta-analyses, caution should be taken when interpreting results. Meta-analyses are a systematic way to combine data from several studies to estimate a summary effect. Analyses were performed with 6 studies, which many would consider small for performing meta-analyses. Rarely will meta-analyses synthesize data from studies with identical study designs and methods. In the meta-analyses performed by IARC (2015) and Chang and Delzell (2016), inclusion was primarily based on whether a study addressed the broader question regarding the association between glyphosate exposure and risk of NHL. For meaningful results, careful consideration of whether studies are similar and should be combined in the analysis. Furthermore, the bias and confounding issues inherent for each individual study are carried over into the meta-analyses. Across the NHL studies, study characteristics varied, such as overall study design (i.e., cohort and case-control), source population, proxy respondent use, covariate adjustments, and confounding control. Even if these differences are not detected statistically, the meta-analysis estimate should be considered in the context of the data that are used to generate it.

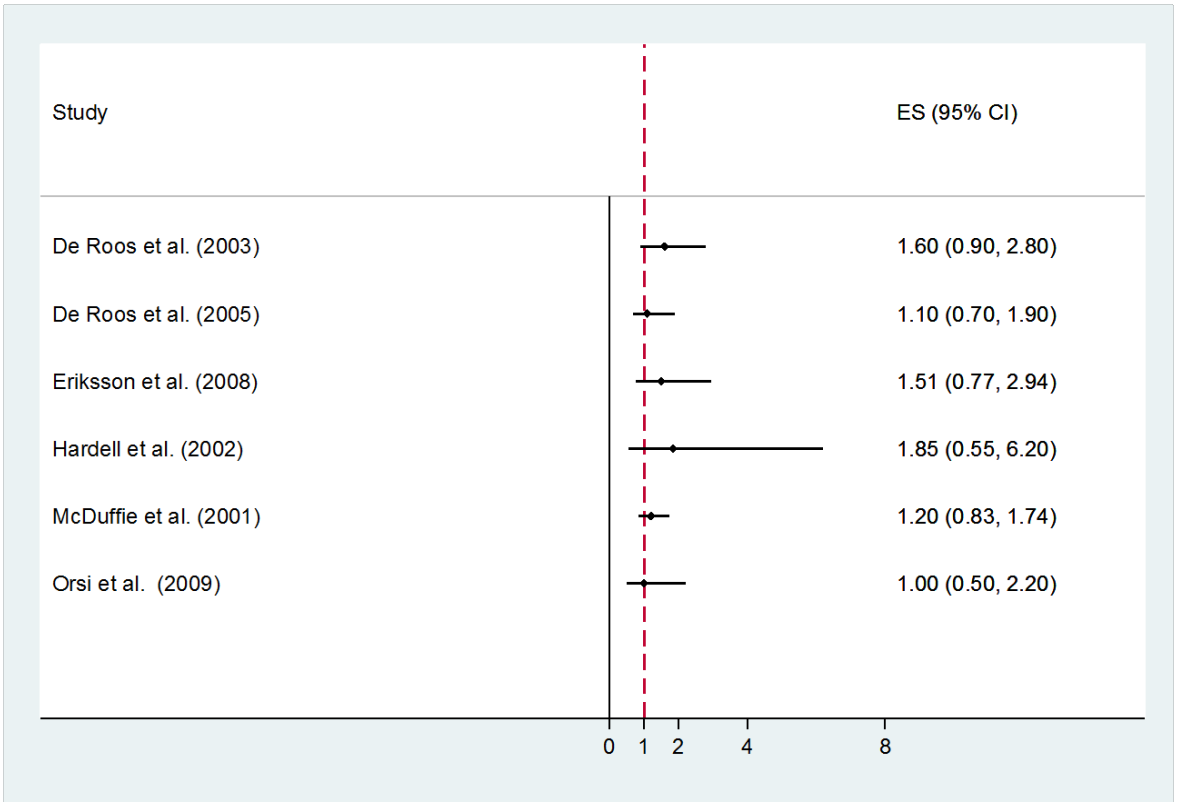

Figure 3.2. Forest plot of effect estimates (denoted as ES for effect sizes) and associated 95% confidence intervals (CI) for Non-Hodgkin lymphoma (NHL).

Using cumulative lifetime and intensity-weighted cumulative exposure metrics, all effect estimates were less than 1 (OR = 0.6-0.9 when comparing to the lowest tertile) in the AHS cohort study (De Roos *et al.*, 2005). Two case-control studies (Eriksson et al., 2008; McDuffie et al., 2001) evaluated the association of glyphosate exposure and NHL stratifying exposure by days per year of use. These studies obtained effect estimates greater than 1, which conflicted with the results in the prospective cohort study; however, these estimates from the case-control studies do not appear to be adjusted for co-exposures to other pesticides. As mentioned previously (and will be discussed further below), there was clearly strong potential for confounding from exposure to other pesticides. In each instance where a study controlled for co-exposure to other pesticides, the adjusted effect estimate decreased in magnitude, including other analyses performed in one of these case-control studies. Consequently, lack of adjustment for co-exposure to other pesticides in these analyses could partially explain the conflicting results between the cohort and case-control studies.

The possible effect of confounding factors, which are related to both the exposure of interest and the risk of disease, may make it difficult to interpret the results. Control for confounding varied considerably across studies (Table 3.2). Studies primarily adjusted for standard variables, such as age, gender, and residency location. Co-exposure to other pesticides was considered for several of the NHL studies for ever/never use (De Roos *et al.*, 2003; De Roos *et al.*, 2005; Eriksson *et al.*, 2008; Hardell *et al.*, 2002); however, analyses of exposure-response and latency effects did not appear to control for these co-exposures.

There is clearly a strong potential for confounding by co-exposures to other pesticides since many are highly correlated and have been reported to be risk factors for NHL. In the studies that did report a quantitative measure adjusted for the use of other pesticides, the risk was always found to be closer to the null than the risk calculated prior to this adjustment. For examples, Eriksson et al. (2008) reported unadjusted and adjusted effect estimates of 2.02 (95% CI: 1.10-3.71) and 1.51 (95% CI:0.77-2.94), respectively. Comparing the magnitude of those effect sizes on the natural log scale, the unadjusted effect was β=0.70 (95% CI: 0.10, 1.31) while the adjusted effect was β=0.41 (95% CI: -0.26, 1.08), suggesting a difference compatible with a degree of confounding by those herbicide co-exposures which appeared to have inflated the unadjusted effect upwards by 70% on the natural log scale (or by 46% on the OR scale). This demonstrates the profound effect this adjustment has on effect estimates and the concern for residual confounding by other pesticides that cause NHL themselves. As discussed in Section 3.2.4, other potential confounders have also been identified. With an association between glyphosate exposure and the outcome of interest, occupational exposure to diesel exhaust fumes, solvents, and UV radiation are highly likely confounders in the NHL studies; however, none of these studies accounted for these potential confounders.

Recall bias and missing data are also limitations in most of the studies. In epidemiologic studies, the quality of the exposure assessment is a major concern since the validity of the evaluations depends in large part on the ability to correctly quantify and classify an individual's exposure. Variation in the quality of exposure assessment, study design and methods, as well as available information concerning potential confounding variables could also explain discrepancies in study findings. During their lifetime, farmers are typically exposed to multiple pesticides and often

several may be used together posing a challenge for identifying specific risk factors. Moreover, there is no direct information on pesticide exposure or absorbed dose because analyses are based on self-reported pesticide use. The studies included in this epidemiology assessment relied primarily on questionnaires and interviews to describe participants' past and/or current exposure to glyphosate. Since the questionnaires are commonly used to account for exposure and capture self-reporting, the results can be subject to misclassification and recall bias.

Furthermore, the use of proxy respondents has the potential to increase recall bias and thus may increase exposure misclassification, especially for proxy respondents not directly involved in farming operations that may be more prone to inaccurate responses than directly interviewed subjects. In some of the NHL studies, the study participants were interviewed directly to assess exposure (De Roos *et al.*, 2005; Eriksson *et al.*, 2008; McDuffie *et al.*, 2001; Orsi *et al.*, 2009), making proxy respondent use a non-issue for these studies. In other studies, however, study participants or proxy respondents were interviewed to assess exposure (Hardell *et al.*, 2002, De Roos *et al.*, 2003). De Roos *et al.* (2003) did not find type of respondent to be statistically significant, but Hardell et al. (2002) did not conduct analyses to evaluate the impact of proxy use In non-NHL studies, proxy analyses were conducted in a small subset (Kachuri *et al.*, 2013; Lee *et al.*, 2004b; Lee *et al.*, 2005; Yiin *et al.*, 2012) and differences in effect estimates were often observed. In a few studies, respondent type was used as an adjustment variable when calculating effect estimates (Band *et al.*, 2011; Kachuri *et al.*, 2013; Lee *et al.*, 2005). As with all study design elements of case-control studies, one concern is whether or not the use of proxy respondents had a differential impact on the cases and controls included in the study because any differential impact may result in differential exposure misclassification. When use of proxy respondents was comparable for cases and controls in the full study population, it could be assumed that there is less concern for potential recall bias from the use of proxy respondents. In Hardell *et al.*, (2002), the percentage of cases and controls with proxy respondents was not fully reported for cases and controls though and this adds a potential source of uncertainty for the study. Moreover, when proxy respondents were used in a study, the percentages were usually reported only for the full study population and were not reported for the specific cases and controls exposed to glyphosate. This lack of information makes it difficult to assess the degree to which recall bias may have occurred due to the use of proxy respondents.

The highest risk measures were reported in studies with subjects developing NHL during a period of relatively low use of glyphosate. For example, Hardell *et al.* (2002) and De Roos *et al.* (2003) acquired cases from 1987-1990 and 1979-1986, respectively. These studies reported the largest adjusted ORs for glyphosate exposure and NHL (1.6 and 1.85); however, these studies investigated subjects prior to the introduction of genetically engineered glyphosate-tolerant crops. As discussed in Section 1.4, glyphosate use dramatically increased following the introduction of genetically engineered glyphosate-tolerant crops in 1996. Prevalence alone would not be expected to result in a corresponding increase in outcomes associated with glyphosate; however, the use pattern changed following the introduction of transgenic crops, such that in addition to new users, individuals already using glyphosate would have a corresponding increase in glyphosate exposure. As a result, if a true association exists between glyphosate exposure and NHL, then a corresponding increase in effect estimates would also be expected during this time. The currently available studies do not display this trend. In more recent years, including the AHS prospective cohort study (De Roos *et al.*, 2005), reported

adjusted risk measures were lower (1.0-1.51). Furthermore, if a true association exists, it would also be expected that the higher effect estimates would be reported in countries where individuals are more exposed to glyphosate, such as the United States and Canada, as compared to countries that exhibit less use[12]. Once again, the expected trend was not observed, such that effect estimates for studies conducted in Sweden (Eriksson *et al.*, 2008; Hardell et al., 2002), where glyphosate-tolerant crops are sparsely grown, were similar or higher than those reported in the United States (De Roos *et al.*, 2003; De Roos *et al.*, 2005) and Canada (McDuffie *et al.*, 2001). These counterintuitive results highlight the need for additional studies to determine the true association between glyphosate exposure and NHL, as well as further elucidate the exposure-response relationship.

Some have argued that the follow-up period (median = 7 years) in De Roos et al. (2005) is not sufficiently long to account for the latency of NHL (Portier et al., 2016); however, the latency period for NHL following environmental exposures is relatively unknown and estimates have ranged from 1-25 years (Fontana et al., 1998; Kato et al., 2005; Weisenburger, 1992). Eriksson et al., 2008) evaluated the impact of time since first exposure. This study found an increased effect estimate for subjects with more than 10 years of glyphosate exposure prior to diagnosis of NHL. This finding suggests a potential for a longer latency for NHL than the follow-up period in De Roos et al. (2005); however, this analysis did not appear to account for co-exposures to other pesticides and the number of subjects in the analysis were not reported. It should be noted that the follow-up time in De Roos et al. (2005) does not represent the amount of time subjects have been exposed. In this study, prior pesticide exposure was provided at time of enrollment and used to evaluate subjects that contribute person-time from enrollment until the point of diagnosis, death, movement from the catchment area, or loss to follow-up. As such, estimated exposure for each subject did not continue to accrue during follow-up. Additionally, subjects were not checked against state registries for inclusion in the cohort. Rather, cancer analyses were restricted to those who are cancer-free at the time of enrollment to remove any issues related to treatment that might impact subsequent cancer risk. At the time of enrollment, the average and median times of exposure 7.5 years and 8 years, respectively, with a standard deviation of 5.3[13]. These values were calculated using the midpoint of exposure categories provided in the questionnaire; therefore, these values represent a range of subject exposure time. Given the majority of the subjects were at least 40 years old at the time of analysis and the recognition that these workers generally start in their profession at a much earlier age and stay in that profession over their lifetime, time of exposure for many of these subjects would be greater than the average and median times. All of this information indicates that subjects within the cohort have ample amount of time for the outcome of interest to develop and be detected during the study. Furthermore, NHL has about 60 subtypes classified by the WHO, which may have etiological differences (Morton *et al.*, 2014). In this evaluation, the analysis of effect estimates was restricted to total NHL due to the small sample sizes in the few instances where NHL subtypes were analyzed. There are concerns with grouping the subtypes together despite etiological differences and the latency period for each NHL subtype may vary due to these etiological differences. Given the latency analysis was limited to Eriksson et al. (2008) and lack of NHL latency understanding in general, further analyses are needed to determine the true

[12] Components in glyphosate formulations in the United States and abroad are similar according to personal communication with Monsanto.
[13] Information provided by email from NIEHS.

latency time of NHL and NHL subtypes. The next update to the AHS cohort study with a longer follow-up would also aid in alleviating any concerns regarding the ability of De Roos et al. (2005) to detect subjects developing NHL.

There are conflicting views on how to interpret the overall results for NHL. Some believe that the data are indicative of a potential association between glyphosate exposure and risk of NHL. This is primarily based on reported effect estimates across studies and the associated meta-analyses greater than 1 despite lack of statistical significance. Additionally, the analysis conducted by Eriksson et al. (2008) observed a slightly statistically significant increase for those with more than 10 years of exposure prior to diagnosis. There were also two case-control studies that investigated the association of glyphosate exposure and NHL by stratifying exposure by days per year of use that reported effect estimates greater than 1 for groups with the highest exposure.

Conversely, others have viewed the effect estimates as relatively small in magnitude and observed associations could be explained by chance and/or bias. All of the effect estimates for ever/never use were non-statistically significant. Sample sizes were small or questionable in some of the studies. Half of the studies reported effect estimates approximately equal to 1, while the other half of the studies reported effect estimates clustered from 1.5-1.85, with the largest effect estimate having the widest confidence interval indicating the estimate was less reliable. As such, the higher effect estimates were contradicted by the results from studies at least equal quality. Meta-analyses were based on studies with varying study characteristics. Given the limitations and concerns discussed above for the studies included in this evaluation, chance and/or bias cannot be excluded as an explanation for the relatively small increase observed in the meta-risk ratios. Meanwhile, analyses performed by De Roos et al. (2005) reported effect estimates less than 1 for cumulative lifetime exposure and intensity-weighted cumulative exposure and these extensive analyses did not detect any exposure-response relationship, which conflicts with the two case-control studies that indicate potential for an exposure-response relationship comparing two groups stratified by days per year of use. Although increased effect estimates were observed in one case-control study (Eriksson et al., 2008) for subjects exposed more than 10 years prior to diagnosis and in two case-control studies (McDuffie et al., 2001; Eriksson et al., 2008) that stratified exposure by days per year of use, none of these analyses appeared to adjust for exposures to other pesticides, which has been found to be particularly important for these analyses and would attenuate these estimates towards the null. Furthermore, none of the studies in this evaluation of glyphosate exposure and risk of NHL accounted for other potential confounders, such as diesel exhaust fumes, solvents, and UV radiation. These adjustments would also be expected to reduce effect estimates towards the null.

Based on the weight-of-evidence, the agency cannot exclude chance and/or bias as an explanation for observed associations in the database. Due to study limitations and contradictory results across studies of at least equal quality, a conclusion regarding the association between glyphosate exposure and risk of NHL cannot be determined based on the available data. The agency will continue to monitor the literature for studies and any updates to the AHS will be considered when available.

4.0 Data Evaluation of Animal Carcinogenicity Studies

4.1 Introduction

Cancer bioassays in animals have historically been the primary studies available to evaluate cancer hazard in humans, since until recently epidemiological evidence was limited. The results of these bioassays, as well as results from screening assays for genotoxicity, are considered in a weight-of-evidence approach to determine the potential of a chemical to induce cancer in humans. Carcinogenicity studies in two rodent species are required for the registration of food use pesticides or when the use of a pesticide is likely to result in repeated human exposure over a considerable portion of the human lifespan (40 CFR Part 158.500). Rodent carcinogenicity studies identified from the data collection phase of the systematic review were evaluated for study quality and acceptable studies were evaluated in the context of the 2005 EPA Guidelines for Carcinogen Risk Assessment as described in Sections 4.2 and 4.3 below, respectively.

4.2 Consideration of Study Quality for Animal Carcinogenicity Studies

The agency has published test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200) and combined chronic/carcinogenicity studies (OCSPP 870.4300) in rodents which have been harmonized with OECD guidelines (Test Nos. 451 and 453). Test substances are typically administered in animal carcinogenicity studies by the oral route for food use pesticides. The studies are generally conducted in mice and rats with exposure durations of 18-24 months for mice and 24 months for rats, which represent exposures of the majority of the expected lifespan in these animals. Guideline carcinogenicity studies are designed to test three or more doses in both sexes (with at least 50 animals/sex/dose) with adequate dose spacing to characterize tumor dose-response relationships. Key considerations when evaluating carcinogenicity studies for cancer hazard assessment include identification of target organs of carcinogenicity, increased incidence of tumors or proportion of malignant neoplasms, and reduction in the time to appearance of tumors relative to the concurrent control group (OECD TG 451).

There are a number of criteria the agency uses when evaluating the technical adequacy of animal carcinogenicity studies. A primary criterion is the determination of the adequacy of dosing. The 2005 EPA Guidelines for Carcinogen Risk Assessment recommends that the highest dose level selected should elicit signs of toxicity without substantially altering the normal life span due to effects other than tumors; or without inducing inappropriate toxicokinetics (e.g., overwhelming absorption or detoxification mechanisms); however, the high dose need not exceed 1,000 mg/kg/day (i.e., limit dose) (OCSPP 870.4200; OCSPP 870.4300). Additional criteria to judge the technical adequacy and acceptability of animal carcinogenicity studies are provided in the test guidelines as well as other published sources (NTP, 1984; OSTP, 1985; Chhabra et al., 1990). As stated in the 2005 EPA Guidelines for Carcinogen Risk Assessment, studies that are judged to be wholly inadequate in protocol, conduct or results, should be discarded from analysis. Studies the agency consider acceptable are further evaluated for potential tumor effects.

Following study quality evaluation, a total of 9 chronic/carcinogenicity studies in the rat and 6 carcinogenicity studies in the mouse were considered acceptable for use in the current evaluation for the active ingredient glyphosate and were subsequently evaluated in the context of the 2005 EPA Guidelines for Carcinogen Risk Assessment as described in Section 4.3. A number of studies were judged to be inadequate in protocol, conduct or reporting and were not considered in the analysis of glyphosate. These studies and the justification for not including them in the analysis are listed below:

1. A two-year chronic oral toxicity study in Albino rats by Reyna (1974)[14]. The study was considered inadequate to assess carcinogenicity due to insufficient reporting on the histopathology findings in the control and treatment groups. Approximately 70 animals were unaccounted for across the study.

2. A two-year drinking water study in Wistar rats with a formulated product (13.6% ammonium salt) by Chruscielska et al., (2000). In addition to deficiencies including inadequate reporting of water consumption and body weight data, this study was conducted with a glyphosate formulated product and not the active ingredient glyphosate, which is the focus of this review. Glyphosate formulations contain various components other than glyphosate and it has been hypothesized these components are more toxic than glyphosate alone. The agency is collaborating with NTP to systematically investigate the mechanism(s) of toxicity for glyphosate and glyphosate formulations. This project is discussed in more detail in Section 7.0 of this document.

3. An initiation-promotion study (George et al., 2010) in male Swiss mice that tested a commercial formulation of glyphosate (41%) on the skin. Study deficiencies included small number (20) of animals, tested only males, and lack of histopathological examination.

4. A carcinogenicity study in Swiss albino mice (Kumar, 2001)[15]. This study was not included due to the presence of a viral infection within the colony, which confounded the interpretation of the study findings. Malignant lymphomas were reported in this study in all dose groups. However, lymphomas are one of the most common types of spontaneous neoplastic lesions in aging mice (Brayton et al., 2012). Murine leukemia viruses (MuLVs) are also a common cause of lymphoma in many different strains of mice (Ward, 2006). For example, Tadesse-Heath et al. (2000) reported 50% lymphoma (mostly B-cell origin) incidence in a colony of Swiss mice infected with MuLVs. Although the lymphoma incidences in Kumar (2001) were within or near normal background variation, it is not clear whether or not the viral infection may have contributed to the lymphoma incidence reported or the lower survival seen at the high dose in this study.

[14] MRID 00062507.
[15] MRID 49987403. In Greim et al. (2015), the same study is cited as Feinchemie Schwebda (2001).

5. A two year feeding study in Sprague-Dawley rats (Excel, 1997) was not included. The agency does not have access to this study to perform an independent assessment of its conduct and; however, Greim et al. (2015) stated that the study "is considered unreliable for carcinogenicity evaluation" and there were "several deviations from the OECD Test Guideline 453".

4.3 Assessment of Animal Carcinogenicity Studies

The agency considers many factors when interpreting the results of carcinogenicity studies. The 2005 EPA Guidelines for Carcinogen Risk Assessment are intended as a guidance only and does not provide a checklist for determining whether tumor findings are related to treatment. These guidelines emphasize the importance of weighing multiple lines of evidence in reaching conclusions regarding human carcinogenic potential of chemicals. Evaluation of observed tumor findings takes into consideration both biological and statistical significance. There are several factors in the 2005 EPA Guidelines for Carcinogen Risk Assessment used in the weight-of-evidence evaluation of individual studies. For this evaluation, the interpretation of the evidence related to tumor findings is described below. The agency is soliciting comment from the SAP regarding several of these factors as they relate to the interpretation of studies as part of Charge Question #3.

Dose Selection

Doses should be selected based on relevant toxicological information. Caution is taken in administering an excessively high dose that would confound the interpretation of the results to humans. As mentioned above, the 2005 EPA Guidelines for Carcinogen Risk Assessment recommends that the highest dose level selected should elicit signs of toxicity without substantially altering the normal life span due to effects other than tumors; or without inducing inappropriate toxicokinetics (e.g., overwhelming absorption or detoxification mechanisms); however, the high dose is not recommended to exceed 1,000 mg/kg/day (OCSPP 870.4200; OCSPP 870.4300). Doses should provide relevant dose-response data for evaluating human hazard for human health risk assessment. In the case of glyphosate, the low (oral) systemic toxicity and limited pharmacokinetic (PK) data for this chemical make it difficult to define a maximum tolerated dose (MTD) for the cancer bioassays. A large number of the carcinogenicity studies conducted with glyphosate approach or exceed the limit dose. The 2005 EPA Guidelines for Carcinogen Risk Assessment state that "weighing of the evidence includes addressing not only the likelihood of human carcinogenic effects of the agent but also the conditions under which such effects may be expressed". As such, the agency puts less weight on observations of tumors that occur near or above the limit dose.

Statistical analyses to evaluate dose response and tumor incidences

The main aim of statistical evaluation is to determine whether exposure to the test agent is associated with an increase in tumor development, rather than due to chance alone. Statistical analyses should be performed on each tumor type separately. The incidence of benign and malignant lesions of the same cell type, usually within a single tissue or organ, are considered

separately, but may be combined when scientifically defensible (McConnell *et al*., 1986). Trend tests and pairwise comparison tests are the recommended tests for determining whether chance, rather than a treatment-related effect, is a plausible explanation for an apparent increase in tumor incidence. The 2005 Guidelines for Carcinogen Risk Assessment states that

"A trend test such as the Cochran-Armitage test (Snedecor and Cochran, 1967) asks whether the results in all dose groups together increase as dose increases. A pairwise comparison test such as the Fisher exact test (Fisher, 1950) asks whether an incidence in one dose group is increased over that of the control group. By convention, for both tests a statically significant comparison one for which *p* is less than 0.05 that the increased incidence is due to chance. Significance in either kind of test is sufficient to reject the hypothesis that chance accounts for the result."

In the current evaluation, the Cochran-Armitage Test for Trend (Snedecor and Cochran, 1967; one-sided) was used. For pairwise comparisons, the Fisher Exact Test (Fisher, 1950; one-sided) was used in the current evaluation to determine if incidences observed in treated groups were different from concurrent controls. Furthermore, the 2005 EPA Guidelines for Carcinogen Risk Assessment state that "considerations of multiple comparisons should also be taken into account". Multiple comparison methods control the familywise error rate, such that the probability of Type I error (incorrect rejection of the null hypothesis or "false positive") for the pairwise comparisons in the family does not exceed the alpha level. In the current evaluation, a Sidak correction method was used to adjust for multiple comparisons.

Forthe current evaluation, statistical significance observed in either test is judged in the context of all of the available evidence. Statistically significant responses may or may not be biologically significant and vice versa (Hsu and Stedeford, 2010; EPA, 2005). If a trend was found to be statistically significant, a closer examination of the tumor incidence was taken to determine whether the data demonstrate a monotonic dose-response where an increase in tumor incidence is expected with corresponding increase in dose. Therefore, statistically significant results with fluctuating tumor incidence across doses are not weighed as heavily as those displaying a monotonic dose-response. If a pair-wise comparison was found to be statistically significant, a closer examination of the tumor incidence and other lines of evidence was taken to determine whether the response was biologically significant. Factors considered in determining the biological relevance of a response are discussed below.

Given that statistical evaluations were performed at different times for each study, all statistical analyses were reanalyzed for the purposes of this evaluation to ensure consistent methods were applied (TXR# 0057494).

Historical Control Data

As indicated in the 2005 EPA Guidelines for Carcinogen Risk Assessment (Section 2.2.2.1.3), the standard for determining statistical significance of tumor incidence comes from a comparison of tumors in dosed animals with those in concurrent control animals. Additional insight into the statistical and/or biological significance of a response can come from the consideration of

historical control data (Tarone, 1982; Haseman, 1995; EPA, 2005). Historical control data can add to the analysis, particularly by enabling identification of uncommon tumor types or high spontaneous incidence of a tumor in a given animal strain. Generally speaking, statistically significant increases in tumors should not be discounted simply because incidence rates in the treated groups are within the range of historical controls or because incidence rates in the concurrent controls are somewhat lower than average.

Historical control data are also useful to determine if concurrent control tumor incidences are consistent with previously reported tumor rates (Haseman, 1995). Given the large number of age-related tumor outcomes in long-term rodent bioassays, and thus the large number of potential statistical tests run, caution is taken when interpreting results that have marginal statistical significance or in which incidence rates in concurrent controls are unusually low in comparison with historical controls since there may be an artificial inflation of the differences between concurrent controls and treated groups. Consequently, in the current evaluation, unusually low incidence in concurrent controls was noted when applicable and considered as part of the weight-of-evidence for the tumor findings. Identification of common or uncommon situations prompts further thought about the meaning of the response in the current study in context with other observations in animal studies and with other evidence about the carcinogenic potential of the agent.

Evidence of supporting preneoplastic lesions or related non-neoplastic lesions

Carcinogenicity rodent studies are designed to examine the production of tumors as well as preneoplastic lesions and other indications of chronic toxicity that may provide evidence of treatment-related effects and insights into the way the test agent produces tumors (EPA, 2005). As such, the presence or lack of supporting preneoplastic or other related non-neoplastic changes were noted in the current evaluation of each study and considered in the weight-of-evidence.

Additional Considerations

Other observations can strengthen or lessen the significance of tumor findings in carcinogenicity studies. Such factors include: uncommon tumor types; tumors at multiple sites; tumors in multiple species, strains, or both sexes; progression of lesions from preneoplastic to benign to malignant; reduced latency of neoplastic lesions (i.e., time to tumor); presence of metastases; unusual magnitude of tumor response; and proportion of malignant tumors (EPA, 2005). The agency considers all of the above factors when determining the significance of tumor findings in animal carcinogenicity studies.

4.4 Summary of Animal Carcinogenicity Studies

A total of 9 chronic toxicity/carcinogenicity studies in the rat and 6 carcinogenicity studies in the mouse were considered acceptable and evaluated in the weight-of-evidence analysis for glyphosate. This includes all of the studies that were part of the 2015 CARC evaluation plus an additional 5 studies identified from the systematic review. In the 2015 CARC evaluation, for some of the studies considered, the CARC relied on summary data that was provided in the supplement to the Greim et al. (2015) review article. Due to the ongoing data collection effort and the acquiring of studies not previously submitted, the agency no longer needs to rely on the

Greim et al. (2015) review article for the study data generated in relevant studies, allowing for a more complete and independent analysis. It should be noted that studies have been cited differently in this evaluation as compared to Greim et al. (2015) so these alternative citations have been noted for applicable studies.

The carcinogenicity studies conducted in the rat and mouse that were considered for the analysis are discussed in Sections 4.5 and 4.6, respectively. In these sections, short study summaries are presented which include information on the study design (including test material, strain of animal used, and doses and route of administration) as well as study findings including effects on survival, general toxicity observed, relevant non-neoplastic lesions, and the incidence and characterization of any tumor findings. The characterization of the tumor response(s) is based on the considerations previously discussed in Section 4.3 for interpreting the significance of tumor findings in animal carcinogenicity studies. The rat and mouse carcinogenicity studies are all summarized in Table 4.11 and Table 4.18, respectively.

4.5 Rat Carcinogenicity Studies with Glyphosate

4.5.1 Burnett et al., 1979 (MRID 00105164)

In a two-year chronic/carcinogenicity oral study, glyphosate (as an aqueous monosodium salt solution) was administered to groups of 90 albino rats/sex/dose at doses of 0, 3, 10, or 30 mg/kg/day (M/F) for 24 months through oral intubation (gavage).

A higher mortality rate was noted in the control group in comparison to the treated groups after 12 and 24 months of testing. No histopathological alterations were observed. There were no treatment-related increases in tumor incidences in the study; however, the highest dose tested in this study was 30 mg/kg/day, which was not considered a maximum tolerable dose to assess the carcinogenic potential of glyphosate.

4.5.2 Lankas, 1981 (MRID 00093879)[16]

In a chronic toxicity/carcinogenicity study, groups of Sprague-Dawley rats (50/sex/dose) were fed diets containing glyphosate (98.7%, pure) at dietary doses of 0, 3/3, 10/11, and 31/34 mg/kg/day (M/F).

There were no treatment-related effects on survival at any dose level. As in Burnett (1979), the highest dose tested of approximately 32 mg/kg/day was not considered a maximum tolerable dose to assess the carcinogenic potential of glyphosate. Consequently, a second study (Stout and Ruecker, 1990) was conducted at higher doses, which is summarized in the Section 4.5.3.

Table 4.1. Testicular Interstitial Cell Tumors in Male Sprague-Dawley Rats (Lankas, 1981) Cochran-Armitage Trend Test & Fisher's Exact Test Results

	0 mg/kg/day	3.05 mg/kg/day	10.3 mg/kg/day	31.49 mg/kg/day

[16] In Greim et al. (2015), the same study is cited as Monsanto (1981).

Table 4.1. Testicular Interstitial Cell Tumors in Male Sprague-Dawley Rats (Lankas, 1981) Cochran-Armitage Trend Test & Fisher's Exact Test Results				
Incidence	0/50	3/47	1/49	6/44
(%)	(0)	(6)	(2)	(12)
Raw p-value =	0.009**	0.121	0.500	0.013*
Sidak p-value =	--	0.321	0.875	0.039*

Note: Trend test results denoted at control; * denotes significance at p=0.05; ** denotes significance at p=0.001.

A statistically significant trend was reported for the testicular interstitial tumors; however, closer examination of the tumor incidence indicates that the data do not demonstrate a monotonic dose response with greater incidence observed at the low-dose as compared at the mid-dose. The incidence at the high dose was found to be statistically significant as compared to the concurrent controls. The observed incidence of interstitial cell tumors in concurrent controls (0%) appears to be unusually low for this tumor type as compared to historical controls provided in the study report for this tumor type (mean = 4.5%; range = 3.4%-6.7%) resulting in an artificial difference at the high dose. Furthermore, the observed incidence of interstitial cell tumors in the glyphosate-treated groups were within the normal biological variation for this tumor type in this strain of rat. There was an absence of pre-neoplastic or related non-neoplastic lesions (e.g., interstitial cell hyperplasia). As a result, the statistically significant results do not appear to be biologically significant and are not supported by any histopathological observations. Based on the weight-of-evidence for this study, the agency does not consider the increases in interstitial cell tumors in the testes to be treatment-related.

4.5.3 Stout and Ruecker, 1990 (MRID 41643801)[17]

In a chronic toxicity/carcinogenicity study, groups of Sprague-Dawley rats (60/sex/dose) were fed diets containing glyphosate (96.5%, pure) at dietary doses of 0, 89/113, 362/457 or 940/1183 mg/kg/day M/F) for 24 months. The highest dose tested in this study approaches or exceeds the highest dose recommended in the test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200 and OCSPP 870.4300). Tumor findings at these high doses are given less weight.

There was no significant increase in mortality. The most frequently seen tumors were pancreatic cell adenomas, hepatocellular adenomas, and thyroid C-cell adenomas in males. A discussion of each tumor type by organ is presented below:

1. Pancreas: Tumor incidences of pancreatic islet cell tumors in male rats and corresponding historical control values are presented in Tables 4.2 and 4.3, respectively. The incidence of pancreatic islet cell tumors lacked monotonic dose-responses and trend analyses were not statistically significant. Statistical significance was observed with raw (unadjusted) p-values for the incidence of adenomas at the low-dose (89 mg/kg/day) and high-dose (940 mg/kg/day) when comparing to concurrent controls; however, none of the incidences were statistically significant with an adjustment for multiple comparisons (p=0.052 at the low-dose and p=0.120 at the high-dose). The statistical significance of

[17] In Greim et al. (2015), the same study is cited as Monsanto (1990).

the pairwise comparisons with the concurrent control group may have been due to the unusually low incidences in the controls and not to an actual treatment-related response. The mean incidence of pancreatic islet cell adenomas in historical control data provided for laboratory (Monsanto Environmental Health Laboratory; MRID No. 41728701) was 5.3% and ranged from 1.8% to 8.3% indicating the concurrent control incidence for this tumor type was at the lower bound of the range. Carcinomas were only observed in the control group and the combined analyses did not yield any statistically significant pairwise comparisons. There were no supporting preneoplastic or other related non-neoplastic changes observed and no evidence of progression from adenomas to carcinomas. Based on a weight-of-evidence for this study, the agency does not consider these increases in pancreatic islet cell tumors to be treatment-related.

Table 4.2. Pancreatic Islet Cell Tumors in Male Sprague-Dawley Rats (Stout and Ruecker, 1990) Cochran-Armitage Trend Test & Fisher's Exact Test Results.

Tumor Type	0 mg/kg/day	89 mg/kg/day	362 mg/kg/day	940 mg/kg/day
Adenoma Incidence (%) Raw p-value = Sidak p-value =	1/43[a] (2) 0.176 --	8/45 (18) 0.018* 0.052	5/49 (10) 0.135 0.352	7/48[b] (15) 0.042* 0.120
Carcinoma Incidence (%) Raw p-value = Sidak p-value =	1/43[c] (2) -[d] --	0/45 (0) 1.000 1.000	0/49 (0) 1.000 1.000	0/48 (0) 1.000 1.000
Combined Incidence (%) Raw p-value = Sidak p-value =	2/43 (2) 0.242 --	8/45 (18) 0.052 0.149	5/49 (10) 0.275 0.619	7/48 (15) 0.108 0.289

Note: Trend test results denoted at control; * denotes significance at p=0.05.

a. Number of tumor-bearing animals/Number of animals examined, excluding those that died or were sacrificed prior to study week 55.

b. First adenoma in the study was observed at week 81 in the 940 mg/kg/day group.

c. First carcinoma in the study was observed at week 105 in the controls.

d. Trend p-value not reported since tumor incidence decreased with increasing dose.

Historical control data on the incidence of pancreatic islet cell adenomas in male Sprague-Dawley rats in 2-year studies (1983–1989) conducted at the testing facility (Monsanto Environmental Health Laboratory; MRID No. 41728701) are presented below in Table 4.3.

Table 4.3. Historical Control Data — Pancreatic Islet Cell Adenomas in Male Sprague- Dawley Rats (MRID No. 41728701).

Study No.	1	2	3	4	5	6	7	Mean
Study Year	07/83	02/85	10/85	6/85	9/88	1/89	3/89	-
Tumor Incidence	2/68	5/59	4/69	1/57	5/60	3/60	3/59	-
Percentage (%)	2.9%	8.5%	5.8%	1.8%	8.3%	5.0%	5.1%	5.3%

2. Liver: Tumor incidences of liver tumors in male rats are presented in Tables 4.4. There was a statistically significant dose trend for liver adenomas only. Closer examination of the incidence indicates a relatively flat response at the low- and mid-dose with only an increase observed at the high-dose (940 mg/kg/day); however, the incidence of liver adenomas at the high-dose was not statistically significant when compared to the concurrent controls. Carcinomas and combined adenomas/carcinomas lacked statistical significance in trend and pairwise comparisons (Table 4.4). Except for a single animal at the mid-dose late in the study (89 weeks), no hyperplasia, preneoplastic foci or other non-neoplastic lesions were observed. Furthermore, there was no evidence of progression from adenomas to carcinomas. Given the lack of both statistical significance and corroborative lesions to support the tumor finding, the agency does not consider these increases in liver tumors to be treatment-related.

Table 4.4. Hepatocellular Tumors in Male Sprague-Dawley Rats (Stout and Ruecker, 1990) Cochran-Armitage Trend Test & Fisher's Exact Test Results

Tumor Type	0 mg/kg/day	89 mg/kg/day	362 mg/kg/day	940 mg/kg/day
Adenoma Incidence (%) Raw p-value = Sidak p-value =	2/44[a] (5) 0.022* --	2/45 (4) 0.700 0.973	3/49 (6) 0.551 0.910	7/48[b] (15) 0.101 0.274
Carcinoma Incidence (%) Raw p-value = Sidak p-value =	3/44 (7) -[d] -	2/45 (4) 0.827 0.995	1/49 (2) 0.954 1.000	2/48[c] (4) 0.845 0.996
Combined Incidence (%) Raw p-value = Sidak p-value =	5/44 (11) 0.078 --	4/45 (9) 0.769 0.988	4/49 (8) 0.808 0.993	9/48 (19) 0.245 0.569

Note: Trend test results denoted at control; * denotes significance at p=0.05.

a. Number of tumor-bearing animals/Number of animals examined, excluding those that died or were sacrificed prior to study week 55.
b. First adenoma in the study was observed at week 88 in the 940 mg/kg/day group.
c. First carcinoma in the study was observed at week 85 in the 940 mg/kg/day group.
d. Trend p-value not reported since tumor incidence decreased with increasing dose.

3. Thyroid: Tumor incidences of thyroid tumors in male and female rats are presented in Tables 4.6 and 4.7, respectively. For males, no statistically significant trends were observed for adenomas, carcinomas, or combined adenomas/carcinomas. For females, a statistically significant trend was observed for adenomas and combined adenomas/carcinomas with no statistically significance in pairwise analyses. Therefore, although there may be an indication of a dose-response in females, the increases observed in the glyphosate treated groups were not considered to be different than those observed in the concurrent controls. Non-neoplastic lesions (thyroid C-cell hyperplasia) were

observed; however, there was a lack of a monotonic dose-response for these histopathological findings and no dose-related increase in severity to support tumor findings (Table 4.8). There was also no evidence of progression from adenomas to carcinomas. Based on a weight-of-evidence for this study, the agency does not consider these increases in thyroid tumors to be treatment-related.

Table 4.6. Thyroid C-Cell Tumors in Male Sprague-Dawley Rats (Stout and Ruecker, 1990) Cochran-Armitage Trend Test & Fisher's Exact Test Results

Tumor Type	0 mg/kg/day	89 mg/kg/day	362 mg/kg/day	940 mg/kg/day
Adenoma Incidence (%) Raw p-value = Sidak p-value =	2/54[a, b] (4) 0.079 --	4/55 (7) 0.348 0.723	8/58 (14) 0.060 0.168	7/58 (12) 0.099 0.269
Carcinoma Incidence (%) Raw p-value = Sidak p-value =	0/54 (0) 0.457 --	2/55[c] (4) 0.252 0.441	0/58 (0) 1.000 1.000	1/58 (4) 0.518 0.768
Combined Incidence (%) Raw p-value = Sidak p-value =	2/54 (4) 0.087 --	6/55 (11) 0.141 0.367	8/58 (14) 0.060 0.168	8/58 (14) 0.060 0.168

Note: Trend test results denoted at control.

a. Number of tumor-bearing animals/Number of animals examined, excluding those that died or were sacrificed prior to study week 55.

b. First adenoma in the study was observed at week 54 in the controls.

c. First carcinoma in the study was observed at week 93 in the 89 mg/kg/day group.

Table 4.7. Thyroid C-Cell Tumors in Female Sprague Dawley Rats Cochran-Armitage Trend Test & Fisher's Exact Test Results (Stout and Ruecker, 1990).

Tumor Type	0 mg/kg/day	113 mg/kg/day	457 mg/kg/day	1183 mg/kg/day
Adenoma Incidence (%) Raw p-value = Sidak p-value =	2/57[a] (4) 0.040* --	2/60 (7) 0.710 0.976	6/59[b] (10) 0.147 0.380	6/55 (11) 0.124 0.328
Carcinoma Incidence (%) Raw p-value = Sidak p-value =	0/57 (0) 0.494 --	0/60 (0) 1.000 1.000	1/59[c] (2) 0.509 0.509	0/55 (0) 1.000 1.000
Adenoma/Carcinoma Incidence (%) Raw p-value = Sidak p-value =	2/57 (4) 0.042* --	2/60 (3) 0.710 0.976	7/59 (12) 0.090 0.246	6/55 (11) 0.124 0.328

Note: Trend test results denoted at control; * denotes significant at p=0.05.

a. Number of tumor-bearing animals/Number of animals examined, excluding those that died or were sacrificed prior to study week 55.

b. First adenoma in the study was observed at week 72 in the controls.
c. First carcinoma in the study was observed at week 93 in the 457 mg/kg/day group.

Table 4.8. Thyroid Non-Neoplastic Lesions (Stout and Ruecker, 1990)				
Males				
Dose	0 mg/kg/day	89 mg/kg/day	362 mg/kg/day	940 mg/kg/day
Total Incidences of thyroid C-cell hyperplasia and severity scores	5/60 (8%) Diffuse (moderate) – 1 Multi-focal (minimal) – 3 Focal (mild) – 1	1/60 (2%) Focal (mild) – 1	6/60 (10%) Focal (minimal) – 4 Multi-focal (minimal) – 1 Multi-Focal (mild) – 1	5/60 (8%) Focal (minimal) – 2 Focal (mild) – 1 Multi-focal (mild) – 1 Multi-focal (moderate) – 1
Females				
	0 mg/kg/day	113 mg/kg/day	457 mg/kg/day	1183 mg/kg/day
Thyroid C-cell hyperplasia and severity scores	10/60 (17%) Diffuse (moderate) – 1 Focal (mild) – 1 Focal (minimal) – 1 Focal (mild) – 1 Focal (moderate) – 1 Multi-focal (minimal) – 3 Multi-focal (moderate) – 1 Diffuse (moderate) – 1	5/60 (8%) Focal (mild) – 3 Focal (minimal) – 1 Multi-focal (minimal) – 1	9/60 (15%) Focal (minimal) – 4 Multi-focal (minimal) – 2 Multi-focal (mild) – 3	5/60 (8%) Focal (mild) – 1 Focal (minimal) – 1 Multi-focal (mild) – 2 Diffuse (moderate) – 1

*Data taken from pages 1071-2114 of the study report.

4.5.4 Atkinson et al., 1993a (MRID 496317023)[18]

In a combined chronic toxicity/carcinogenicity study, glyphosate (98.9% pure) was administered to 50 Sprague-Dawley rats/sex/dose in the diet at doses of 0, 11/12, 112/109, 320/347, and 1147/1134 mg/kg/day for 104 weeks (M/F) for 104 weeks. An additional 35 rats/sex/dose were included for 1-year interim sacrifice.

No adverse effects on survival were seen in either sex across the doses tested. There were no changes in histopathological findings observed. There were no treatment-related increases in tumor incidences in the study.

4.5.5 Brammer, 2001 (MRID 49704601)[19]

In a combined chronic toxicity/carcinogenicity study, glyphosate acid (97.6% pure) was administered to groups of Wistar rats in the diet. Groups of 52 rats/sex received diets containing doses of 0, 121/145, 361/437 or 1214/1498 mg/kg/day for 24 months, in males/females, respectively. The highest dose tested in this study exceeds the highest dose recommended in the

[18] Note: In Greim et al. (2015), the same study is cited as Cheminova (1993a).
[19] Note: In Greim et al. (2015), the same study is cited as Syngenta (2001).

test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200 and OCSPP 870.4300).

A statistically significant higher survival (p=0.02) was observed in males at the highest dose tested at the end of 104 weeks relative to concurrent controls, and a statistically significant trend for improved survival was observed in treated males (p=0.03). The inter-current (early) deaths were 37/52, 36/52, 35/52, and 26/52 for the control, low-, mid-, and high-dose groups, respectively. The terminal deaths were 16/52, 17/52, 18/52, and 26/52 for the control, low-, mid- and high-dose groups, respectively. There were no treatment-related non-neoplastic lesions in any organs of either sex at any dose level tested. As shown in Table 4.9, a statistically significant trend in the incidences of liver adenomas was observed in male rats; however, a monotonic dose-response was not observed upon closer examination of the incidence data. Tumor incidences appear to fluctuate with increases observed at the low- and high-dose and no tumors observed in the control and mid-dose. Statistical significance with raw (unadjusted) p-values was observed for the tumor incidence at the high-dose (1214 mg/kg/day) when compared to concurrent controls; however, it was not statistically significant with an adjustment for multiple comparisons (p= 0.056). Tumor findings at these high doses are given less weight. The improved survival in the high-dose group may help explain a modestly higher incidence of an age-related background tumor like liver adenomas and this corresponds with the lack of associated lesions. Given that the tumor findings did not reflect a monotonic dose response and the high dose tumors were not statistically significant with an adjustment for multiple comparisons, the agency does not consider these increases in liver adenomas to be treatment-related.

Table 4.9. Liver Adenomas in Male Wistar Rats (Brammer, 2001)
Cochran-Armitage Trend Test and Fisher's Exact Test Results.

	0 mg/kg/day	121 mg/kg/day	361 mg/kg/day	1214 mg/kg/day
Adenoma Incidence (%)	0/52[a] (0)	2/52 (4)	0/52 (0)	5/52 (10)
Raw p-value =	0.008**	0.248	1.000	0.028*
Sidak p-value =	--	0.434	1.000	0.056

Note: Trend test results denoted at control; * denotes significance at p=0.05; ** denotes significance at p=0.01
a. Number of tumor-bearing animals/Number of animals examined.

4.5.6 Pavkov and Wyand 1987 (MRIDs 40214007, 41209905, 41209907)

Glyphosate trimesium salt (sulfosate, 56.2% pure) was tested in a 2-year chronic feeding/carcinogenicity study in male and female Sprague-Dawley (Crl:CD[SD]BR) rats. Sixty animals/sex were tested in control group 1 (basal diet, no vehicle), 80/sex were tested in control group 2 (basal diet plus propylene g1ycol at 1% w/w vehicle) and in the low and mid-dose groups, and 90/sex were tested in the high dose group. The following dose levels were tested: 0, 4.2/5.4, 21.2/27 or 41.8/55.7 mg/kg/day in males and females respectively.

Treatment had no effect on survival. There were no changes in histopathological findings observed. There were no treatment-related increases in tumor incidences in the study.

4.5.7 Suresh, 1996 (MRID 49987401)[20]

In a combined chronic toxicity/carcinogenicity study, glyphosate (96.0-96.8% pure) was administered to groups of Wistar rats in the diet. Groups of 50 rats/sex/group received diets containing 0, 6.3/8.6, 59.4/88.5, and 595.2/886 mg/kg/day glyphosate for 24 months in males and females respectively. The highest dose tested in females in this study approaches the highest dose recommended in the test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200 and OCSPP 870.4300).

No adverse effects on survival were observed in either sex across the doses tested. There were no changes in histopathological findings observed. There were no treatment-related increases in tumor incidence observed in the study.

4.5.8 Enemoto, 1997 (MRID 50017103-50017105)[21]

In a combined chronic toxicity and carcinogenicity study, groups of 50 Sprague-Dawley rats/sex/group received daily dietary doses of 0, 104/115, 354/393 and 1127/1247 mg/kg bw/day glyphosate for males and females, respectively. In addition, 10 rats/sex/group were included for interim sacrifices at 26, 52, and 78 weeks. The highest dose tested in this study exceeds the highest dose recommended in the test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200 and OCSPP 870.4300).

There were no changes in mortality at any of the doses tested. There were no changes in histopathological findings observed. There were no treatment-related increases in tumor incidence observed in the study.

4.5.9 Wood et al., 2009a (MRID 49957404)[22]

In a combined chronic toxicity/carcinogenicity study, glyphosate (95.7% pure) was administered to groups of Wistar rats in the diet. Groups of 51 rats/sex/group received diets containing 0, 95.0, 316.9, and 1229.7 mg/kg/day glyphosate for males and female, respectively. The highest dose tested in this study exceeds the highest dose recommended in the test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200 and OCSPP 870.4300).

No adverse effects on survival were seen in either sex across the doses tested. There were no treatment-related preneoplastic or related non-neoplastic lesions in either sex at any dose level.

In female rats, mammary gland tumors were noted. Tumor incidences for mammary gland adenomas, adenocarcinomas, and combined adenomas/adenocarcinomas in female mice are presented in Table 4.10. Statistically significant trends were observed for the adenocarcinoma and combined analyses. Tumor incidence for adenocarcinomas was not statistically significant

[20] Note: In Greim et al. (2015), the same study is cited as Feinchemie Schwebda (1996).
[21] Note: In Greim et al. (2015), the same study is cited as Arysta Life Sciences (1997b).
[22] Note: In Greim et al. (2015), the same study is cited as NuFarm (2009b).

in pairwise comparisons as compared to concurrent controls. Marginal statistical significance was observed with the raw (unadjusted) p-value for combined mammary gland tumors at the high-dose (1229.7 mg/kg/day) when comparing to concurrent controls; however, with an adjustment for multiple comparisons, the increased incidence at the high-dose was not statistically significant (p=0.132). There was also no evidence of progression from adenomas to carcinomas. Based on a weight-of-evidence for this study, the agency does not consider these increases in mammary gland tumors in female rats to be treatment-related.

Table 4.10. Mammary Gland Tumor Incidences in Female Rats (Wood et al., 2009a) Fisher's Exact Test and Cochran-Armitage Trend Test Results

Tumor Type	0 mg/kg/day	95.0 mg/kg/day	316.9 mg/kg/day	1229.7 mg/kg/day
Adenoma				
Incidence	0/51	0/51	0/51	2/51
(%)	(0)	(0)	(0)	(4)
Raw p-value =	0.062	1.000	1.000	0.248
Sidak p-value =	--	1.000	1.000	0.248
Adenocarcinoma				
Incidence	2/51	3/51	1/51	6/51
(%)	(4)	(6)	(2)	(12)
Raw p-value =	0.042*	0.500	0.879	0.135
Sidak p-value =	--	0.875	0.998	0.352
Combined				
Incidence	2/51	3/51	1/51	8/51
(%)	(4)	(6)	(2)	(16)
Raw p-value =	0.007**	0.500	0.879	0.046*
Sidak p-value =	--	0.875	0.998	0.132

Note: Trend test results denoted at control; * denotes significance at p=0.05; ** denotes significant at p=0.01.

4.5.10 Summary of Rat Data

In 5 of the 9 rat studies conducted with glyphosate, no tumors were identified for detailed evaluation. Of the remaining 4 rat studies, a statistically significant trend was observed for tumor incidences in the testes, pancreas, liver, thyroid, or mammary gland; however, the agency determined that these tumor findings are not considered to be related to treatment. Although a statistically significant trend was obtained, closer examination of the incidence data across doses did not demonstrate a monotonic dose response in several instances. Some of the tumor incidences at the highest dose tested (approaching or exceeding 1,000 mg/kg/day for almost all studies) were statistically significant from concurrent controls using raw (unadjusted) p-values; however, none of the pairwise comparisons were found to be statistically significant following adjustment for multiple comparisons, except the testicular tumors seen in a single study. Furthermore, these high-dose tumors were given less weight. There was no evidence of corroborating pre-neoplastic or related non-neoplastic lesions or evidence of tumor progression (progression from pre-neoplastic to malignancy) to support biological significance of tumor findings. In a limited number of cases, the agency considered historical control data to inform the relevance of a tumor increase when incidence rates in the concurrent controls were unusually low.

Table 4.11. Summary of Rat Carcinogenicity Studies			
Study	**Dose Range**	**Pre-Neoplastic or Related Non-Neoplastic Lesions**	**Tumors Incidences, Statistical Significance, and Related Comments**
Burnett et al. (1979) Albino rats	0, 3, 10 or 30 mg/kg/day for 24 months [M/F]	None observed	There were no treatment-related increases in tumor incidences.
Lankas (1981) Sprague-Dawley rats	98.7% Technical in diet 0, 3/3, 10/11, and 31/34 mg/kg/day [M/F]	None observed	Statistically significant trend observed for testicular interstitial cell tumors; however, did not observe monotonic dose-response with higher incidence at low-dose than mid-dose. Incidences were 0/50 in controls, 3/47 at low-dose, 1/49 at mid-dose, and 6/44 at high-dose. Increased incidence at high-dose statistically significant, but unusually low control incidence (based on historical control data in study report) inflated increase at high-dose.
Stout and Ruecker (1990) Sprague-Dawley rats	96.5% Technical in diet 0, 89/113, 362/457 and 940/1183 mg/kg/day [M/F] for 24 months	None observed	Pancreatic tumors lacked statistically significant trend. Tumor incidence for pancreatic adenomas in males were 1/43 in controls, 8/45 at the low-dose, 5/49 at the mid-dose, and 7/48 at the high-dose. Concurrent control incidence for this tumor type was at the lower bound of the historical control range. No statistically significant pairwise comparisons, including the highest dose tested which is approaching/exceeding 1,000 mg/kg/day. Statistically significant trend for liver adenomas in males with only an increase at high-dose. Incidences were 2/44 in controls, 2/45 at the low-dose, 3/49 at the mid-dose, and 7/48 at the high-dose. No statistically significant pairwise comparisons, including the highest dose tested which is approaching/exceeding 1,000 mg/kg/day. No statistically significant trend for thyroid C-cell tumors in males. For females, statistically significant trend for adenomas and combined adenomas/carcinomas. Incidences for adenomas were 2/57 in controls, 2/60 at the low-dose, 6/59 at the mid-dose, and 6/55 at the high-dose. Similar incidences were seen for combined except the mid-dose was 7/59. No statistically significant pairwise comparisons, including the highest dose tested which is approaching/exceeding 1,000 mg/kg/day.
Atkinson et al. (1993a) Sprague-Dawley rats	98.9% Technical in diet 0, 11/12, 112/109, 320/347, and 1147/1134 mg/kg/day for 104 weeks (M/F)	None observed	There were no treatment-related increases in tumor incidences, including the highest dose tested which exceeded 1,000 mg/kg/day.

Table 4.11. Summary of Rat Carcinogenicity Studies			
Study	**Dose Range**	**Pre-Neoplastic or Related Non-Neoplastic Lesions**	**Tumors Incidences, Statistical Significance, and Related Comments**
Brammer. (2001) Wistar rats	97.6% Technical in diet 0, 121/145, 361/437 and 1214/1498 mg/kg/day [M/F]	None observed	Statistically significant trend in liver adenomas in males. Incidences were 0/52 in controls, 2/52 at the low-dose, 0/52 at the mid-dose, and 5/52 at the high-dose. No statistically significant pairwise comparisons when adjusting for multiple comparisons, including the highest dose tested which exceeded 1,000 mg/kg/day.
Pavkov and Wyand (1987) Sprague-Dawley rats	56.2% Technical (Trimesium salt; Sulfosate) 0, 4.2/5.4, 21.2/27 and 41.8/55.7 mg/kg/day [M/F]	None observed	There were no treatment-related increases in tumor incidences.
Suresh (1996) Wistar rats	96.0-96.8% Technical in diet 0, 6.3/8.6, 59.4/88.5, and 595.2/886 mg/kg/day [M/F]	None observed	There were no treatment-related increases in tumor incidences, including the highest dose tested which exceeded 1,000 mg/kg/day.
Enemoto (1997) Sprague-Dawley rats	94.61-97.56% Technical in diet 0, 104/115, 354/393 and 1127/1247 mg/kg/day [M/F]	None observed	There were no treatment-related increases in tumor incidences, including the highest dose tested which exceeded 1,000 mg/kg/day.
Wood et al. (2009a) Wistar rats	95.7% Technical in diet 0, 86/105, 285/349 or 1077/1382 mg/kg/day [M/F]	None observed	Statistically significant trends were observed for the mammary gland adenocarcinoma and combined adenoma/adenocarcinoma analyses. Incidences for adenocarcinomas were 2/51 in controls, 3/51 at the low-dose, 1/51 at the mid-dose, and 6/51 at the high-dose. Similar incidences observed for combined adenoma/adenocarcinomas except incidence at high-dose was 8/51. No statistically significant pairwise comparisons when adjusting for multiple comparisons, including the highest dose tested which exceed 1,000 mg/kg/day.

4.6 Mouse Carcinogenicity Studies with Glyphosate

4.6.1 Reyna and Gordon, 1973 (MRID 00061113)

In an 18-month carcinogenicity study, groups of 50 Swiss white mice/sex/dose were fed glyphosate at dietary levels of approximately 17 mg/kg/day and 50 mg/kg/day. There was no effect on survival at any of the doses tested. There were no changes in histopathological findings observed. There were no treatment-related increases in tumor incidence observed in the study. Although only ten mice/sex/dose were examined for histopathological changes, there were no statistically significant increases in tumors observed in the study; therefore, this deficiency would not impact the overall conclusion regarding tumor findings.

4.6.2 Knezevich and Hogan, 1983 (MRID 00130406)[23]

Groups of 50 male and female CD-1 mice received glyphosate (99.78%, pure) at dietary doses of 0, 161/195, 835/968, 4945/6069 mg/kg/day for males and females, respectively for 24 months. The highest dose tested in this study far exceeds the highest dose recommended in the test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200 and OCSPP 870.4300). Furthermore, the mid-dose tested in this study was approaching 1,000 mg/kg/day. Tumor findings at these high doses are given less weight.

No effect on survival was observed. There were no corroborating lesions to support any tumor findings in this study.

A low incidence of renal tubule adenomas, which are considered rare, were noted in males. The incidences of renal tubule adenomas following initial evaluation of the study were reported as follows: 0/49 in the controls; 0/49 at the low-dose; 1/50 at the mid-dose; and 3/50 at the high dose (TXR No. 0004370). In 1985, the registrant directed a re-evaluation of the original renal sections by a consulting pathologist. This re-evaluation identified a small renal tubule adenoma in one control male mouse, which was not diagnosed as such in the original pathology report. In 1986, at the request of the agency, additional renal sections (3 sections/kidney/mouse spaced at 150 micron intervals) were evaluated in all control and all glyphosate-treated male mice in order to determine if additional tumors were present. The additional pathological and statistical evaluations concluded that the renal tumors in male mice were not compound-related.

Subsequently, the agency requested a Pathology Work Group (PWG) evaluate the kidney sections. The PWG examined all sections of the kidney, including the additional renal sections, and were blinded to treatment group. The renal tubular-cell lesions diagnosed by the PWG are presented below in Table 4.12 with results from statistical analyses. The PWG noted that because differentiation between tubular-cell adenoma and tubular-cell carcinoma is not always clearly apparent and because both lesions are derived from the same cell type, it is appropriate to combine the incidences from these two tumor types for purposes of evaluation and statistical

[23] Note: In Greim et al. (2015), the same study is cited as Monsanto (1983).

analysis. The PWG unanimously concluded that these lesions are not compound-related based on the following considerations: 1) renal tubular cell tumors are spontaneous lesions for which there is a paucity of historical control data for this mouse stock; 2) there was no statistical significance in a pairwise comparison of treated groups with the concurrent controls and there was no evidence of a statistically significant linear trend; 3) multiple renal tumors were not found in any animal; and 4) compound-related nephrotoxic lesions, including pre-neoplastic changes, were not present in male mice in this study (TXR No. 0005590).

Table 4.12. Kidney Tubular Cell Tumors in Male CD-1 Mice (Knezevich and Hogan, 1983) Cochran-Armitage Trend Test & Fisher's Exact Test Results.

Tumor Type	0 mg/kg/day	161 mg/kg/day	835 mg/kg/day	4945 mg/kg/day
Adenoma Incidence (%) Raw p-value = Sidak p-value =	 1/49 (2) 0.4422 --	 0/49 (0) 1.000 1.000	 0/50 (0) 1.000 1.000	 1/50 (2) 0.758 0.986
Carcinoma Incidence (%) Raw p-value = Sidak p-value =	 0/49 (0) 0.063 --	 0/49 (0) 1.000 1.000	 1/50 (2) 0.505 0.755	 2/50 (4) 0.253 0.441
Combined Incidence (%) Raw p-value = Sidak p-value =	 1/49 (2) 0.065 --	 0/49 (0) 1.000 1.000	 1/50 (2) 0.758 0.986	 3/50 (6) 0.316 0.680

Note: Trend test results denoted at control.

Histopathological examinations noted chronic interstitial nephritis and tubular epithelial changes (basophilia and hypertrophy) in the kidneys of male rats in the study (Table 4.13). The increased incidence of chronic interstitial nephritis in males lacked a dose-response. The incidence in controls of bilateral interstitial nephritis was higher than low-dose group and approximately the same as the mid-dose group. Unilateral chronic interstitial nephritis was only seen in 1 animal in the low- and high-dose groups. Furthermore, chronic interstitial nephritis is not considered to be a precursor lesion for tubular neoplasms. A monotonic dose-response was not observed for the epithelial basophilia and hypertrophy, such that the incidence fluctuated with dose and the lowest incidence was observed at the highest dose tested. There was no increase in supporting preneoplastic or related non-neoplastic renal tubular lesions (e.g., tubular epithelial necrosis/regeneration, hyperplasia) observed in male mice.

Table 4.13. Kidney Histopathological Alterations in Male CD-1 Mice (Knezevich and Hogan, 1983)

Males				
Dose	0 mg/kg/day	161 mg/kg/day	835 mg/kg/day	4945 mg/kg/day
Bilateral Chronic Interstitial Nephritis	5/49 (10%)	1/49 (2%)	7/50 (14%)	11/50 (22%)

Unilateral Chronic Interstitial Nephritis	0/49 (0%)	1/49 (2%)	0/49 (0%)	1/50 (2%)
Proximal Tubule Epithelial Basophilia and Hypertrophy	15/49 (31%)	10/49 (20%)	15/50 (30%)	7/50 (14%)

*Data taken from page 305 and 306, and the study pathology report; incidences were moderate diffuse

Based on the weight-of-evidence for this study, the agency concurs with the PWG conclusion, following a thorough examination of all kidney sections, that the renal tubular neoplasms are not treatment-related with a lack of statistical significance in the trend and pairwise tests. Although there was an increase in chronic interstitial nephritis at the highest dose tested, this finding is not considered relevant to the tubular neoplasms.

4.6.3 Atkinson, 1993b (MRID 49631702)[24]

In a carcinogenicity study, glyphosate (>97% pure) was administered to groups of 50 CD-1 mice/sex/dose in the diet for 104 weeks at doses of 0, 98/102, 297/298, 988/1000 mg/kg/day for males and females, respectively. No interim sacrifices were performed.
There was no effect on survival in the study. There were no preneoplastic lesions or related non-neoplastic lesions observed. As shown in Table 4.14, hemangiosarcomas were found in 4/45 (9%) of high-dose male mice (1000 mg/kg/day) compared to none in the concurrent controls or other treated groups. Hemangiosarcomas are commonly observed in mice (generally more common in males for CD-1 strain) as both spontaneous and treatment-related tumors arising from endothelial cells. As vascular tumors, they can occur at different sites, with liver and spleen tending to be the most common sites in mice. In the high-dose mice with hemangiosarcomas, one had the tumors present in the liver and spleen, one had the tumor present in the liver only, one had the tumors present in the liver, spleen, and prostate, and one had the tumor present in the spleen only. A statistically significant trend was observed (p=0.00296). Closer examination of the incidence indicates a relatively flat response at the low- and mid-dose with only an increase observed at the high-dose; however, the incidence of hemangiosarcomas at the high-dose was not statistically significant when compared to the concurrent controls. Based on a weight-of-evidence for this study, the agency does not consider these increases in hemangiosarcomas in male mice to be treatment-related.

Table 4.14. Hemangiosarcomas in Male CD-1 Mice (Atkinson, 1993b) Cochran-Armitage Trend Test and Fisher's Exact Test Results.

Dose (mg/kg/day)	0	100	300	1000
Hemangiosarcoma Incidence (%)	0/47[a] (0)	0/46 (0)	0/50 (0)	4/45 (9)
Raw p-value =	0.003**	1.000	1.000	0.053
Sidak p-value =	--	1.000	1.000	0.053

Note: Trend test results denoted at control; * denotes significance at p=0.05; ** denotes significance at p=0.01
a= Number of tumor bearing animals/Number of animals examined, excluding those that died before week 52.

[24] Note: In Greim et al. (2015), the same study is cited as Cheminova (1993b).

4.6.4 Wood et al., 2009b (MRID 49957402)[25]

In a feeding study conducted in 2009, CD-1 mice (50/sex/dose) received glyphosate (95.7%) for 80 weeks at dietary dose levels of 0, 71.4/97.9, 234.2/299.5, or 810/1081.2 mg/kg/day for males and females, respectively. The highest dose tested in this study approaches or exceeds the highest dose recommended in the test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200 and OCSPP 870.4300).

There was no effect on survival in the study. In male mice at the high dose, there were increases in the incidences of lung adenocarcinomas and malignant lymphomas. A discussion of each tumor type is presented below:

1. Lung: Tumor incidence for lung adenomas, adenocarcinomas, and combined adenomas/adenocarcinomas are presented in Table 4.15. A statistically significant trend was only noted for the adenocarcinomas. Closer examination of the tumor incidence indicates the dose-response was relatively flat at the low- and mid-dose with only an increase observed at the high-dose; however, the incidence of lung adenocarcinomas at the high-dose (810 mg/kg/day) was not statistically significant when compared to the concurrent controls. There were no treatment-related preneoplastic or related non-neoplastic lesions observed. There was also no evidence of progression from adenomas to carcinomas. Based on a weight-of-evidence for this study, the agency does not consider these increases in lung tumors to be treatment-related.

2. Malignant lymphoma: Tumor incidence for malignant lymphoma are also presented in Table 4.16. A statistically significant trend was observed and the incidence at the high-dose (810 mg/kg/day) was statistically significantly elevated as compared to concurrent controls with the raw (unadjusted) p-value; however, with an adjustment for multiple comparisons, the increased incidence at the high-dose was not statistically significant (p= 0.082). Historical control data were also considered to better understand the significance of the reported increased incidence of lymphoma. Historical control data from the same laboratory and same supplier are preferred; however, this data were not available for consideration with the study report. The 2005 EPA Guidelines for Carcinogen Risk Assessment does not prohibit the use of historical control data from other sources; however, it does state it should be used with caution. For this strain of mouse, the mean incidence for untreated animals is approximately 4.5% (range: 1.5%-21.7%) based on historical control data from Charles River (59 studies performed from 1987-2000; Giknis and Clifford, 2005) and Huntingdon Laboratories (20 studies from 1990-2002; Son and Gopinath, 2004). Although the data are not from the performing laboratory, it does indicate that the incidence in concurrent controls in this study was low, which can contribute to the pairwise significance observed at the highest dose tested with the raw (unadjusted) p-value. Based on a weight-of-evidence for this study, the agency does not consider the increase in malignant lymphoma to be treatment-related.

[25] Note: In Greim et al. (2015), the same study is cited as NuFarm (2009a).

Table 4.15. Lung Tumors in Male CD-1 Mice (Wood et al., 2009b) Fisher's Exact Test and Cochran-Armitage Trend Test Results.				
Dose (mg/kg/day)	0	71.4	234.2	810
Lung Adenoma Incidence (%)	9/51 (18)	7/51 (14)	9/51 (18)	4/51 (8)
Raw p-value =	-[b]	0.793	0.602	0.964
Sidak p-value =	-	0.991	0.937	1.000
Lung Adenocarcinoma (%)	5/51[a] (10)	5/51 (10)	7/51 (14)	11/51 (22)
Raw p-value =	0.028*	0.630	0.380	0.086
Sidak p-value =	--	0.949	0.762	0.237
Lung Combined Incidence (%)	14/51 (27)	12/51 (24)	16/51 (31)	15/51 (29)
Raw p-value =	0.336	0.752	0.414	0.500
Sidak p-value =	--	0.985	0.799	0.875

Note: Trend test results denoted at control; * denotes significance at p=0.05;** denotes significance at p=0.01
a= Number of tumor bearing animals/Number of animals examined.
b = Trend p-value not reported since tumor incidence decreased with increasing dose.

Table 4.16. Malignant Lymphomas in Male CD-1 Mice (Wood et al., 2009b) Fisher's Exact Test and Cochran-Armitage Trend Test Results.				
Dose (mg/kg/day)	0	71.4	234.2	810
Malignant Lymphoma Incidence (%)	0/51 (0)	1/51 (2)	2/51 (4)	5/51 (10)
Raw p-value =	0.007**	0.500	0.248	0.028*
Sidak p-value =	--	0.875	0.574	0.082

Note: Trend test results denoted at control; * denotes significance at p=0.05;** denotes significance at p=0.01
a= Number of tumor bearing animals/Number of animals examined.

4.6.5 Sugimoto, 1997 (MRID 50017108 - 50017109)[26]

In a carcinogenicity study, glyphosate (purity 97.56 and 94.61%; two lots) was administered to groups of 50 male and 50 female Specific-Pathogen-Free (SPF) ICR (Crj: CD-1) mice/dose in the diet at dose levels of 0, 165/153.2, 838.1/786.8, or 4348/4116 mg/kg/day for males and females, respectively, for 18 months. The highest dose tested in this study far exceeds the highest dose recommended in the test guidelines on how to conduct carcinogenicity studies (OCSPP 870.4200 and OCSPP 870.4300). Furthermore, the mid-dose tested in this study was approaching 1,000 mg/kg/day. Tumor findings at these high doses are given less weight.

There were no treatment-related effects on mortality or survival. There were no changes in histopathological findings observed.

[26]Note: In Greim et al. (2015), the same study is cited as Arysta Life Sciences (1997b)

Hemangiomas in female mice were found to occur at different sites. The tumor incidences are presented in Table 4.17. A statistically significant trend was observed. Tumor incidence at the high-dose, which was approximately 4 times the recommended high-dose in test guidelines (4116 mg/kg/day), was statistically significant with the raw (unadjusted) p-value as compared to concurrent controls; however, with an adjustment for multiple comparisons, the high dose tumors were not statistically significant (p=0.055). Based on a weight-of-evidence for this study, the agency does not consider these increases in hemangiomas in female rats to be treatment-related.

Table 4.17. Hemangioma Incidences (Sugimoto, 1997)
Fisher's Exact Test and Cochran-Armitage Trend Test Results

Tumor Type	0 mg/kg/day	153.2 mg/kg/day	786.8 mg/kg/day	4116 mg/kg/day
Hemangioma Incidence (%)	0/50 (0)	0/50 (0)	2/50 (4)	5/50 (10)
Raw p-value =	0.002**	1.000	0.247	0.028*
Sidak p-value =	--	1.000	0.434	0.055

Note: Trend test results denoted at control; * denotes significance at p=0.05; ** denotes significance at p=0.01.

4.6.6 Pavkov and Turnier, 1987 (MRIDs 40214006, 41209907)

Glyphosate trimesium salt (sulfosate, 56.2% pure) was tested in a 2-year chronic feeding/carcinogenicity study in male and female CD-1 mice. Sixty animals/sex were tested in control group 1 (basal diet, no vehicle), 80/sex were tested in control group 2 (basal diet plus propylene glycol at 1% w/w vehicle) and in the low- and mid-dose groups, and 90/sex were tested in the high-dose group. The following dose levels were tested: 0, 11.7/16, 118/159, and 991/1341 mg/kg/day for males and females, respectively.

No adverse effects on survival were seen in either sex across the doses tested. There were no changes in histopathological findings observed. There were no treatment-related increases in tumor incidence observed in the study.

4.6.7 Summary of Mouse Data

No tumors were identified for detailed evaluation in 2 of the 6 mouse carcinogenicity studies. In the remaining 4 mouse studies, 3 observed a statistically significant trend in tumor incidences in the hemangiosarcomas, lung adenomas, malignant lymphomas or hemangiomas; however, the agency determined that none of the tumors observed in the mouse are treatment related. Although a statistically significant trend was obtained, closer examination of the incidence data across doses did not demonstrate a monotonic dose response in several instances. Some of the tumor incidences at the highest dose tested (approaching or exceeding 1,000 mg/kg/day for almost all studies) were statistically significant from concurrent controls using raw (unadjusted) p-values; however, none of the pairwise comparisons were found to be statistically significant following adjustment for multiple comparisons. Furthermore, these high-dose tumors were given less weight. There was no evidence of corroborating pre-neoplastic or related non-neoplastic lesions or evidence of tumor progression (progression from pre-neoplastic to malignancy) to support

biological significance of tumor findings. In a limited number of cases, the agency considered historical control data to inform the relevance of a tumor increase when incidence rates in the concurrent controls were unusually low.

Table 4.18. Summary of Mouse Carcinogenicity Studies			
Study	**Dose Range**	**Pre-Neoplastic or Related Non-Neoplastic Lesions**	**Tumors Incidences, Statistical Significance, and Related Comments**
Reyna and Gordon (1973) Swiss white mice	0, 17 or 50 mg/kg/day for 18 months	None observed	There were no treatment-related increases in tumor incidence.
Knezevich and Hogan (1983) CD-1 mice	99.78% Technical in diet 0, 161/195, 835/968, 4945/6069 mg/kg/day for [M/F] for 24 months.	Chronic interstitial nephritis lacked dose-response and not considered relevant to renal tumors. Tubular epithelial changes in kidney were approximately the same in controls, low- and mid-doses and then decreased at high-dose.	The incidences of renal tubule adenomas were: 1/49 (2%) in the controls; 0/49 at the low-dose; 1/50 at the mid-dose; and 3/50 (6%) at the high dose. No statistical significance in trend or pairwise comparisons, including the mid- and high-doses which approached or exceeded 1,000 mg/kg/day.
Atkinson et al. (1993b). CD-1 mice	97.5 - 100.2% Technical in diet 0, 98/102, 297/298, 988/1000 mg/kg/day for 104 weeks (M/F)	None observed	Statistically significant trend for hemangiosarcomas that were only observed in 4/45 (9%) high-dose male mice. Increased incidence was not statistically significant from the concurrent controls at all doses, including the highest dose tested which is approximately 1,000 mg/kg/day.
Wood et al. (2009b) CD-1 mice	95.7% Technical in diet 0, 71.4/97.9, 234.2/299.5, or 810/1081.2 mg/kg/day [M/F] for 80 weeks	None observed	Statistically significant trend for lung adenocarcinomas with incidences of 5/51 in controls, 5/51 at the low-dose, 7/51 at the mid-dose, and 11/51 at the high-dose. No statistical significance in pairwise comparisons. Statistically significant trend for malignant lymphoma with incidences of 0/51 in controls, 1/51 at the low-dose, 2/51 at the mid-dose, and 5/51 at the high-dose. Incidence in concurrent controls for this tumor type was low. No statistically significant pairwise results with multiple comparison adjustment, including the highest dose tested which was approaching 1,000 mg/kg/day.
Sugimoto (1997) CD-1 mice	94.61 – 97.56% Technical in diet 0, 165/153.2, 838.1/786.8, or 4348/4116 mg/kg/day [M/F] for 18 months	None observed	Statistically significant trend for hemangiomas female mice with incidences of 0/50 in controls, 0/50 at the low-dose, 2/50 at the mid-dose, and 5/50 at the high-dose. No statistically significant pairwise results with multiple comparison adjustment, including the mid- and high-doses which approached or exceeded 1,000 mg/kg/day.

Table 4.18. Summary of Mouse Carcinogenicity Studies			
Study	**Dose Range**	**Pre-Neoplastic or Related Non-Neoplastic Lesions**	**Tumors Incidences, Statistical Significance, and Related Comments**
Pavkov and Turnier (1987) CD-1 mice	56.2% Technical (Trimesium salt; Sulfosate) 0, 11.7/16, 118/159, and 991/1341 mg/kg/day [M/F] for 24 months.	None observed	There were no treatment-related increases in tumor incidence, including the highest dose tested which approached/exceeded 1,000 mg/kg/day.

4.7 Absorption, Distribution, Metabolism, Excretion (ADME)

The 2005 EPA Guidelines for Carcinogen Risk Assessment also permit analysis of other key data that may provide valuable insights into the likelihood of human cancer risk from exposure to a chemical, such as information regarding the absorption, distribution, metabolism, and excretion (ADME) of a test chemical. EPA's Harmonized Test Guidelines for pesticides include a series of studies for characterizing a chemical's metabolism and pharmacokinetics. As described in the test guideline (OCSPP 870.7485), testing of the disposition of a test substance is designed to obtain adequate information on its: absorption, distribution, biotransformation (metabolism), and excretion, which can all collectively aid in understanding the chemical's mechanism of toxicity. Basic pharmacokinetic/toxicokinetic parameters determined from these studies can also provide information on the potential for accumulation of the test substance in tissues and/or organs and the potential for induction of biotransformation as a result of exposure to the test substance. These data can be used to assess the adequacy and relevance of the extrapolation of animal toxicity data (particularly chronic toxicity and/or carcinogenicity data) to estimate human risk.

Oral exposure is considered the primary route of concern for glyphosate. The maximum absorption from the GI tract for glyphosate was estimated to be ~30% with one study showing up to 40% based upon radiolabel detected in the urine. In general, the amounts of glyphosate detected in tissues were negligible indicating low tissue retention following dosing. Parent glyphosate is the principal form excreted in urine and feces. The primary route of excretion following oral administration of glyphosate is the feces, as verified by the intravenous dosing and bile cannulation experiments. Within the dose ranges tested, elimination was essentially complete by 24 hours indicating that glyphosate does not bioaccumulate.

Multiple studies examined the pharmacokinetics of a single dose of radiolabeled glyphosate ranging from 5.6 – 400 mg/kg. Across these studies, time to reach peak plasma concentrations (T_{max}) appeared to increase with increasing dose; however, the reported range of T_{max} (1-5.5 hours) suggests only a slight shift in absorption kinetics occurs despite large increases in dose. In the one study that tested two doses (NTP, 1992), data graphically show that peak blood levels were only roughly 3-fold with a 10-fold increase between the two doses. Reported area under the curve (AUC) values indicated conflicting results regarding whether linear or non-linear absorption kinetics was occurring at higher doses.

In general, EPA and OECD guideline ADME studies are designed for a different purpose and do not provide the information needed to adequately determine whether linear kinetics is still occurring at high doses of glyphosate. These studies are often limited to one or two doses and do not include time course data. A well-conducted pharmacokinetic study testing multiple doses is needed to conclusively make this determination.

4.8 Discussion

Glyphosate has been extensively tested in rodents to evaluate its carcinogenic potential. A total of 15 rodent carcinogenicity studies were considered to be adequate for this analysis. Nine studies were conducted in the rat and 6 studies were conducted in the mouse. When a potential tumor signal was identified in a study, the agency considered several factors. Consistent with the EPA's 2005 Guidelines for Carcinogen Risk Assessment, the agency evaluated the tumor responses for both statistical and biological significance by considering factors such as historical control data; rarity of tumor types; tumors at multiple sites; tumors in multiple species, strains, or both sexes; progression of lesions from preneoplastic to benign to malignant; reduced latency of neoplastic lesions (i.e., time to tumor); presence of metastases; unusual magnitude of tumor response; proportion of malignant tumors; and dose-related increases. When these factors were considered together, the agency made a determination of whether or not the observed tumor was related to treatment with glyphosate. A weight of the evidence approach was used to determine the carcinogenic potential of glyphosate in rodents.

In 5 of the 9 rat studies conducted with glyphosate, no tumors were identified for detailed evaluation. Of the remaining 4 rat studies, a statistically significant trend was observed for tumor incidences in the testes, pancreas, liver, thyroid, or mammary gland; however, the agency determined that these tumor findings are not considered to be related to treatment, as described in Section 4.5, due to lack of pairwise statistical significance, lack of a monotonic dose response, absence of preneoplastic or non-neoplastic lesions, no evidence of tumor progression, and/or historical control information (in limited instances). Lastly, tumors seen in individual rat studies were not reproduced in other studies, including those conducted in the same animal species and strain at similar or higher doses.

In 2 of the 6 mouse studies, no tumors were identified for detailed evaluation. In the remaining 4 mouse studies, 3 observed a statistically significant trend in tumor incidences in the hemangiosarcomas, lung adenomas, malignant lymphomas or hemangiomas; however, the agency determined that none of the tumors observed in the mouse are treatment related, as described in Section 4.6, due to lack of pairwise statistical significance, lack of a monotonic dose response, absence of preneoplastic or non-neoplastic lesions, no evidence of tumor progression, and/or historical control information (in limited instances). Lastly, tumors seen in individual mouse studies were not reproduced in other studies, including those conducted in the same animal species and strain at similar or higher doses.

In addition to the lines of evidence considered when determining if a tumor was treatment-related within in a study, the agency also looked across all of the relevant studies to determine if the tumor findings were reproducible in other studies conducted in the same species and strain. Increased incidence of testicular, pancreatic, thyroid and mammary gland tumors were seen in only one study and were not reproduced in the other four studies for that strain at similar or higher doses. An increased incidence of hepatocellular adenomas were seen in one study with Sprague-Dawley rats and one study with Wistar rats, but this tumor type was not significantly

increased in the other six studies tested in these rat strains at similar or higher doses. In the mice, an increase in the incidence of renal tumors, hemangiosarcomas, lung adenomas, malignant lymphoma and hemangiomas were reported only in a single study and findings were not seen in the four other studies conducted in CD-1 mice at similar or higher doses.

When looking across the studies at doses where potential tumor signals were identified, doses below 500 mg/kg/day consistently showed no increased incidence of tumors with the single exception of the testicular tumors in SD rats (Lankas, 1981), where an increase in incidence was seen at approximately 31.5 mg/kg/day. However, as discussed in Section 4.5.2, the testicular tumor data do not show a monotonic dose response, the concurrent controls appear to be unusually low for this tumor, there were no pre-neoplastic or related non-neoplastic lesions, and this tumor type was not seen in other studies at doses up to 35-fold higher in the same strain of rat. As a result, the increased incidence in testicular tumors was not considered treatment-related based on the weight-of-evidence for the study. Even if the tumor findings observed above 500 mg/kg/day were considered indicative of treatment-related effects, the 2005 EPA Guidelines for Carcinogen Risk Assessment state that the "weighing of the evidence includes addressing not only the likelihood of human carcinogenic effects of the agent but also the conditions under which such effects may be expressed". As such, the high doses (~1,000 mg/kg/day or greater) where these tumor findings were observed were considered in the context of potential exposure to glyphosate in residential and occupational settings. As previously discussed in Section 1.4, oral exposure is the primary route of concern for glyphosate. In residential/non-occupational settings, children 1-2 years old are considered the most highly exposed subpopulation with an estimate of potential combined exposure of 0.47 mg/kg/day. The estimated maximum potential exposure for occupational workers is 7 mg/kg/day. The estimate of exposure children and occupational workers is at least 2,000-fold and 140-fold lower, respectively, than the doses (~1000 mg/kg/day) where increases in tumor incidences were typically observed in the rodent studies. Based on these exposure estimates, the high dose tumor findings are not considered relevant for human health risk assessment.

Based on the weight-of-evidence, the agency has determined that any tumor findings observed in the rat and mouse carcinogenicity studies for glyphosate are not considered treatment-related. Tumor findings observed at the highest doses tested were also not reproduced in studies in the same animal strain at similar or higher doses. Furthermore, even if the high-dose tumors were considered treatment-related, these findings are not considered relevant for human health risk assessment based on the use pattern and potential exposures for glyphosate.

5.0 Data Evaluation of Genetic Toxicity

5.1 Introduction

Genotoxicity is a broad term for any damage to the genetic material, whether the damage is transient or permanent. Transient damage refers to unintended modifications to the structure of DNA, which may or may not undergo successful repair. Permanent damage refers to heritable changes in the DNA sequence, known as mutations. Types of mutations include: 1) changes in single base pairs, partial, single or multiple genes, or chromosomes, 2) breaks in chromosomes that result in transmissible deletion, duplication or rearrangement of chromosome segments, and 3) mitotic recombination (OECD, 2015). In somatic cells, DNA-reactive chemicals can cause cancer if the mutations occur within regulatory genes that control cell growth, cell division and differentiation, such as proto-oncogenes, tumor suppressor genes and/or DNA damage response genes (OECD, 2015). Additionally, DNA damage may signal the cell to undergo apoptosis (cell death) rather than cell division and, therefore, the damage is not "fixed" as a mutation and is not passed along to daughter cells.

Evaluation of genotoxicity data entails a weight-of-evidence approach that includes consideration of the various types of genetic damage that can occur. Since no single genotoxicity assay evaluates the many types of genetic alterations that can be induced by a chemical, one must employ a battery of genotoxicity tests to adequately cover all the genetic endpoints important for regulatory decisions. EPA, like other regulatory agencies, considers genotoxicity information as part of the weight of evidence when assessing the potential of a chemical to induce cancer in humans. Under FIFRA, OPP requires genotoxicity tests of the technical grade active ingredient for the registration of both food and non-food use pesticides. The current genotoxicity test battery (40 CFR Part 158.500) for pesticide registration consists of:

> 1) Bacterial reverse mutation test (typically conducted in bacteria strains *Salmonella typhimurium* and *Escherichia coli*),
> 2) *in vitro* mammalian (forward) gene mutation *and in vitro* mammalian chromosomal aberration test, and
> 3) *in vivo* test for micronucleus induction (mammalian erythrocyte micronucleus test) *or in vivo* chromosomal aberration test (mammalian bone marrow chromosomal aberration test).

In cases where equivocal or inconsistent results are obtained for the same endpoint in different test systems, additional testing may be required. Test Guidelines on how to conduct the genotoxicity tests have been published by the agency and have been harmonized with the Organization for Economic Cooperation and Development (OECD, 2015; Cimino 2006). These guidelines identify specific test species, genetic endpoints, test conditions, exposure durations as well information on how to report data and interpret the results. The test guidelines provide a level of consistency and predictability for regulatory compliance and regulatory decision making.

5.2 Scope of the Assessment Considerations for Study Quality Evaluation

Previous genotoxicity assessments conducted as part of the CARC reviews for glyphosate in 1991 and 2015, considered only studies conducted with glyphosate technical and included only studies that provided adequate characterization of the test material (*i.e*. purity information provided). In the current analysis, a fit-for-purpose systematic review process was conducted to identify relevant genotoxicity data from regulatory studies and published literature from open sources (published and unpublished) for both glyphosate technical and glyphosate-based formulations. Studies conducted with glyphosate formulations that were identified and considered relevant for genotoxicity evaluation are summarized in table form in Appendix F. As described in Section 7.0 of this document, glyphosate formulations are hypothesized to be more toxic than glyphosate alone. The agency is collaborating with NTP to systematically investigate the mechanism(s) of toxicity for glyphosate and glyphosate formulations. However the focus of this section is the genotoxic potential of glyphosate technical.

As described previously in Section 2.1.3, the list of studies identified in this process were also cross-referenced with genotoxicity review articles for glyphosate from the open literature [Kier and Kirkland (2013), and Williams *et al.* (2000)], as well as recent international evaluations of glyphosate (IARC 2015, EFSA 2015, JMPR 2016). The current analysis also includes studies conducted by other registrants that were not previously available to the agency. Sixteen studies for glyphosate technical that were included in Kier and Kirkland (2013) were not available to the agency; therefore, data and study summaries provided in the review articles were relied upon in the current review and are identified in the data tables with a footnote. The Kier and Kirkland (2013) article serves as the original publication for these studies and provided relevant information on study design and conditions as well as summary data. The data set includes *in vitro* and *in vivo* studies conducted in mammalian systems, with the exception of standard bacterial test strains, which have a long history of detecting chemicals that are mutagenic in humans. Studies conducted in non-mammalian species (e.g. worms, fish, reptiles, plants), were excluded because they were considered to be not relevant for informing genotoxic risk in humans.

When evaluating the quality of the published and unpublished data for inclusion in the analysis, the agency considered the reporting quality (how well a study was reported), the study design and how well the study was conducted. Critical elements in study design and interpretation for genotoxicity tests are described in the various EPA and OECD test guidelines. Elements such as test conditions (e.g. solubility, pH, osmolarity, and cytotoxicity) and study design (e.g. number of test organisms, doses selected, use of positive and negative controls; blinded evaluation) were used to evaluate the quality of published and non-published studies. In cases where inappropriate testing conditions or study design clearly had an impact on the outcome the study, the study was excluded from the analysis. For example, early studies by Majeska (1982) were excluded from the analysis since it was clearly demonstrated that altered pH by the test chemical can result in false positive responses in several of *in vitro* genotoxicity tests (Majeska, 1985d,e,f). In other cases, particularly with the published literature studies, where test conditions and/or study design differed from what is generally considered as acceptable following in the EPA or OECD guidelines, the differences are noted, but the studies were not excluded from analysis unless the condition made the study unreliable. Summaries of relevant genotoxicity studies can be found in TXR# 0057499. Studies that were excluded from the analysis are listed in Appendix G.

The studies evaluating the genetic toxicity of the active ingredient glyphosate are presented in the following sections according to the type of genetic endpoints evaluated: mutations, chromosomal aberrations and other assays evaluating DNA damage. *In vitro* and *in vivo* assays are discussed separately according to the genetic endpoint. For the purpose of this analysis, glyphosate and its salts are considered together when evaluating the genotoxic potential of the active ingredient glyphosate.

5.3 Tests for Gene Mutations for Glyphosate Technical

5.3.1 Bacterial Mutagenicity Assays

Bacteria have traditionally been employed as a primary test organism for the detection of chemical mutagens. The bacterial reverse mutation assay is routinely performed in the test strains of *Salmonella typhimurium* and *Escherichia coli.* These test strains are mutant strains that are deficient for the synthesis of an essential amino acid. The assay detects mutations that revert the test strains back to wild type for amino acid synthesis and the revertants are identified by their ability to grow in culture medium deficient of the specific amino acid(s). This mutagenicity test identifies point mutations, which includes base substitutions and deletions and insertions of up to a few base pairs (OECD 471). The tests are typically conducted in the presence and absence of an exogenous source of metabolic activation (e.g., S9 microsomal fraction of activated liver homogenates) to identify potential mutagenic metabolites.

Glyphosate has been extensively evaluated for its potential to induce mutations in bacteria. Most of the studies considered consist of the full battery of bacterial strains (*i.e.* the recommend strains in EPA and OECD Test Guidelines) and were evaluated at appropriate test concentrations (up to cytotoxic or assay limit concentrations).

EPA identified 27 studies that tested glyphosate technical in bacterial mutagenicity assays by means of the standard plate incorporation method or the pre-incubation modification of the standard assay. Glyphosate was negative in the presence and absence of metabolic activation in all the studies. The results of the bacterial reversion mutation assays evaluating glyphosate technical are presented in Table 5.1

Table 5.1. *In vitro* Test for Gene Mutations in Bacteria: Glyphosate Technical.

Test/Endpoint	Test System	Concentrations	Purity	Results	Reference	Comments
Bacterial Reverse Mutation	*S. typhimurium* TA1535, TA1537, TA98 and TA100 and WP *uvrA* ± S9	156-5000 µg/plate	95.68%	Negative ± S9	Akanuma (1995) [MRID 50017102]	
Bacterial Reverse Mutation	*S. typhimurium* TA535, TA1537, TA98 and TA100 and *E. coli* WP2P and WP2P *uvrA* ± S9	100-5000 µg/plate in DMSO	95.6% glyphosate acid	Negative ± S9	Callander (1996) [MRID 44320617]	
Bacterial Reverse Mutation	*S. typhimurium* TA 1535, TA1537, TA98 and TA100 and *E. coli* WP2P and WP2P *uvrA* ± S9	100-5000 µg/plate in water	60% potassium glyphosate salt	Negative ± S9	Callander (1999)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA97a, TA98, TA100 and TA102, ± S9	25-2000 µg in aqueous solution	Not provided	Negative ± S9	Chruscielska *et al.* (2000)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 ± S9	10-1000 µg/plate	98.4%	Negative ± S9	Flowers and Kier (1978) [MRID 00078620]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, TA1537 ± S9	31.6-3160 µg/plate	98.8%	Negative ± S9	Flügge (2009a)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, TA1537 ± S9	31.6-3160 µg/plate	96.4% technical	Negative ± S9	Flügge (2010b)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA1535, TA1537, TA98 and TA100	310-5000 µg/plate (+S9); 160-2500 µg/plate (−S9)	98.6%	Negative ± S9	Jensen (1991a) [MRID 49961502]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, TA1537 ± S9	1-1000 µg/plate	98.05%	Negative ± S9	Miyaji (2008)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537, TA1538 ± S9	5000 µg/plate	Not reported	Negative ± S9	Moriya et al. (1983)	
Bacterial Reverse Mutation	*S. typhimurium* TA1535, TA97, TA98 and TA100 ± S9	33-10,000 µg/plate	99%	Negative ± S9	NTP (1992)	Hamster and rat S9

Table 5.1. *In vitro* Test for Gene Mutations in Bacteria: Glyphosate Technical.						
Test/Endpoint	**Test System**	**Concentrations**	**Purity**	**Results**	**Reference**	**Comments**
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535 and TA97a ± S9	1-5000 µg/plate	61.27 % Glyphosate isopropyl-amine salt	Negative ± S9	Ranzani (2000)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, TA1537 ± S9	648-5000 µg/plate	98.01%	Negative ± S9	Ribeiro do Val (2007) [MRID 50000903]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. Coli* WP2 *uvrA* ± S9	31.6-5000 µg/plate	96.0% technical	Negative ± S9	Schreib (2010)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA1535, TA1537, TA1538, TA98, TA100 and *E. coli* WP2 *hcr* ± S9	10-5000 µg/plate	98.4%	Negative ± S9	Shirasu *et al*. (1978) [MRID 00078619]	Published in Li & Long, 1988
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP *uvrA* ± S9	3-5000 µg/plate (plate-incorporation), 33-5000 µg/plate (pre-incubation test)	95.1%	Negative ± S9	Sokolowski (2007a) [MRID 49957406]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP *uvrA* ± S9	3-5000 µg/plate (plate–incorporation) 33 – 5000 µg/plate (pre-incubation test)	97.7%	Negative ± S9	Sokolowski (2007b) [MRID 49957407]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP *uvrA* ± S9	3-5000 µg/plate (plate–incorporation) 33-5000 µg/plate (pre-incubation test)	95.0%	Negative ± S9	Sokolowski (2007c) [MRID 49957408]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP *uvrA* ± S9	3-5000 µg/plate	96.66% technical	Negative ± S9	Sokolowski (2009a)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* pKM 101 and WP2 pKM 101 ± S9	3-5000 µg/plate	96.3% glyphosate acid	Negative ± S9	Sokolowski (2009b) [MRID 49961801]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP *uvrA* ± S9	3-5000 µg/plate	97.16 %	Negative ± S9	Sokolowski (2010) [MRID 50000902]	

Table 5.1. *In vitro* Test for Gene Mutations in Bacteria: Glyphosate Technical.

Test/Endpoint	Test System	Concentrations	Purity	Results	Reference	Comments
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537, TA1538 ± S9	1-1000 µg/plate	96.0%	Negative ± S9	Suresh (1993a)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP *uvrA* ± S9	0-5000 µg/plate	95.3%	Negative ± S9	Thompson (1996) [MRID 49957409]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, TA1537 ± S9	31.6-5000 µg/plate	98.2%	Negative ± S9	Wallner (2010)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98 and TA100 ± S9	25 µg/plate	Not reported	Negative ± S9	Wilderman and Nazar (1982)	Rat S9 and plant cell-free homogenates were used for metabolic activation
Bacterial Reverse Mutation	*S. typhimurium* TA1535, TA1537, TA1538, TA98 and TA100 ± S9	0.12-10 mg/plate –S9 0.56-15 mg/plate +S9	90% glyphosate trimesium salt	Negative ± S9	Majeska et al. (1982a) [MRID 00126612]	
Bacterial Reverse Mutation	*S. typhimurium* TA1535, TA1537, TA98 and TA100 ± S9	0.005-50 µL/mL	55.6% glyphosate trimesium salt	Negative ± S9	Majeska (1985a) [MRID 00155527]	

[1] Study was cited in Kier and Kirkland (2013). Supplementary information about the study was provided online including test guideline, test material purity, control chemicals and summary data tables.

5.3.2 *In vitro* Tests for Gene Mutations in Mammalian Cells

In vitro gene mutation studies in mammalian cells are conducted in cell lines with reporter genes for forward mutations. The most common reporter genes are the endogenous thymidine kinase (TK) gene, endogenous hypoxanthine-guanine phosphoribosyl transferase (HPRT) gene and the xanthine-guanine phosphoribosyl transferase transgene (XPRT). Mutations that occur within these reporter genes result in mutant cells that are resistant to the cytotoxic effect of the pyrimidine analogue trifluorothymidine (for TK) or the purine analogue 6-thioguanine (for HPRT and XPRT) (OPPTS 870.5330). Suitable cell lines for this assay include L5178Y mouse lymphoma cells, Chinese hamster ovary (CHO) cells, hamster AS52 and V79 lung fibroblasts and human TK6 lymphoblastoid cells. Similar to other *in vitro* assays, chemicals are tested both in the presence and absence of S9 metabolic activation.

A total of four studies were conducted for (forward) mutations in mammalian cells (Table 5.3). Three studies were conducted with a high purity concentration of glyphosate technical (≥95.6%) and the remaining study was performed with glyphosate trimesium salt. In four of the assays, mouse lymphoma L5178Y $TK^{+/-}$ cells were the target organism and one was conducted in CHO cells with the HPRT endpoint. Glyphosate technical and the glyphosate trimesium salt were negative in the mouse lymphoma cell assays (Jensen, 1991b; Clay, 1996; Majesak, 1985b) when tested up to the current guideline limit concentration and glyphosate was negative in CHO/HPRT cells when tested up to cytotoxic concentrations (Li, 1983a).

Table 5.2. *In vitro* Mammalian Gene Mutation Assays: Glyphosate Technical.

Test/Endpoint	Test System	Concentrations/ Conditions	Test Material Purity	Results	Reference	Comments
Gene Mutations in Mammalian Cells	Mouse lymphoma L5178Y $TK^{+/-}$ cells ± S9	296-1000 µg/mL	95.6%	Negative	Clay (1996)[1]	Relative survival was 90% (-S9) and 57% (+S9) at top concentration
Gene Mutations in Mammalian Cells	Mouse lymphoma L5178Y $TK^{+/-}$ cells ± S9	520–4200 µg/mL (+S9); 610–5000 µg/mL (-S9)	98.6%	Negative	Jensen (1991b) [MRID 49961504]	Reported no significant reduction in cloning efficiency at any concentration.
Gene Mutations in Mammalian Cells	Chinese hamster ovary (CHO) cells, HPRT locus ± S9	500–25000 µg/mL (+S9); 500-22500 µg/mL (-S9)	98.7%	Negative	Li (1983a); [MRID 00132681]	Tested S9 from 1-10% Cytotoxic at 22.5 mg/mL (-S9, and with 1,2 and 10% S9) and at 17.5 mg/ml (10% S9)
Gene Mutations in Mammalian Cells	Mouse lymphoma L5178Y $TK^{+/-}$ cells ± S9	1-5 µl/mL	55.6% *Glyphosate trimesium salt*	Negative	Majeska (1985b) [MRID 00155530]	Negative with pH adjusted

[1] Study was cited in Kier and Kirkland (2013). Supplementary information about the study was provided online including test guideline, test material purity, control chemicals and summary data tables.

5.4 *In vitro* Tests for Chromosomal Abnormalities

Cytogenetic assays are tests that can detect chemicals that cause structural chromosomal damage (clastogenicity) or affect the segregation of chromosomes during cell division and alter chromosome number (aneuploidy). Generally, there are two types of *in vitro* cytogenetic assays that identify chemicals inducing chromosomal abnormalities: chromosomal aberration assays and micronucleus assays. Although chromosomal damage observed in these assays are not considered heritable mutations, chemicals that can induce these types of chromosomal damage can also induce transmissible mutations to daughter cells indicating their role in cancer (Yauk *et al.*, 2015; OECD 2015). In addition, assays such as (fluorescence *in situ* hybridization (FISH)) can provide additional mechanistic information on the formation of chromosomal abnormalities. It is important to note that factors such as cytotoxicity, solubility of the test substance, changes in pH or osmolality play a significant role in the outcome of the assay. Like other *in vitro* assays, compounds are generally tested in the presence or absence of S9 metabolic activation to determine if metabolism affects the genotoxic activity of the parent compound and to determine if potential genotoxic metabolites are formed.

5.4.1 *In vitro* Mammalian Chromosomal Aberration Test

Chromosomal aberration assays detect both structural chromosomal and numerical aberrations. Structural chromosomal aberrations are of two types: chromatid and chromosome and include breaks, deletions and rearrangements (OPPTS 870.5375, OECD 2015). Numerical chromosomal aberrations generally results from the loss of an entire chromosome mostly due to damage in the spindle fiber resulting in aneuploidy. The types of cells that are most commonly used in chromosomal aberration assays include established cell lines such as Chinese hamster lung (CHL) and CHO cells or primary cell cultures such as human or other mammalian peripheral blood lymphocytes. In this assay, cells are typically sampled at a time equivalent to the length of approximately 1.5 cell cycles from the start of treatment. Prior to harvesting, cells are treated with Colcemid® or colchicine to arrest cells at the first metaphase stage of the cell cycle following the beginning of exposure to the test article. Once harvested, the cells are stained and metaphase cells are evaluated microscopically for various types of chromosome aberrations. (OECD TG 473). Data should be presented in a way that indicates the percentage of affected cells in the population of cells scored (e.g., % cells with aberrations or # aberrant cells/100 cells). Gaps should not be included in the analysis; they are scored but gaps alone in the absence of any additional chromosomal aberrations (e.g., a fragment or a ring chromosome) are not sufficient to define a cell as aberrant.

Glyphosate technical was evaluated in eight chromosomal aberrations tests to determine its potential to induce clastogenic effects *in vitro*. The findings are presented in Table 5.3. Six of the eight studies were negative. The two positive studies were both from the same laboratory where, Lioi *et al*. reported an increase in chromosomal aberrations at glyphosate concentrations of 8.5µM and above in bovine lymphocytes (Lioi et al., 1998b) and at all concentrations of glyphosate tested (7-170 µM) in human lymphocytes (Lioi et al., 1998a) following a 72-hour exposure period. No chromosomal aberrations were observed as a result of exposure to glyphosate in one study using CHO cells (Majeska, 1985c) and in two studies with CHL cells

(Matsumoto, 1995; and Wright, 1996). Sivikova and Dianovsky (2006) reported no statistically significant increases in chromosomal aberrations in bovine lymphocytes treated with glyphosate (62% pure) at concentrations up 1120 µM following 24-hour exposure. (Sivikova and Dianovsky, 2006). In studies conducted with human lymphocytes treated with glyphosate (≥95%) for 24-96 hours at concentrations, no increase in chromosomal aberrations were seen at concentrations as high as 6000 µM (Fox, 1998; and Manas *et al*., 2009).

5.4.2 *In vitro* Mammalian Micronucleus Test

The *in vitro* micronucleus test can detect the induction of micronuclei in the cytoplasm of cells in the interphase stage of the cell cycle. Micronuclei form from acentric chromosome fragments (i.e., chromosome fragments lacking a centromere) or when whole chromosomes are unable to migrate to the cellular poles during anaphase prior to cell division. (OECD 487). Thus, the micronucleus assay can detect both structural and numerical chromosomal changes. It should be noted, however, that additional work is required to distinguish whether induced micronuclei have arisen from a clastogenic versus an aneugenic mechanism, *e.g*., staining micronuclei to detect the presence of kinetochore proteins. The assay is typically performed with cell lines or primary cell cultures of human or rodent origin. The assay can be conducted with the addition of cytochalasin B which inhibits cytokinesis resulting in the formation of binucleated cells. The presence of binucleated cells, indicates that cells have undergone one round of mitosis, a necessary prerequisite for micronucleus formation.

Six studies evaluated glyphosate technical for its potential to induce micronuclei *in vitro* (Table 5.4). Four of the six studies were positive and the remaining two studies were equivocal. In a study by Koller *et al*. (2012), TR146 cells (derived from a human neck metastasis of buccal epithelial origin) were treated for 20 minutes with up to 20 mg/L (~0.12 mM) glyphosate (95%), the authors reported a statistically significant increase in binucleated cells with micronuclei at 15 (~0.09 mM) and 20 (~0.12 mM) mg/L, and also indicated significant apoptosis and necrosis at 20 mg/L. The short exposure period in this study was unusually short (20 minutes) and was conducted in a tumor cell line that had not been well characterized in regards to its degree of chromosomal instability and DNA damage and repair capacity. In another study, Roustan *et al*. (2014) reported positive findings +S9 only in CHO cells treated with glyphosate (unknown purity) at 10- 100 µg/mL with little evidence of a dose response over that concentration range.

Two other studies evaluated glyphosate technical in human lymphocytes (Mladinic *et al*., 2009a, 2009b). These studies used an exposure protocol that is different from the OECD recommendations for the *in vitro* micronucleus assay. OECD recommends that whole blood or isolated lymphocytes are cultured in the presence of a mitogen (e.g. phytohemagglutinin; PHA) prior to exposure of a test chemical in order to detect micronuclei formed via an aneugenic mechanism. However, in these two studies, blood cells were exposed to glyphosate for 4 hours, washed, and then treated with PHA to stimulate cell division. Both studies reported a statistically significant increase in micronucleated cells at 580 µg/mL (~3.4 mM), but not at lower concentrations, following 4-hour exposures in the presence of S9. The frequency of micronucleated cells (+S9) ranged from 11.3 to 28.7 in one study (Mladinic *et al*., 2009a) and 33.3 to 65.2 in the other study (Mladinic *et al*., 2009b) over the 1000-fold concentration range. No statistically significant increases in micronucleated cells were seen in either study in the absence of S9 activation. When cells were evaluated with vital stains, cells treated with 580

μg/mL showed a significant ($p<0.05$) increase in the percentage of cells undergoing apoptosis and necrosis compared to the negative controls.

Piesova et al. (2004, 2005) conducted two *in vitro* micronucleus studies using glyphosate technical (62%) up to 560 uM in bovine lymphocytes. In the 2004 study, bovine lymphocytes from two donors were treated for 24 or 48 hours without S9 metabolic activation, and for 2 hours (with and without S9 activation) or 48 hours (-S9) in the 2005 study. Both studies yielded similar results following 48-hour exposure to glyphosate. In both cases, the authors reported a weak induction of micronuclei in one donor at 280 μM and at 560 μM in the second donor. The induction was approximately 2-fold ($p < 0.05$), but with no clear dose response. No effects on micronuclei induction were seen at the 2- or 24-hour time points; however, with these early time points it is unlikely that one cell division has occurred during or after treatment. .

Table 5.3. *In vitro* Tests for Chromosome Aberrations in Mammalian Cells- Glyphosate Technical

Test/Endpoint	Test System	Concentrations/ Conditions	Test Material Purity	Results	Reference	Comments
In vitro Chromosomal Aberration	Chinese hamster ovary (CHO) cells	4-10 µl/mL, ± S9	55.6% *Glyphosate trimesium salt*	Negative	Majeska (1985c) [MRID 00155530]	pH adjusted (7.4-7.6)
In vitro Chromosomal Aberration	Chinese Hamster lung (CHL) cells	±S9: 0, 250, 500, 1000 and 2000 µg/mL; 24 and 48 h treatment - S9; 6 h treatment ±S9 harvest 24 h	95.68%	Negative	Matsumoto (1995) [MRID 50017106]	Decline in pH noted at 500 and 1000 µg/mL.
In vitro Chromosomal Aberration	Chinese hamster lung (CHL) cells	-S9: 24 & 48-hr exposure: 0-1250 µg/mL; +S9: 0-1250 µg/mL	95.3%	Negative	Wright (1996) [MRID 49957410]	Excessive decrease in pH >1250 µg/mL
In vitro Chromosomal Aberration	Bovine lymphocytes	-S9 only: 0, 7, 85 and 170 µM; 72 h exposure	≥98%	Positive (all concs.)	Lioi *et al.* (1998b)	
In vitro Chromosomal Aberration	Bovine lymphocytes	±S9: 0, 28, 56, 140, 280, 560 and 1120 µM; 24 h exposure	62.0%	Negative	Sivikova and Dianovsky (2006)	Decreased MI and PI at ≥ 560 µM
In vitro Chromosomal Aberration	Human lymphocytes	±S9: 100-1250 µg/mL cultures analyzed; 68 & 92 h	95.6%	Negative	Fox (1998) [MRID 49961803]	Excessive decrease in pH >1250 µg/mL
In vitro Chromosomal Aberration	Human lymphocytes	-S9 only: 0, 5.0, 8.5, 17.0 and 51.1 µM; 72 h exposure	≥98%	Positive ≥ 8.5 µM	Lioi *et al.* (1998a)	No significant ↓ in MI observed.
In vitro Chromosomal Aberration	Human lymphocytes	-S9: 0, 200, 1200 and 6000 µM; 48 h exposure	96.0%	Negative	Manas *et al.* (2009)	No toxicity observed up to 6000 µM

[1] Study was cited in Kier and Kirkland (2013). Supplementary information about the study was provided online including test guideline, test material purity, control chemicals and summary data tables.
CA= chromosomal aberrations, MI= mitotic index, PI= proliferation index.

Table 5.4. *In vitro* Tests for Micronuclei Induction in Mammalian Cells- Glyphosate Technical

Test/Endpoint	Test System	Concentrations/ Conditions	Test Material Purity	Results	Reference	Comments
In vitro Cytokinesis Block Micronucleus Assay (with FISH analysis)	TR146 cells (human-derived buccal carcinoma cell line)	10, 15 and 20 mg/L; 20 minute exposure.	95%	Positive Statistically significant ($p<0.05$) increase in MN at 15 and 20 mg/L.	Koller *et al.* (2012)	Apoptosis and necrosis reported at 20 mg/L Also reported ↑ in NB and NPB
In vitro Cytokinesis Block Micronucleus Test	CHO-K1 cells	5 - 100 µg/mL, ±S9	Not stated	Negative –S9 Positive +S9 at 10-100 µg/mL	Roustan et al., (2014)	No clear dose response
In vitro Cytokinesis Block Micronucleus Test	Bovine lymphocytes (2 donors)	0, 28, 56, 140, 280 and 560 µM 24 & 48 h exposure	62%	24 h: Negative 48 h: Equivocal ↑ MN at 280 µM only (donor A) ↑ MN at 560 µM only (donor B)	Piesova, 2004	No dose-response No significant decrease in CBPI observed.
In vitro Cytokinesis Block Micronucleus Test	Bovine lymphocytes (2 donors)	0, 28, 56, 140, 280 and 560 µM; 2 h (±S9) and 48 h (-S9) exposure	62%	2 h: Negative 48 h: Equivocal ↑ MN at 280 µM only (donor A) and at 560 µM only (donor B)	Piesova, 2005	No dose-response; No significant decrease in CBPI observed. Metabolic activation had no effect on MN formation after 2 h exposure.

Table 5.4. *In vitro* Tests for Micronuclei Induction in Mammalian Cells- Glyphosate Technical						
Test/Endpoint	**Test System**	**Concentrations/ Conditions**	**Test Material Purity**	**Results**	**Reference**	**Comments**
In vitro Cytokinesis Block Micronucleus Assay (with FISH analysis)	Human lymphocytes (treated with cytochalasin B)	4h treatment ±S9; 0.5, 2.91, 3.50, 92.8 and 580 µg/mL; harvested 72 h	98.0%	Negative –S9 Positive +S9, ↑ MN at 580 µg/mL, but not at 0.5-92.8 µg/mL Also observed ↑ in NB at 580 µg/mL (±S9); ↑ NPB at 580 µg/mL (+S9)	Mladinic *et al.* (2009a)	Cells were exposed to glyphosate and washed prior to treatment with PHA. Authors did not report being blind to treatment.
In vitro Cytokinesis Block Micronucleus Assay (with FISH analysis)	Human lymphocytes (treated with cytochalasin B)	4h treatment ±S9; 0.5, 2.91, 3.50, 92.8 and 580 µg/mL	98%	Negative –S9 Positive +S9 ↑ MN at 580 µg/mL, but not at 0.5 -92.8 µg/mL ↑ apoptosis and necrosis at 580 µg/mL (-S9); ↑ apoptosis at ≥ 2.91 µg/mL and necrosis at 580 µg/mL (+S9) ↑ in NB at 580 µg/mL (±S9) and NPB at 580 µg/mL (+S9)	Mladinic *et al.* (2009b)	Cells were exposed to glyphosate and washed prior to treatment with PHA. Authors did not report being blind to treatment. .

CBPI= cytokinesis block proliferation index, FISH= fluorescent in situ hybridization; MN= micronuclei; NB= nuclear buds; NPB= nucleoplasmic bridges.

5.5 *In Vivo* Genetic Toxicology Tests

5.5.1 *In Vivo* Assays for Chromosomal Abnormalities

5.5.1.1 Mammalian Bone Marrow Chromosomal Aberration Assays

The *in vivo* mammalian bone marrow chromosomal assay detects the ability of a chemical to cause structural chromosomal damage in cells in the bone marrow. The assay is typically conducted in rodents (mouse or rat) and detects both chromosome-type and chromatid-type aberrations. Chromatid-type aberrations are expressed when a single chromatid break occurs and/or a reunion between chromatids, and chromosome-type aberrations result from damage expressed in both sister chromatids (OPPTS 870.5385). In this test, animals are exposed (typically via oral route or intraperitoneal injection) and sacrificed at sequential intervals. Prior to sacrifice, animals are treated with a spindle inhibitor such as colchicine or Colcemid® to arrest cells at metaphase. Chromosome preparations from the bone marrow are stained and scored for chromosomal aberrations. (OPPTS 870.5385). Generally, the optimal time to detect chromosomal aberrations in the bone marrow is 24 hours after treatment.

Three *in vivo* mammalian bone marrow chromosomal assays were conducted with glyphosate technical for regulatory purposes and all were negative (Table 5.8). In the first study, Sprague Dawley rats were administered glyphosate (98%) at 0 or 1000 mg/kg and the bone marrow was sampled at 6, 12 or 24 hours after dosing. No significant increase in bone marrow chromosomal aberrations were observed (Li, 1983b). In the second study, Swiss albino mice were treated twice by oral gavage (24 hours apart) with 0 or 5000 mg/kg glyphosate technical (96.8%) resulting in no significant increase in bone marrow chromosomal aberrations (Suresh, 1994). In a third study conducted with glyphosate trimesium salt, no increase in chromosomal aberrations were seen in the bone marrow of rats treated by oral gavage with up to 188 mg/kg (Majeska, 1982c).

5.5.1.2 Rodent Dominant Lethal Test

Dominant lethal mutations cause embryonic or fetal death. The induction of a dominant lethal mutation after exposure to a chemical indicates that the test chemical has affected the germinal tissue (sperm at some point in development, from stem cell to spermatocyte). Dominant lethal effects are considered to result from chromosomal damage (structural or numerical), but may also reflect gene mutations or systemic toxicity (OPPTS 870.5450, OECD 2016). In this test, male rodents are treated with the test material and mated with (untreated) virgin females. The females animals are sacrificed at an appropriate time and the uteri are examined to determine the number of implants, and live and dead embryos. Two dominant lethal studies were identified. One study was conducted in the rat (Suresh, 1992) where male rats were dosed by oral gavage with glyphosate up to 5000 mg/kg. The other study (Rodney, 1980) was conducted in male mice treated with up to 2000 mg/kg glyphosate (98.7%) by oral gavage. No significant increase in dominant lethal mutations were observed in either study (Table 5.5).

5.5.1.3 *In Vivo* Mammalian Erythrocyte Micronucleus Assays

The mammalian micronucleus test is the most commonly conducted *in vivo* test to detect clastogenic or aneugenic chemicals. The test identifies chemicals that induce micronuclei in proerythrocytes (progenitor cells) by assessing micronucleus frequency in immature erythrocytes (polychromatic erythrocytes, PCEs) sampled from the bone marrow or from the peripheral blood (reticulocytes). This test is typically conducted in mice or rats. When bone marrow erythroblasts develop into erythrocytes, the main nucleus is extruded following the final cell division (erythrocytes are the only mammalian cell that does not contain a nucleus). Any micronuclei formed after the final cell division may remain in the cytoplasm following extrusion of the main nucleus. The visualization of micronuclei is facilitated by the lack of a nucleus in these cells (OPPTS 870.5395, OECD 474). Micronuclei can originate from acentric chromosomes, lagging chromosome fragments, or whole chromosomes; thus, micronuclei are biomarkers of both altered chromosome structure or chromosome number. The assay is based on an increase in the frequency of micronucleated erythrocytes in treated animals, in either peripheral blood samples or bone marrow samples (OPPTS 870.5395). Additional mechanistic information on the formation of chromosomal abnormalities can be obtained from the incorporation of centromeric and telomeric fluorescent probes (FISH) assay. . According to EPA test guidelines, a single dose of the test substance may be used in this test if the dose is the maximum tolerated dose (MTD), a dose that produces some indication of bone marrow cytotoxicity (e.g., a reduction in the proportion of immature erythrocytes (PCEs) to total erythrocytes by >50%) or a maximum limit dose of 5000 mg/kg. The routes of administration for this test are typically oral or intraperitoneal injection and generally involve a single administration.

Glyphosate technical has been extensively evaluated for micronuclei induction in *in vivo* studies. Fourteen studies were conducted for regulatory purposes, four were identified from the open literature, and one study was conducted by the U.S. National Toxicology Program (NTP). This included nine studies with administration of glyphosate by the intraperitoneal (i.p.) route and 10 studies by the oral route. The findings are presented in Table 5.10. Of the nine i.p. studies, seven (Costa, 2008; Chruscielska *et al.*, 2000; Durward, 2006; Gava, 2000; Marques, 1999; Rank *et al.*, 1993 and Zaccaria, 1996) were negative. These studies tested doses as high as 2016 mg/kg (single and double administration) with sampling times at 24 and 48 hours post-dose. Two positive findings were reported when glyphosate technical was administered by i.p. Bolognesi *et al.* (1997) reported a significant increase in micronuclei in the bone marrow of male Swiss CD mice 24 hours after i.p. treatment with 300 mg/kg glyphosate technical (99.9%). The dose in this study was administered as ½ dose (150 mg/kg) injections 24 hours apart to 3 male mice. Manas *et al.* (2009) evaluated glyphosate technical (96%) in BALB/c male and female mice (5/sex/dose) administered 50, 100 or 200 mg/kg by two i.p. injections, 24 hours apart. The results showed a significant increase in micronucleated erythrocytes at 200 mg/kg, but not at 50 or 100 mg/kg. It should be noted that doses that resulted in the positive responses in these two studies were above the reported i.p. LD50 value (130 mg/kg) for glyphosate in mice (NTP 1992).

Glyphosate technical was also evaluated in nine micronucleus assays with administration by the oral route in mice and one in the rat. Eight of the nine oral studies in the mouse were negative for micronuclei induction. The single positive response was seen in female mice treated with two 5000 mg/kg (limit dose) doses, 24 hours apart with bone marrow sampling at 24 hours post-dose (Suresh, 1993b). No increase was observed at lower doses (50 and 500 mg/kg) in females or at any dose in males. The eight negative oral studies in mice included single dose administrations of 5000 mg/kg and bone marrow analysis at 24, 48, and/or 72 hours (Jensen, 1991c; Fox and Mackay, 1996) and one or two administrations of glyphosate technical with top doses between 30 and 2000 mg/kg (Honarvar, 2005; Honarvar, 2008; Jones, 1999; and Zoriki-Hosmi, 2007). It should be noted that evaluations at 48 and 72 hours post dose may be too late to detect chemically-induced micronucleated PCEs in the bone marrow as these cells may have already migrated into the peripheral blood. No significant increase in micronucleated erythrocytes were seen in male or female mice following 13-weeks of dietary (feed) administration of glyphosate technical at doses up to 3393 mg/kg/day (NTP, 1992). In the single study that evaluated micronuclei induction in rats, glyphosate technical did not induce significant induce micronuclei in CD1 rats treated by oral gavage at doses up to 2000 mg/kg (Flügge, 2009b). When glyphosate trimesium salt was evaluated, no increase in micronuclei induction was seen in mice treated orally up to 1100 and 800 mg/kg in males and females, respectively (Majeska, 1987).

Table 5.5. *In Vivo* Tests for Chromosomal Aberrations in Mammals- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Chromosomal Aberration Test	Sprague Dawley rats (males and females)	Intraperitoneal injection; sampled at 6, 12 and 24 h after treatment	0, 1000 mg/kg (6/sex/dose/sampling time)	98%	Negative	Li (1983b) [MRID 00132683]	No toxicity observed. A separate study using ^{14}C-glyphosate showed that glyphosate reaches BM 0.5 h after dosing with ½ life elimination at 7.6 h. Peak BM value was 400 ppm, corresponding to 2000 ppm plasma value.
Bone Marrow Chromosomal Aberration Test	Sprague Dawley rats (males and females) Vehicle: distilled water	Oral gavage, sampling after 6, 12, 24, 48 h and 5 d	0, 21, 63 and 188 mg/kg	58.5% *Glyphosate trimesium salt*	Negative	Majeska (1982c) [MRID 00132176]	
Bone Marrow Chromosomal Aberration Test	Swiss Albino mice (males and females) Vehicle: peanut oil	Oral gavage (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 5000 mg/kg (5/sex/dose)	96.8%	Negative	Suresh (1994) [MRID 49987408]	Significant ($p<0.05$) decrease in bw of females at high dose.
Rodent Dominant Lethal Test	CD-1 mice Each dosed male mated with 2 females/week for 8 weeks	Oral gavage	0, 200, 800, and 2000 mg/kg	98.7%	Negative	Rodwell (1980) [MRID 00046364]	
Rodent Dominant Lethal Test	Wistar rat Each dosed male mated with 1 female/week for 10 weeks	Oral gavage	0, 200, 100 and 5000 mg/kg	96.8%	Negative	Suresh (1992) [MRID 49987404]	

Table 5.6. In Vivo Tests for Micronuclei Induction in Mammals- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Micronucleus Test	Swiss CD1 mice (males only)	Intraperitoneal injection; 2 injections of half the dosage of 300 mg/kg 24 h apart; sampling at 6 and 24 h	0, 300 mg/kg (3/dose)	99.9%	Positive Stat significant increase in MN at 24 h	Bolognesi *et al.* (1997)	Material and methods indicate 3 animals/dose; however, Table 1 of article indicates 4 animals were evaluated.
Bone Marrow Micronucleus Test	Balb C mice (males and females) Vehicle: Saline	Intraperitoneal Injection (two injections, 24 h apart); sampling after 24 h (last treatment)	0, 50, 100, and 200 mg/kg (5/sex/dose)	96%	Positive ↑MN at 200 mg/kg, but not at 50 or 100 mg/kg	Manas *et al.* (2009)	No significant signs of toxicity observed.
Bone Marrow Micronucleus Test	C3H mice (males only) Vehicle: water	Intraperitoneal Injection (single treatment); sampling after 24, 48 and 72 h	0, 300 mg/kg	Not reported	Negative	Chruscielska *et al.* (2000)	
Bone Marrow Micronucleus Test	Swiss Albino mice (males and females) Vehicle: corn oil	Intraperitoneal Injection (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 15.62, 31.25, and 62.5 mg/kg (5/sex/dose)	980 g/kg Glyphosate technical	Negative#	Costa (2008)[1]	OECD guideline 474 #Was not tested up to limit dose and did not demonstrate that compound was tested up to toxic dose. No mention of BM toxicity or clinical signs.

Table 5.6. In Vivo Tests for Micronuclei Induction in Mammals- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Micronucleus Test	Crl:CD-1TM(ICR) BR mice (males only[1]) Vehicle: PBS	Intraperitoneal Injection (single treatment); sampling after 24 and 48 h (high dose only)	0, 150, 300 and 600 mg/kg (7/dose)	95.7%	Negative	Durward (2006) [MRID 49957411]	Clinical signs reported at ≥ 150 mg/kg. Significant ↓ in %PCEs reported at 24 h in 600 mg/kg group. ↑in MN PCEs observed at 600 mg/kg (1.9± 0.7 vs. 1.0 ± 1.2 control; $p<0.05$), at 24 h, but not 48 h, within historical control range.
Bone Marrow Micronucleus Test	Swiss Albino mice (males and females) Vehicle: water	Intraperitoneal Injection (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 1008, 2016, and 3024 mg/kg 5/sex/dose	612.7 g/kg (glyphosate technical Nufarm)	Negative	Gava (2000)[1]	LD50 was 4032 mg/kg Mortality observed in 1 animal at high dose (only 4 m/f scored for MPCEs). No effect on PCE/NCE.
Bone Marrow Micronucleus Test	Swiss Albino mice (males and females) Vehicle: water	Intraperitoneal Injection (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 187.5, 375 and 562.5 mg/kg 5/sex/dose	954.9 g/kg (glyphosate technical Nufarm)	Negative	Marques (1999) [MRID 49957412]	LD50 was 750 mg/kg No significant signs of toxicity observed in main study
Bone Marrow Micronucleus Test	NMRI-Bom mice	Intraperitoneal Injection (single treatment); sampling after 24 h (all doses) and 48 h (150 and 200 mg/kg)	0, 150, and 200 mg/kg (5/sex/dose)	glyphosate isopropylamine (purity not specified)	Negative	Rank *et al.* (1993)	

Table 5.6. In Vivo Tests for Micronuclei Induction in Mammals- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Micronucleus Test	Swiss albino mice (males and females)	Intraperitoneal Injection (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 68, 137, and 206 mg/kg (	360 g/L	Negative	Zaccaria (1996) [MRID 49961501]	Doses selected were reported as corresponding to 25, 50 and 75% LD_{50}
Bone Marrow Micronucleus Test	CD-1 mice (males and females) Vehicle: saline	Oral gavage (single treatment); sampling after 24 and 48 h	0, 5000 mg/kg 5/sex/dose	95.6%	Negative	Fox and Mackay (1996) [MRID 44320619]	No significant signs of toxicity observed
Bone Marrow Micronucleus Test	NMRI mice (males and females) Vehicle: PEG 400	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 mg/kg 5 sex/dose	97.73%	Negative	Honarvar (2005)[1]	OECD guideline 474 No significant signs of toxicity observed
Bone Marrow Micronucleus Test	NMRI mice (males only) Vehicle: 0.5% carboxymethylcellulose	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 mg/kg (5/dose)	99.1%	Negative	Honarvar (2008) [MRID 49961802]	No significant signs of toxicity observed
Bone Marrow Micronucleus Test	NMRI mice (males and females) Vehicle: 0.5% carboxymethylcellulose	Oral gavage (single treatment); sampling after 24, 48 and 72h	0, 5000 mg/kg; 5/sex/dose	98.6%	Negative	Jensen (1991c) [MRID 49961503]	No significant signs of toxicity observed
Bone Marrow Micronucleus Test	CD-1 mice (males only[1]) Vehicle: water	Oral gavage single treatment); sampling after 24 and 48 h	0, 2000 mg/kg 5/dose	59.3% potassium glyphosate salt	Negative	Jones (1999)[1]	OECD guideline 474 No significant signs of toxicity observed
Bone Marrow Micronucleus Test	Swiss albino mice; (males and females)	Oral gavage (2 treatments, 24 h apart); sampling	0, 50, 500, 5000 mg/kg 5/sex/dose	96.8% glyphosate acid	Positive in females at 5000	Suresh (1993b) [MRID 49987407]	No significant signs of toxicity observed

Table 5.6. In Vivo Tests for Micronuclei Induction in Mammals- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
	Vehicle: peanut oil	after 24 h (last treatment)			mg/kg only. Negative in males at all doses		
Bone Marrow Micronucleus Test	Swiss mice (males only) Vehicle: corn oil	Oral gavage (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 8, 15 and 30 mg/kg (6/dose)	980.1 g/kg	Negative	Zoriki Hosomi (2007) [MRID 50000901]	OECD guideline 474 No significant signs of toxicity observed
Bone Marrow Micronucleus Test	CD-1 mice (males and females) Vehicle: distilled water	Oral gavage , Sampling 24, 48 and 72 h after treatment	Males: 0, 700, 900 and 1100 mg/kg Females: 0, 400, 600 and 800 mg/kg	55.3% *Glyphosate trimesium salt*	Negative	Majeska (1987) [MRID 40214004]	
Bone Marrow Micronucleus Test	B6CF3 Mice (males and females)	Oral (dietary). MN assay conducted following 13 week feed study.	0, 205/213, 410/421, 811/844, 1678/1690 and 3393/3393 mg/kg (m/f) (10/sex/dose)	99%	Negative	NTP (1992)	
Bone Marrow Micronucleus Test	CD Rats (males and females) Vehicle: 0.8% hydroxypropylmethyl cellulose	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 mg/kg (5/sex/dose)	98.8%	Negative	Flügge (2009b)[1]	OECD guideline 474 No significant signs of toxicity observed

[1] Study was cited in Kier and Kirkland (2013). Supplementary information about the study was provided online including test guideline followed, test material purity, control chemicals and summary data tables.

[2]Only males tested; report indicated that there were no difference between sexes seen in range finding study.

CA= chromosomal aberrations, MPCE= micronucleated polychromatic erythrocytes, NCE= normochromatic erythrocytes, PCE=polychromatic erythrocytes.

5.6 Additional Genotoxicity Assays Evaluating Primary DNA Damage

There are a number of genotoxicity assays that evaluate primary DNA damage, but do not measure the consequence of the genetic damage (*i.e.*, mutation or chromosomal damage). As discussed in the Guidance Document on Revisions to OECD Genetic Toxicology Test Guidelines (OECD 2015), the endpoints measured in primary DNA damage tests such as DNA adducts, comet assay, or unscheduled DNA synthesis may lead to cell death or may initiate DNA repair, rather than a mutation. These types of assays can, however, provide mechanistic information when interpreting positive findings in other genotoxicity tests or when determining whether a chemical is acting through a mutagenic mode of action. Additionally, indirect mechanisms of DNA damage such as oxidative DNA damage can be detected by these test systems. Oxidative damage results from oxidative stress, which occurs when there is a disturbance in the balance between the production of reactive oxygen species (ROS) and antioxidant defense systems. Normal cellular metabolism is a source of endogenous reactive oxygen species that accounts for background levels of oxidative damage in normal cells. Some types of oxidative damage are repairable while others lead to serious consequences in the cell. (Cooke et al, 2003). The various assays evaluating primary DNA damage in glyphosate technical are presented in Table 5.7 Details of the findings are discussed below.

Glyphosate technical is not electrophilic and is not considered to be DNA-reactive. In a study to evaluate the potential for glyphosate to directly interact with DNA, Peluso et al. (1998) reported that glyphosate technical did not form DNA adducts in mice when tested up to 270 mg/kg via i.p. Bolognesi et al. (1997) reported an increase in the oxidative damage biomarker 8-hydroxydeoxyguanosine (8-OHdG) in the liver 24 h after i.p. injection of 300 mg/kg in mice. No increase in 8-OHdG was seen in the kidney with glyphosate technical. The dose in this study was high (300 mg/kg) for an i.p. injection and within the i.p. LD_{50} range (134- 545 mg/kg) that has been reported elsewhere (WHO, 1994).

The comet assay, also known as single cell gel electrophoresis (SCGE), is a sensitive and rapid method to detect DNA strand breaks in individual cells. In this assay, individual cells are embedded in agarose. The cells are then lysed (which digests the cellular and nuclear membranes) and the DNA is allowed to unwind under alkaline or neutral conditions. During electrophoresis, chromatin (which is in a supercoiled state) that has undergone steric relaxation due to DNA damage migrates away from the nucleoid (nucleus) toward the anode, yielding images that resemble a comet. The intensity of the comet tail relative to the comet head reflects the amount of DNA breakage (Tice et al., 2000; Collins et al., 2008). The comet assay can detect single and double strand breaks resulting from direct interactions with DNA, alkali labile sites, or transient DNA breaks resulting during DNA excision repair. These types of strand breaks may be, (a) repaired with no persistent effect, (b) be lethal to the cell or (c) be fixed as a mutation (OECD TG 489). DNA strand breaks in the comet assay can be measured by endpoints such as percent tail DNA (also referred to as % tail intensity), tail length, and tail moment. However, % tail DNA is the recommended metric for evaluating and interpreting results using this assay (OECD TG 489).

The five studies that evaluated glyphosate technical using the comet assay are summarized in Table 5.12. Two of the studies were conducted using tumor cell lines. Koller et al. (2012) reported positive comet effects (increased tail intensity) in a human buccal carcinoma cell line (TR146) following a 20-minute treatment with ≥ 20 mg/L (~0.118 mM) glyphosate. Although no evidence of cytotoxicity was reported in this study, the authors did report an increase in apoptosis and necrosis at the same concentrations (≥ 20 mg/L) when the same cell line was tested for *in vitro* micronuclei induction (discussed previously). In a study using Hep-2 cells (presumably a HeLa cell derivative), Manas et al. (2009) reported a statistically significant increase in mean tail length, and tail intensity at all concentrations (3.0-7.5 mM) tested. In a comet study conducted on human lymphocytes, Alvarez-Moya et al. (2014) reported significant increases in tail length only (but not % tail DNA) following treatment with glyphosate concentrations of 0.7-700 µM. Mladinic et al. (2009a) evaluated DNA damage in non-dividing human lymphocytes (±S9) following treatment from 0.5 to 580 µg/mL using the standard alkaline comet method and a modified comet method that detects DNA damage due to oxidative damage (human 8-hydroxyguanidine DNA-glycosylase, hOGG1 comet method). In this study, the authors reported statistically significant increases in tail intensity at 3.5 µg/mL and higher in the absence of S9, with significance only at 580 µg/mL (~3.4 mM) in the presence of S9 using the alkaline method. This concentration also resulted in increased apoptosis and necrosis as well as an increase in plasma total antioxidant capacity (TAC) and changes in plasma lipid peroxidation (thiobarbituric reactive substances, TBARs); however, only a dose-related increase in tail length (not % tail DNA) was observed at 580 µg/mL (+S9) using the hOGG1 method. When the Manas et al. (2013) evaluated blood and liver cells following a 14 day drinking water study in mice treated with 40 and 400 mg/kg/day glyphosate, significant increases in tail intensity, tail length and tail moment were reported were observed at both doses in both tissues (except for DNA tail intensity in liver at 40 mg/kg); however, there were no substantial effects on oxidative stress measurements suggesting that DNA damage reported may not be due to oxidative damage.

The Unscheduled DNA Synthesis (UDS) test with mammalian liver cells *in vitro* identifies substances that induce DNA repair after excision and removal of a segment of damaged DNA. The test is typically conducted in liver cells, which have relatively few cells in the S-phase of the cell cycle. The assay measures the incorporation of radiolabeled nucleotide [^{3}H]-thymidine into DNA during the repair process in non-S phase cells. (OPPTS 870.5555). Substances that produce either a statistically significant dose-related increase or statistically significant and reproducible increase in ^{3}H-TdR incorporation in at least one test point are considered to be positive in this test. A UDS study that evaluated glyphosate technical in rat primary hepatocytes was negative (Williams, 1978). Glyphosate technical was also negative in a DNA repair test conducted in bacteria (Rec-A test) (Shirasu, 1978).

In an alkaline elution assay, which detects single strand DNA breaks, Bolognesi et al. (1997) reported an increase in single strand breaks (i.e. increased DNA elution rate) in the liver and kidney 4 hours after a single i.p. injection of 300 mg/kg. The elution rate returned to control

levels at 24 hours. Glyphosate technical was also negative in a DNA repair test conducted in *Bacillus subtilis* H17 (rec^+) and M45 (rec^-) bacterial Rec-A test (Shirasu, 1978).

Finally, the sister chromatid exchange (SCE) test is an assay that can measure the consequence of primary DNA damage. The mechanism(s) of action for chemical induction of SCE is unclear. The SCE assay detects the exchange of DNA between two sister chromatid arms within a single chromosome. The assay can be performed *in vitro* or *in vivo*. Following exposure, cells/animals are treated with bromodeoxyuridine (BrdU) to allow for the differentiation of the two sister chromatids (harlequin staining) and prior to harvest are treated with a spindle inhibitor to accumulate cells in metaphase. The chromosome preparations are then stained and analyzed for SCEs (OPPTS 870.5900, 870.5915). The SCE studies that evaluated glyphosate technical are also presented in Table 12. Positive SCE findings were reported in all four studies; two evaluating bovine lymphocytes (Lioi, 1988b, Sivikova and Dianovksy, 2006) and two studies evaluating human lymphocytes (Lioi, 1988a; Bolognesi et al., 1997). In all four studies the induction did not demonstrate a clear dose response.

Additionally, although it is recognized that mechanisms other than genotoxicity may be involved in cell transformation, glyphosate trimesium salt was evaluated in the Balb/3T cell transformation assay (an *in vitro* tumor formation assay) and was negative up to 5.0 mg/ml (Majeska, 1982b).

Table 5.7 Assays for Detecting Primary DNA Damage- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses/ Concentrations	Test Material Purity	Results	Reference	Comments
DNA Adducts ^{32}P-postlabeling	Swiss CD1 mice (males and females) Liver and kidney evaluated	Intraperitoneal injection; 24 h exposure	0, 130 and 270 mg/kg	Not reported	Negative	Peluso *et al.* (1998)	
DNA oxidative damage: 8-OHdG formation	Swiss CD-1 mice (males) liver and kidney evaluated	Intraperitoneal injection (single dose); sampling 4 and 24 h after injection	0, 300 mg/kg (3/dose)	99.9%	Kidney: negative Liver: positive (24 h)	Bolognesi *et al.* (1997)	
Single-cell gel electrophoresis (SCGE) assays- Comet assay	TR146 cells (human-derived buccal epithelial cell line).	NA (*in vitro*)	-S9: 10-2000 mg/L; 20 minute exposure.	95%	Positive Increased DNA migration at >20 mg/L	Koller *et al.* (2012)	Also measured multiple cellular integrity parameters to assess cytotoxicity. No clear evidence of cytotoxicity seen except for increase in enzyme activity (indicative of membrane damage) in LDHe (extracellular lactate dehydrogenase) assay at >80 mg/L. No mention of monitoring pH
Single-cell gel electrophoresis (SCGE) assays- Comet assay	Hep-2 cells	NA (*in vitro*)	0, 3, 4.5, 6, 7.5, 9, 12 and 15 mM	96%	Positive Stat. significant increase in mean tail length, and tail intensity at all concs.	Manas *et al.* (2009)	The authors did not report a source for the Hep-2 cells. The agency presumes that this is a HeLa derived cervical carcinoma cell line.

Table 5.7 Assays for Detecting Primary DNA Damage- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses/ Concentrations	Test Material Purity	Results	Reference	Comments
Single-cell gel electrophoresis (SCGE) assays- Comet assay	Human lymphocytes	NA (*in vitro*)	0, 0.7, 7, 70, 700 µM	96%	Positive at all doses (increase in tail length only)	Alvarez-Moya *et al*., (2014)	Issues were identified with this study resulting in a low quality ranking. These include: 1) blood was washed with PBS and then held at 4º C for an indeterminate amount of time before exposure to glyphosate. (2) Cells were treated for 20 hours at room temperature. (3) The same amount of damage was reported across 2 orders of magnitude concentration.
Single-cell gel electrophoresis (SCGE) assays- Comet assay	Human lymphocytes; ±S9 Alkaline and hOOG1 Comet assays performed	NA (*in vitro*)	0, 0.5, 2.91, 3.5, 92.8 and 580 µg/mL	98%	Positive ±S9	Mladinic *et al.* (2009a)	<u>The alkaline comet assay</u> -S9: ↑ in mean tail length at 580 µg/mL and ↑ in tail intensity at ≥ 3.5 µg/mL). +S9: ↑ DNA tail length at ≥3.5 µg/mL. Tail intensity ↑ only at 580 µg/mL <u>hOOG1 comet assay</u>: -S9 no effect on tail length, ↑tail intensity only at 3.50 µg/mL +S9: ↑ tail length at 580 µg/mL, no effect on tail intensity compared to controls at any conc.

Table 5.7 Assays for Detecting Primary DNA Damage- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses/ Concentrations	Test Material Purity	Results	Reference	Comments
Single-cell gel electrophoresis (SCGE) assays- Comet assay with oxidative stress measures	Balb/C mice; evaluated blood and liver	Drinking water (14 days)	0, 40, and 400 mg/kg	96%	Positive Blood and liver at both doses	Manas et al. (2013)	Only minor effects seen on oxidative stress measurements (TBARs, SOD, CAT)
Sister Chromatid Exchange (SCE)	Bovine lymphocytes (3 donors)	NA (*in vitro*)	-S9: 0, 17, 85 and 170 µM; 72 h exposure	≥98%	Positive Significant (p>0.05) increase in SC/cell at all concentrations	Lioi (1998b)	1.8-, 2.1-, 1.6-fold increases, respectively
Sister Chromatid Exchange (SCE)	Human lymphocytes	NA (*in vitro*)	-S9: 0, 5, 8.5, 17 and 51 µM; 72 h exposure	≥98%	Positive Significant (p>0.05) increase in SCE/cell at ≥ 8.5 µM	Lioi (1998a)	1.9-, 2.8-, and 2.6-fold increase at 8.5, 17 and 51 µM, respectively
Sister Chromatid Exchange (SCE)	Human lymphocytes	NA (*in vitro*)	-S9: 0, 0.33, 1,3 and 6 mg/mL; 72 h exposure	99.9%	Positive	Bolognesi *et al.* (1997)	Very limited information was provided on the methods used in this paper. Authors report a dose –dependent increase in SCE frequency; however, no statistical analysis for dose response was reported. Data presented graphically with no error bars.
Sister Chromatid Exchange (SCE)	Human lymphocytes	NA (*in vitro*)	28, 56, 140, 280, 560 and 1120 µM; 24 h exposure ±S9	62%	Positive	Sivikova and Dianovsky (2006)	The increases in SCEs observed did not show a clear concentration related increase across a 40-fold increase in the concentrations tested

Table 5.7 Assays for Detecting Primary DNA Damage- Glyphosate Technical.

Test/Endpoint	Test System	Route of Administration	Doses/ Concentrations	Test Material Purity	Results	Reference	Comments
Alkaline elution assay- DNA single strand breaks	Swiss CD-1 mice (males) liver and kidney evaluated	Intraperitoneal injection (single dose); sampling 8 and 24 h after injection	0, 300 mg/kg (3/dose)	99.9%	Positive (Increased elution rate) at 4 hours in liver and kidney At 24 h, elution rate returned to control levels	Bolognesi *et al.* (1997)	Return to control values may indicate DNA repair or reflect rapid elimination of compound
DNA Repair Test (Rec-A test)	*B. subtilis* H17 (rec+) and M45 (rec-)	NA (*in vitro*)	20-2000 µg/disk	98.4%	Negative	Shirasu (1978) [MRID 00078619]	
Unscheduled DNA synthesis (DNA repair)	F-344 rat primary hepatocytes	NA (*in vitro*)	0, 0.0125, 0.0625, 0.125, 0.6.5, 1.25, 12.5, 125 µg/mL	98%	Negative	Li and Long (1988)	
Cell Transformation Assay	BALB/3T cells	NA (*in vitro*)	0.313-5.0 mg/mL	90% *Glyphosate trimesium salt*	Negative	Majeska (1982b) [MRID 00126616]	

h- hour; CAT= catalase, G6PD= glucose 6-phosphate dehydrogenase, NA= not applicable, hOOG1 =,TBARs= thiobarbituric acid reactive substances, SOD= superoxide dismutase

5.7 Summary and Discussion

The genotoxic potential of glyphosate has been extensively investigated using a variety of test systems and genetic endpoints. This assessment focuses only on test systems that the agency considered relevant for assessing genotoxic risks in humans. The totality of the genetic toxicology information was evaluated using a weight of evidence approach to determine the genotoxic potential of glyphosate. This involves the integration of *in vitro* and *in vivo* results as well as an overall evaluation of the quality, consistency, reproducibility, magnitude of response, dose-response relationship and relevance of the findings. In the weight of evidence analysis, studies evaluating endpoints that measured gene mutations and chromosomal aberrations (i.e. permanent DNA damage) were given more weight than endpoints reflecting DNA events that may be transient or reversible such as primary DNA damage (*e.g.,* comet assays). *In vivo* studies in mammals were given the greatest weight and more weight was given to doses and routes of administration that were considered relevant for evaluating genotoxic risk based on human exposure to glyphosate. Also, since the molecular mechanisms underlying the observation of SCEs are unclear and thus, the consequences of increased frequencies of SCEs are unclear, the data from this test were given low weight in the overall analysis. A summary of the various lines of evidence of considered in the weight of evidence evaluation for the genotoxic potential of the active ingredient glyphosate is presented below.

Evidence of primary DNA damage

Glyphosate technical is not considered to be electrophilic and did not induce DNA adducts in the liver or kidney at an i.p. dose of 270 mg/kg. However, evidence of DNA strand breaks were reported in a number mammalian cell studies using the comet assay. Additionally, transient increases in alkali labile sites in the liver and kidney of mice and an induction of 8-OHdG in DNA were seen in the livers of mice following i.p. injections with 300 mg/kg glyphosate. These effects were seen at high doses for the i.p. route in mice (LD_{50} for mouse =130 mg/kg; NTP, 1992). However, due to technical limitations identified in a number of these studies (e.g. use of cancer cell lines that have not been well-characterized, atypical exposure protocols and no indication of blind to treatment), caution should be exercised in interpreting the results.

In vitro mutations

Glyphosate technical was negative in all 39 studies for mutagenicity in bacteria. In the four studies that tested for gene mutations in mammalian cells *in vitro,* no increase in mutations were observed.

In vitro chromosomal alterations

Mixed results were observed in studies evaluating *in vitro* chromosomal alterations with glyphosate treatment. Three SCE studies reported positive findings (Lioi, 1998a, b; Bolognesi *et al*., 1997) bovine and human lymphocytes. As stated previously, low weight is given to SCE results in the overall analysis given the uncertainty regarding the consequence of increases in the frequencies of SCEs. The SCE responses were weak and not concentration dependent. Eight of the 10 studies measuring *in vitro* chromosomal aberrations were negative. The two positive

findings were reported by Lioi et al., one study was conducted with bovine lymphocytes and the other with human lymphocytes. The authors reported positive findings in these studies at concentrations much lower than four other studies that reported negative results using the same cell types. Additionally, in both studies, Lioi et al. used an atypical exposure protocol of 72 hours which is very long for analyzing one round of mitosis. Furthermore, in both studies, nearly the same level effect for aberration frequency and percent of cells with aberrations were observed for the same concentrations of glyphosate and the two other chemicals tested in those experiments.

Four of the six studies evaluating micronuclei induction *in vitro* were positive and two showed equivocal results. Three of the positive responses required S9 activation, two conducted with human lymphocytes and one conducted with CHO cells. The remaining positive micronucleus study was conducted using a TR146 cells which is a tumor cell line derived from human buccal mucosa. The authors state that this cell line had not been previously used for genotoxicity testing. It is difficult to interpret any genotoxicity findings conducted in a tumor cell line that has not been well-characterized regarding its DNA damage response and repair capacity, and its degree of chromosomal instability.

Glyphosate was negative in all three L5178Y mouse lymphoma cell studies which may detect chromosomal damage in addition to mutations.

Mammalian *in vivo* chromosomal alterations

All three *in vivo* mammalian studies evaluating chromosomal aberrations with glyphosate technical were negative. Two studies were conducted in rats (i.p. and oral) and one was conducted in mice (oral). In addition glyphosate was also negative in a rodent dominant lethal test. Glyphosate was negative in 15 of the 19 bone marrow micronucleus studies evaluated. In two of the positive studies, glyphosate technical was administered by i.p. injection. In these studies, the authors reported positive findings at doses of 200-300 mg/kg. Based on the available ADME data for glyphosate, assuming 30% oral absorption, an oral dose of ~700-1000 mg/kg would be needed to achieve a dose of 200-300 mg/kg in the blood. Seven other i.p. studies in mice reported no increase in micronuclei induction at doses up to 3000 mg/kg. The remaining positive finding was reported in an oral gavage study in mice where an approximately 2-fold increase in micronuclei were reported in females only at a dose of 5000 mg/kg, which is considerably higher than the current guideline recommended limit dose of 2000 mg/kg. The effect was not seen in the 7 other oral gavage studies in mice when glyphosate was tested at similar doses. In addition, glyphosate was negative for micronuclei induction following a 13 week dietary study with a dose up to approximately 3000 mg/kg/day. A negative finding was also reported in the only study that evaluated *in vivo* micronuclei induction in the rat using doses up to 2000 mg/kg.

In a meta-analytic review of micronuclei frequency across mammalian and non-mammalian species (primarily fish, amphibians, reptiles and plants), Ghisi et al. (2016), not surprisingly, reported that different responses were observed when comparing mammalian results to phylogenetically distant non-mammalian species for micronuclei induction. Their analyses included most, but not all, of the mammalian studies that the agency evaluated and determined to

be negative for micronuclei induction. The authors reported a statistically significant increase in micronuclei by the i.p. route across the studies in the data set they considered; however, when glyphosate was administered by the oral route (which is the most physiologically relevant route for human exposure to glyphosate), no significant difference was observed.

Conclusion for Glyphosate

The overall weight of evidence indicates that there is no convincing evidence that glyphosate induces mutations *in vivo* via the oral route. When administered by i.p. injection, the micronucleus studies were predominantly negative. In the two cases where an increase in micronuclei were reported via this route, the effects occurred above the reported i.p. LD50 for mice and were not observed in other i.p. injection studies at similar or higher doses. While there is limited evidence genotoxic for effects in some *in vitro* experiments, i*n vivo* effects were given more weight than *in vitro* effects particularly when the same genetic endpoint was measured, which is consistent with current OECD guidance. The only positive findings reported *in vivo* were seen at relatively high doses that are not relevant for human health risk assessment.

6.0 Data Integration & Weight-of-Evidence Analysis Across Multiple Lines of Evidence

6.1 Background

In 2010, OPP developed a draft "Framework for Incorporating Human Epidemiologic & Incident Data in Health Risk Assessment" which provides the foundation for evaluating multiple lines of scientific evidence (U.S. EPA, 2010). OPP's draft framework is consistent with updates to the World Health Organization/International Programme on Chemical Safety MOA/human relevance framework, which highlights the importance of problem formulation and the need to integrate information at different levels of biological organization (Meek et al, 2014).

One of the key components of the agency's draft framework is the use of modified Bradford Hill Criteria (Hill, 1965) like those described in the 2005 Guidelines for Carcinogen Risk Assessment. These criteria are used to evaluate the experimental support considers such concepts as strength, consistency, dose response, temporal concordance and biological plausibility in a weight-of-evidence analysis.

6.2 Dose-Response and Temporal Concordance

Given the lack of consistent positive findings particularly at doses < 1000 mg/kg/day across the lines of evidence, lack of mechanistic understanding, and lack of biological activity in mammalian systems to the parent compound glyphosate, there are few data to assess key events in the biological pathway and any associated temporal or dose concordance. Temporal concordance can be assessed using the experimental animal studies and epidemiological studies that evaluated exposure prior to outcomes. Similarly, dose concordance can be assessed using findings of apical outcomes in experimental animal studies, as well as epidemiological studies that utilize exposure metrics that are stratified by the number of exposure days.

A prospective cohort study is designed to collect exposure information prior to the development of cancer. As such, exposure is known to occur before the outcome. In De Roos *et al.* (2005), a prospective cohort study, no association was observed between glyphosate exposure and numerous cancer subtypes in the AHS cohort. Although the median follow-up time following recruitment into the cohort was approximately 7 years, it does not represent the amount of time subjects were exposed. Study participants provided pesticide exposure information prior to enrollment in the study and this information was used to evaluate has cumulative lifetime days of exposure and intensity-weighted cumulative days of exposure. An updated analysis of the AHS cohort is anticipated with a longer follow-up period, which includes the time period after the introduction of glyphosate-tolerant crops and the subsequent substantial increase in glyphosate use. The updated AHS cohort analysis will further elucidate the impact of increased glyphosate use due to glyphosate-tolerant crops. In De Roos *et al.* (2005), effect estimates did not increase across categories of increasing exposure for almost all cancer types, including NHL, in the prospective cohort study.

Two case-control studies evaluating the risk of NHL (Eriksson *et al.*, 2008 and McDuffie *et al.*, 2001) observed increased effect estimates in the highest exposure categories analyzed. Eriksson *et al.* (2008) found a greater effect estimate for subjects with >10 days (based on the median days of exposure among controls) and >10 years of exposure (for latency analysis) when compared to subjects with ≤10 days and 1-10 years of exposure, respectively; however, this analysis did not appear to adjust for co-exposures to other pesticides. By dividing the total number of exposed cases and controls using these exposure metrics, wider confidence intervals were observed indicating reduced power from smaller sample sizes. This may indicate that a longer follow-up time is needed to detect the risk for NHL; however, given the latency analysis of NHL was limited to Eriksson et al. (2008) and lack of NHL latency understanding in general, further studies are needed to determine the true latency of NHL. McDuffie *et al.* (2001), stratifying based on the average number of days per year of exposure, observed similar effect estimates in the lower exposure category (>0 and ≤2 days/year) while a greater effect estimate was observed in the highest exposure category (>2 days/year). The results from these two case-control studies conflict with the results observed in the cohort study (De Roos *et al.*, 2005), where no dose-response was seen across three exposure categories (stratified by tertiles; however, the case-control studies did not adjust for co-exposure to other pesticides. It is also difficult to make conclusions regarding dose-response with only two exposure categories used for the analyses by Eriksson et al. (2008) and McDuffie et al. (2001). It should also be noted that these analyses combine all NHL subtypes, which may have etiological differences (Morton *et al.*, 2014). Although some studies did provide effect estimates for subtypes, as stated in Section 3.5.2, these were not considered in the current evaluation due to the limited sample sizes. At this time, there are no data available to evaluate dose-response for NHL subtypes.

Furthermore, as discussed in Section 3.6, a dose-response relationship was not observed following the dramatic increase in glyphosate use due to the introduction of genetically engineered glyphosate-tolerant crops in 1996. Due to the change in use pattern, if a true association exists between glyphosate exposure and NHL, this large increase in use would be expected to result in a corresponding increase in risk of NHL associated with glyphosate exposure; therefore, higher effect estimates would be expected in more recent years. This trend was not observed though. For example, some of the highest adjusted risk measures for NHL

were reported for study years prior to 1996. Furthermore, it would also be expected that higher effect estimates would be reported in countries with higher use of glyphosate and/or that use glyphosate-tolerant crops, such as the United States and Canada, as compared to countries that exhibit less use. Once again, this trend was not observed with NHL studies, such that effect estimates for studies conducted in Sweden (Eriksson et al., 2008; Hardell *et al*., 2002) were similar or higher than those reported in the United States (De Roos *et al.*, 2003; De Roos *et al.*, 2005) and Canada (McDuffie *et al.*, 2001).

With respect to animal carcinogenicity studies, key events in a MOA/AOP are evaluated to confirm that they precede tumor appearance. This temporal concordance evaluation cannot be conducted for glyphosate since a MOA/AOP has not been established. In general, the tumor incidences lacked a monotonic dose-response. It should be noted, however, that no preneoplastic or related non-neoplastic lesions were reported in any of the animal carcinogenicity studies to support any observed tumors. Furthermore, genotoxicity assays did not support a direct mutagenic MOA. While there is limited evidence of genotoxic in some *in vitro* endpoints, multiple *in vivo* do not support a genotoxic risk at relevant human exposure levels.

6.3 Strength, Consistency, and Specificity

A large database is available for evaluating the carcinogenicity potential of glyphosate. Across animal carcinogenicity and genotoxicity studies, results were consistent. For epidemiological studies, only one or two studies were available for almost all cancers investigated. The largest number of studies was available investigating NHL; however, there were conflicting results across studies.

In epidemiological studies, there was no evidence of an association between glyphosate exposure and solid tumors, leukemia, and HL. This conclusion is consistent with those recently conducted by IARC, EFSA, and JMPR. The available data for multiple myeloma are not considered adequate to assess carcinogenic potential at this time.

At this time, a conclusion regarding the association between glyphosate exposure and risk of NHL cannot be supported based on the available data due to conflicting results. Chance and/or bias cannot be excluded as an explanation for observed associations. The magnitude of adjusted risk estimates for never/ever use were relatively small ranging from 1.0 (no association) to 1.85 in adjusted analyses, with the widest confidence interval observed for the highest effect estimate indicating the estimate is less reliable. All of the estimates were not statistically significant with half of the effect estimates approximately equal to 1, while the other half of the effect estimates ranged from 1.5-1.85. As a result, studies of at least equal quality provided conflicting results. There were various limitations identified in Section 3.6 for these studies that could impact calculated effect estimates and explain the weak responses observed in these studies. Meta-risk ratios using these studies were also of small magnitude ranging from 1.3-1.5. As discussed in Section 3.6, meta-analyses should be interpreted with caution and are susceptible to the same limitations identified for individual studies.

Although none of the effect estimates were below 1 using the never/ever exposure metric, risk estimates were all below 1 (0.6-0.9) when using cumulative lifetime and intensity-weighted

cumulative exposure metrics in the prospective cohort study (De Roos et al., 2005). As discussed in Section 6.2, two case-control studies that investigated an exposure-response relationship conflicted with the extensive analyses conducted by De Roos et al. (2005). This may be due to differences in confounding control, differences associated with study design, limitations from small sample sizes, and/or, as some may suggest, a potentially short follow-up time in the cohort. It should also be noted that publication bias may play a role in this evaluation given there is a tendency to only publish positive results and potential concerns regarding glyphosate have only been raised in recent years.

A total of 15 (9 rat and 6 mouse) animal carcinogenicity studies with glyphosate, glyphosate acid, or glyphosate salts were analyzed for the current evaluation. Although increases in tumor incidences were observed in some studies, none were considered treatment-related based on weight-of-evidence evaluations. In 7 of these studies, no tumors were identified for detailed evaluation. In the remaining studies, tumor incidences were not increased at doses <500 mg/kg/day, except for the testicular tumors observed in one study. The high dose tumors, as well as the testicular tumors, were not reproduced in other studies, including those testing the same animal strain with similar or higher dosing. Additionally, the tumors typically lacked a monotonic dose response, pairwise significance, and/or corroborating preneoplastic lesions.

Over 80 genotoxicity studies with the active ingredient glyphosate were analyzed for the current evaluation. The overall weight-of-evidence indicates that there is no convincing evidence that glyphosate is genotoxic *in vivo* via the oral route. When administered via i.p. injection the studies were predominantly negative. In the two cases where an increase in micronuclei were reported via this route, the effects were not observed in other i.p. injection studies at similar or higher doses. Technical glyphosate was negative in all gene mutation studies. There was limited evidence of positive findings in studies evaluating primary DNA damage; however, as discussed in Section 5.6, the endpoints measured in these assays are less specific in regards to detecting permanent DNA changes (mutations) and can be attributed to other factors, such as cytotoxicity or cell culture conditions. Although some positive findings were reported for chromosomal alterations *in vitro*, these findings were limited to a few studies and are not supported by the *in vivo* studies that are the most relevant for human risk assessment.

Overall, there is remarkable consistency in the database for glyphosate across multiple lines of evidence. For NHL, observed associations in epidemiological studies were non-statistically significant and were of relatively small magnitude. Chance and/or bias cannot be excluded as an explanation for the observed associations. For all other cancer types, there were no associations found; however, only one or two studies were available for evaluation of most cancer types. Across species, strain, and laboratory, tumor incidence was not increased at doses <500 mg/kg/day, except the testicular tumors which were only seen in one study. Observed tumors were not reproduced in other studies, including those conducted using the same strain at similar or higher doses. The genotoxicity studies demonstrate that glyphosate is not directly mutagenic or genotoxic *in vivo*.

6.4 Biological Plausibility and Coherence

The Guidelines for Carcinogen Risk Assessment (U.S. EPA, 2005) include the following guidance regarding the criteria of biological plausibility and coherence:

> "*evaluation of the biological plausibility of the associations observed in epidemiologic studies reflects consideration of both exposure-related factors and toxicological evidence relevant to identification of potential modes of action (MOAs). Similarly, consideration of the coherence of health effects associations reported in the epidemiologic literature reflects broad consideration of information pertaining to the nature of the biological markers evaluated in toxicologic and epidemiologic studies*. [p.39]."

The genotoxicity studies demonstrate that glyphosate is not directly mutagenic or genotoxic *in vivo*. The available data regarding non-cancer endpoints also do not provide any support for a carcinogenic process for glyphosate, and have shown glyphosate has relatively low toxicity. Laboratory animals generally display non-specific effects (e.g., clinical signs, reduced body weight) following glyphosate exposure at relatively high-doses, and no preneoplastic or related non-neoplastic lesions were observed to corroborate any of the observed tumors in the carcinogenicity studies. As discussed in Section 4.2, metabolism studies demonstrate low oral absorption and rapid excretion of glyphosate. The data are not sufficient to determine whether linear kinetics is occurring at high doses where tumors were observed. In the carcinogenicity test guideline (OCSPP 870.4200) and the 2005 Guidelines for Carcinogen Risk Assessment, inappropriate toxicokinetics (e.g., overwhelming absorption or detoxification mechanisms) should be avoided. A study evaluating the toxicokinetic profile of glyphosate using multiple doses is needed to further investigate the pharmacokinetic properties between low- and high-dose levels.

Although many of the studies included in this document focus on the potential for glyphosate to cause a cancer outcome, the agency is also aware of a limited number of studies in the open literature that have shown glyphosate and its metabolite, AMPA, can inhibit proliferation and promote apoptosis in cancer cells indicating the compounds have potential to be developed into therapeutic drugs for cancer treatment (Li *et al*, 2013; Parajuli *et al.*, 2015; Parajuli *et al.*, 2016). It is unknown if this is due to lack of additional studies that have investigated these compounds for cancer treatment or if this may be due to publication bias. The bias towards only publishing positive and/or novel results can hamper the ability to evaluate whether there are plausible biological mechanisms for observed outcomes and/or sufficient information to support a cause-and-effect interpretation of an association. Overall, this further supports the need for mechanistic data to elucidate the true mammalian MOA/AOP for glyphosate. There is a distinct lack of mechanistic understanding for the toxicity of glyphosate in mammals and the plant MOA is not relevant for mammalian systems.

As noted previously, tumor incidence in animal carcinogenicity studies was typically only increased at the highest doses tested (≥1000 mg/kg/day). It is very unlikely for people to be exposed to such large doses of glyphosate via the oral route. Glyphosate is registered for pre- and post-emergence application to a variety of fruit, vegetable, and field crops, as well as desiccant applications to several commodities. The highest dietary exposure value for any population subgroup in an unrefined chronic dietary analysis would be 0.23 mg/kg/day for children (1-2 years old). Since glyphosate also has residential uses, including application to turf,

there is also the potential for children at this age to be exposed via incidental oral exposures (e.g., hand to mouth, object to mouth and soil ingestion) from playing on treated lawns. The highest exposure for the incidental oral and dermal exposures would be 0.16 mg/kg/day (from hand-to-mouth behaviors for children) and 0.08 mg/kg/day, respectively. Combining exposures from the dietary and residential exposures for children would, therefore, result in an aggregate exposure of 0.47 mg/kg/day. These calculations use a number of assumptions that have been extensively peer-reviewed[27] and yet the potential oral exposure of glyphosate for the most highly exposed residential population subgroup is more than 2,000 times lower than the highest doses tested in the animal carcinogenicity studies (see Appendix E for more details regarding these calculations). The maximum potential exposure calculated for occupational handlers would be 7 mg/kg/day, which is still significantly lower than the highest doses tested in the animal carcinogenicity studies. As a result, even though tumors were observed in animal carcinogenicity studies, the possibility of being exposed to these excessive dietary doses over time is considered implausible based on the currently registered use pattern and not relevant to human health risk assessment.

6.5 Uncertainty

When evaluating a database, it is also important to assess the uncertainties associated with the available data. When uncertainty is high there is less confidence in the exposure and effect estimates and, therefore, informs the reliability of results. Understanding the sources of uncertainty within a database can help characterize observed results and aid in developing new research with reduced uncertainty.

In some instances, the agency did not have access to all of the data underlying the studies analyzed for the current evaluation. This includes all of the epidemiological studies, 17 genotoxicity studies, and 1 animal carcinogenicity study. For these studies, the agency had to rely upon information the study authors reported. Without the raw data, statistical analyses could not be replicated or recalculated. On the other hand, studies that include full reports with detailed methodology, analytically measured doses, and individual animal data may provide a higher level of confidence. It also allows the agency to perform its own evaluation of the data using current practices and policies.

Several uncertainties have already been identified throughout this document. There are numerous metabolism studies available for glyphosate; however, the data are not sufficient to determine whether linear kinetics is occurring at high doses where tumors were observed in animal carcinogenicity studies. In the carcinogenicity test guideline (OCSPP 870.4200) and the 2005 Guidelines for Carcinogen Risk Assessment, inappropriate toxicokinetics (e.g., overwhelming absorption or detoxification mechanisms) should be avoided. A study evaluating the toxicokinetic profile of glyphosate using multiple doses is needed to further investigate the pharmacokinetic properties between low- and high-dose levels.

[27] Using the 2012 Standard Operating Procedures for Residential Exposure Assessment. Available: http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

With respect to the epidemiological data, the database is limited for each investigated cancer with only one or two studies available. Although six studies were used in the evaluation of NHL, the results were constrained by the limitations of the individual studies, such as small sample size/limited power, missing data, and control selection issues. The quality of the exposure assessment is a major concern since the validity of the overall study results depend in large part on the ability of the study to correctly quantify and classify a subject's exposure. There was no direct information on pesticide exposure or absorbed dose because the exposures were self-reported. All of the studies conducted exposure assessments through questionnaires and interviews that are susceptible to recall bias, which can result in exposure misclassification. The study with the highest ranking (De Roos *et al.*, 2005) did not find an association between glyphosate exposure and NHL; however, it has been noted that the median follow-up time for this study was ~7 years. A longer follow-up from the AHS cohort would be beneficial to better understand whether there is an association between glyphosate exposure and NHL. An update from the AHS cohort would also provide a more recent evaluation of glyphosate exposure and cancer outcomes. Many of the studies were conducted prior to the introduction of glyphosate-tolerant crops in 1996, which resulted in a dramatic increase of glyphosate use in subsequent use. More recent studies will help further elucidate the association between glyphosate exposure and cancer outcomes during this period of time.

Another consideration is that farmers and other applicators apply formulations, not the active ingredient alone. It is possible that different formulations were used across and/or within the different epidemiological studies. Formulations are end-use products that are sold as a mixture of registered pesticidal active ingredients, such as glyphosate, and additional substances that increase the effectiveness of a pesticidal product, which are often referred to as "inert ingredients." For example, inert ingredients may act as a solvent to allow a pesticide active ingredient to penetrate a plant's outer surface, may facilitate and accentuate the dispersion of the product, or may extend the pesticide product's shelf-life[28]. Inert ingredients and the proportion of these inert ingredients vary across formulations. It has been hypothesized that glyphosate formulations may be more toxic than glyphosate alone. Glyphosate has been studied in a multitude of studies and there are studies that have been conducted on numerous formulations that contain glyphosate; however, there are relatively few research projects that have attempted to systematically compare glyphosate and the formulations in the same experimental design. Furthermore, there are even less instances of studies comparing toxicity across formulations. This is one aspect of the uncertainty in the database that the agency has been working to address by developing a strategic research plan in collaboration with NTP (see Section 7.0).

It is recognized that these uncertainties exist for the current database; however, the available data are adequate for evaluating the carcinogenic potential of glyphosate and determine the cancer classification using the 2005 Guidelines for Carcinogen Risk Assessment. As discussed in Section 6.3, there are a large number of studies available and the database is remarkably consistent across these studies.

[28] https://www.epa.gov/pesticide-registration/inert-ingredients-overview-and-guidance

6.6 Evaluation of Cancer Classification per the 2005 EPA Guidelines for Carcinogen Risk Assessment

6.6.1 Introduction

In the 2005 Guidelines for Carcinogen Risk Assessment, five classification descriptors are provided:

- Carcinogenic to Humans
- Likely to be Carcinogenic to Humans
- Suggestive Evidence of Carcinogenic Potential
- Inadequate Information to Assess Carcinogenic Potential
- Not Likely to be Carcinogenic to Humans

Descriptors are assigned using all available data from the multiple lines of evidence. The following text has been excerpted/summarized from the guidelines regarding these descriptors:

> Choosing a descriptor is a matter of judgment and cannot be reduced to a formula. Each descriptor may be applicable to a wide variety of potential data sets and weights of evidence. The weight-of-evidence, including the selected descriptor, is presented as a narrative laying out the complexity of information that is essential to understanding the hazard and its dependence on the quality, quantity, and type(s) of data available. The descriptors and narratives are intended to permit sufficient flexibility to accommodate new scientific understanding and new testing methods. The descriptors represent points along a continuum of evidence; consequently, there are gradations and borderline cases that are clarified by the full weight-of-evidence narrative. Rather than focusing simply on the descriptor, the entire range of information included in the weight-of-evidence narrative should be considered.

The weight-of-evidence presented in Sections 6.2-6.5 and based on the available epidemiological, animal carcinogenicity, and genotoxicity data for glyphosate was considered for each classification descriptor. For each descriptor, the guidelines provide examples and/or conditions for when the descriptor may be appropriate and the weight-of-evidence for glyphosate is assessed to determine which descriptor is supported by the available data. As stated in the 2005 EPA Guidelines for Carcinogen Risk Assessment, "the entire range of information included in the weight-of-evidence should be considered". Based on all of the available data, the weight-of-evidence clearly do not support the descriptors "carcinogenic to humans" and "likely to be carcinogenic to humans" at this time. According to the 2005 Cancer Guidelines, "carcinogenic to humans" is appropriate "when there is convincing epidemiologic evidence of a causal association between human exposure and cancer." Similarly, "likely to be carcinogenic to humans" descriptor is appropriate "when the weight of the evidence is adequate to demonstrate carcinogenic potential to humans but does not reach the weight of evidence for the descriptor."

In epidemiological studies, there was no evidence of an association between glyphosate exposure and solid tumors, leukemia, or HL. The available data for multiple myeloma are not considered adequate to assess carcinogenic potential and a conclusion regarding the association between

glyphosate exposure and risk of NHL cannot be determined based on the available data due to conflicting results and various limitations identified in studies investigating NHL. In 7 of the 15 animal carcinogenicity studies, no tumors were identified for detailed evaluation. In the remaining 8 studies, tumor incidences were not increased at doses <500 mg/kg/day, except for testicular tumors. The tumors observed at doses at or exceeding 1,000 mg/kg/day are not considered relevant to human health risk assessment. Tumor findings were not reproduced in studies in the same animal strain at similar or higher doses. Furthermore, the tumors often lacked a monotonic dose response, pairwise significance, and/or corroborating preneoplastic lesions. The mammalian MOA/AOP is unknown for glyphosate and precursor events are unknown; however, the genotoxicity data were highly reproducible and consistent with a clear demonstration that glyphosate does not have a mutagenic MOA.

The descriptor "inadequate information to assess carcinogenic potential" is used when available data are judged inadequate for applying one of the other descriptors. Given the extensive size of the glyphosate database, which includes a multitude of well-designed and well-conducted studies, this classification descriptor is not supported. The epidemiological data at this time are limited and study results appear to be inconsistent for some cancer types. However, it is important to note that epidemiological studies are not available for most pesticides. Similarly, for most pesticides, generally, only two animal bioassays are available. EPA routinely evaluates human cancer potential using the small, more typical datasets. As such, for glyphosate, given the significant amount of information across multiple lines of evidence, the agency believes the database is sufficient to designate a cancer classification descriptor for glyphosate and that "inadequate information to assess carcinogenic potential" is not appropriate.

The remaining two cancer classification descriptors (*"Suggestive Evidence of Carcinogenic Potential"* and *"Not Likely to Be Carcinogenic to Humans")* from the 2005 EPA Guidelines for Carcinogen Risk Assessment are described in detail below. Subsequently, these descriptors are discussed in the context of whether the available evidence do or do not support them.

"Suggestive Evidence of Carcinogenic Potential"

This descriptor is appropriate when a concern for potential carcinogenic effects in humans is raised, but the data are judged not sufficient for a stronger conclusion. It covers a spectrum of evidence associated with varying levels of concern for carcinogenicity. Depending on the extent of the database, additional studies may or may not provide further insights.

Some examples of when this descriptor may be appropriate include the following:

- If a small, and possibly not statistically significant, increase in tumor incidence observed in a single animal or human study that does not reach the weight-of-evidence for the descriptor of "likely to be carcinogenic to humans." The study generally would not be contradicted by other studies of equal quality in the same population group or experimental system;
- If there is evidence of a positive response in a study whose power, design, or conduct limits the ability to draw a confident conclusion (but does not make the study fatally flawed), but where the carcinogenic potential is strengthened by other lines of evidence;

- If there is a small increase in a tumor with a high background rate in that sex and strain, when there is some but insufficient evidence that the observed tumors may be due to intrinsic factors that cause background tumors and not due to the agent being assessed (when there is a high background rate of a specific tumor in animals of a particular sex and strain, then there may be biological factors operating independently of the agent being assessed that could be responsible for the development of the tumors). In this case, the reasons for determining that the tumors are not due to the agent are explained; or
- If there is a statistically significant increase at one dose only, but no significant response at the other doses and no overall trend.

"Not Likely to Be Carcinogenic to Humans"

This descriptor is appropriate when the available data are considered robust for deciding that there is no basis for human hazard concern. In some instances, there can be positive results in experimental animals when there is strong, consistent evidence that each MOA in experimental animals does not operate in humans. In other cases, there can be convincing evidence in both humans and animals that the agent is not carcinogenic.

This descriptor would be appropriate if any of the following was observed:

- Animal evidence demonstrates lack of carcinogenic effects in both sexes in well-designed and well-conducted studies in at least two appropriate animal species in the absence of other animal or human data suggesting a potential for cancer effects, or
- Convincing and extensive experimental evidence showing that the only carcinogenic effects observed in animals are not relevant to humans, or
- Convincing evidence that carcinogenic effects are not likely by a particular exposure route, or
- Convincing evidence that carcinogenic effects are not likely below a defined dose range.

6.6.2 Discussion of Evidence to Support Cancer Classification Descriptors

As stated above, the available data and weight-of-evidence clearly do not support the descriptors "carcinogenic to humans", "likely to be carcinogenic to humans", or "inadequate information to assess carcinogenic potential". The following discusses the remaining cancer classification descriptors and how the evidence does or does not support the descriptors.

It could be argued that the "suggestive evidence of carcinogenic potential" descriptor would be appropriate. The evidence to support this includes:

- Non-statistically significant effect estimates greater than the null were reported for NHL across studies and meta-analyses based on ever/never use ranged from 1.3-1.5.
- There was limited evidence of a possible exposure-response relationship between glyphosate exposure and NHL.

- In several animal carcinogenicity studies, a statistically significant trend was observed. In some instances, tumor incidences at the highest dose tested were statistically significant as compared to concurrent controls using raw (unadjusted) p-values.
- Positive responses were observed in a limited number of genotoxicity assays evaluating chromosomal and primary DNA damage.

However, according to the 2005 EPA Guidelines for Carcinogen Risk Assessment, in order for the above evidence to support the "suggestive evidence of carcinogenic potential" descriptor, "the study generally would not be contradicted by other studies of equal quality in the same population group or experimental system". Furthermore, the guidelines state that "rather than focusing simply on the descriptor, the entire range of information included in the weight-of-evidence narrative should be considered". For the epidemiological studies evaluating NHL, half of the studies reported effect estimates for ever/never use ranging from 1.5-1.85, with the widest confidence interval observed for the highest effect estimate indicating the effect estimate is less reliable. In the other half of the studies, which were of equal or higher quality, the reported effect estimates were approximately equal to the null. All of the effect estimates were non-statistically significant. There were conflicting results in exposure-response assessments investigating glyphosate exposure and the risk of NHL. Although two-case control studies (McDuffie et al., 2001; Eriksson et al., 2008) reported elevated effect estimates when analyzing for exposure-response relationships across two exposure categories, extensive analyses in a study of equal or higher quality (De Roos et al., 2005) for cumulative lifetime exposure and intensity-weighted cumulative exposure contradicted these results reporting effect estimates less than null (ranging from 0.6-0.9) when analyzing across tertiles. Furthermore, the two-case control studies did not account for co-exposure to other pesticides, which would be expected to cause inflated effect estimates. Various limitations that could impact the calculated effect estimate were identified for these studies and discussed in Section 3.6. The effect estimates greater than the null were not strengthened by other lines of evidence, as described in Sections 6.2-6.5.

In 7 (5 rat and 2 mouse) of the 15 animal carcinogenicity studies conducted with glyphosate, no tumors were identified for detailed evaluation. Of the remaining 8 studies, 7 observed a statistically significant trend for a particular tumor type; however, the agency determined that these tumors findings are not considered to be related to treatment. Although a statistically significant trend was obtained, closer examination of the incidence data across doses did not demonstrate a monotonic dose responses in several instances. Although the incidence at the highest dose tested (approaching or exceeding 1,000 mg/kg/day for almost all studies) for some of these tumors were statistically significant from concurrent controls using raw (unadjusted) p-values, none of the pairwise comparisons were found to be statistically significant following adjustment for multiple comparisons, except the testicular tumors that were seen in a single study. Furthermore, these high-dose tumors were given less weight. There was no evidence of corroborating pre-neoplastic or related non-neoplastic lesions and tumors showed no evidence of tumor progression to support the biological significance of tumor findings. In a limited number of cases, the agency also considered historical control data to inform the relevance of tumor findings when incidence rates in the concurrent controls were unusually low. Lastly, tumors seen in individual studies were not reproduced in studies of equal quality, including studies in the same animal species and strain at similar or higher doses.

Although positive responses were observed in a limited number of genotoxicity assays evaluating chromosomal and primary DNA damage, the overall weight-of-evidence indicates that there is no convincing evidence that glyphosate induces mutations *in vivo* via the oral route. When administered via i.p. injection the studies were predominantly negative. In the two cases where an increase in micronuclei were reported via this route of administration, the results were contradicted by numerous other studies at similar or higher doses using the same assays and route of administration. Technical glyphosate was negative in all gene mutation studies. There was limited evidence of positive findings in studies evaluating primary DNA damage; however, the endpoints measured in these assays are less specific in regards to detecting permanent DNA changes (mutations) and can be attributed to other factors, such as cytotoxicity or cell culture conditions. Although some positive findings were reported for chromosomal alterations *in vitro*, these findings were limited to a few studies and are not supported by the *in vivo* studies that are the most relevant for human risk assessment.

In summary, considering the entire range of information for the weight-of-evidence, the evidence outlined above to potentially support the "suggestive evidence of carcinogenic potential" descriptor are contradicted by other studies of equal or higher quality and, therefore, the data do not support this cancer classification descriptor.

For the "not likely to be carcinogenic to humans" descriptor, one of the considerations is whether there is "convincing evidence that carcinogenic effects are not likely below a defined dose range". In the case of glyphosate, effects are not likely below 500 mg/kg/day based on oral studies. Tumor incidences were not increased in animal carcinogenicity at doses <500 mg/kg/day, except for the testicular tumors observed in a single study that were not considered treatment-related. In genotoxicity studies, assays with oral administration were negative except for one instance where an extremely high dose (5,000 mg/kg/day) was administered.

The 2005 EPA Guidelines for Carcinogen Risk Assessment also state that "weighing of the evidence includes addressing not only the likelihood of human carcinogenic effects of the agent but also the conditions under which such effects may be expressed". Increased tumor incidence was typically observed at doses of 1,000 mg/kg/day or greater. Additionally, the only *in vivo* positive assays seen in the genotoxicity studies were administered via i.p. injection at doses of 200 mg/kg/day and 300 mg/kg/day or orally at 5,000 mg/kg/day. These high doses are not considered relevant to human health risk assessment based on the currently registered use pattern for glyphosate. Maximum potential glyphosate exposure in residential and occupational settings have been estimated at 0.47 mg/kg/day and 7 mg/kg/day, respectively, which are well-below the doses necessary to elicit the effects seen in these animal carcinogenicity and genotoxicity studies. Additionally, non-linear kinetics may also be occurring at the high doses. The carcinogenicity test guidelines (OCSPP 870.4200 and OCSPP 870.4300) and the 2005 Guidelines for Carcinogen Risk Assessment state that inappropriate toxicokinetics (e.g., overwhelming absorption or detoxification mechanisms) should be avoided. A well-conducted pharmacokinetic study evaluating the toxicokinetic profile of glyphosate is needed to further investigate the toxicokinetic properties between high and low dose levels to ensure that inappropriate toxicokinetics is avoided.

Overall, there is not strong support for the "suggestive evidence of carcinogenic potential" cancer classification descriptor based on the weight-of-evidence, which includes the fact that even small, non-statistically significant changes observed in animal carcinogenicity and epidemiological studies were contradicted by studies of equal or higher quality. The strongest support is for "not likely to be carcinogenic to humans" at the doses relevant to human health risk assessment for glyphosate.

6.7 Proposed Conclusions Regarding the Carcinogenic Potential of Glyphosate

Glyphosate is a non-selective, phosphonomethyl amino acid herbicide registered to control weeds in various agricultural and non-agricultural settings. Labeled uses of glyphosate include over 100 terrestrial food crops as well as other non-agricultural sites, such as greenhouses, aquatic areas, and residential areas. Following the introduction of glyphosate-resistant crops in 1996, glyphosate use increased dramatically; however, glyphosate use has stabilized in recent years due to the increasing number of glyphosate-resistant weed species.

Since its registration in 1974, numerous human and environmental health analyses have been completed for glyphosate, which consider all anticipated exposure pathways. Glyphosate is currently undergoing Registration Review. As part of this process, the hazard and exposure of glyphosate are reevaluated to determine its potential risk to human and environmental health using current practices and policies. The human carcinogenic potential of glyphosate has been evaluated by the agency several times. As part of the current evaluation for Registration Review, the agency has performed a comprehensive analysis of available data from submitted guideline studies and the open literature. This includes epidemiological, animal carcinogenicity, and genotoxicity studies.

An extensive database exists for evaluating the carcinogenic potential of glyphosate, including 23 epidemiological studies, 15 animal carcinogenicity studies, and nearly 90 genotoxicity studies for the active ingredient glyphosate. These studies were evaluated for quality and results were analyzed across studies within each line of evidence. The modified Bradford Hill criteria were then used to evaluate multiple lines of evidence using such concepts as strength, consistency, dose response, temporal concordance and biological plausibility. The available data at this time do no support a carcinogenic process for glyphosate. Overall, animal carcinogenicity and genotoxicity studies were remarkably consistent and did not demonstrate a clear association between glyphosate exposure and outcomes of interest related to carcinogenic potential. In epidemiological studies, there was no evidence of an association between glyphosate exposure and numerous cancer outcomes; however, due to conflicting results and various limitations identified in studies investigating NHL, a conclusion regarding the association between glyphosate exposure and risk of NHL cannot be determined based on the available data. Increases in tumor incidence were not considered treatment-related in any of the animal carcinogenicity studies. In 7 of these studies, no tumors were identified for detailed evaluation. In the remaining studies, tumor incidences were not increased at doses <500 mg/kg/day, except for the testicular tumors observed in a single study. Increased tumor incidences at or exceeding the limit dose (≥1000 mg/kg/day) are not considered relevant to human health. Furthermore, data from epidemiological and animal carcinogenicity studies do not reliably demonstrate expected dose-response relationships.

For cancer descriptors, the available data and weight-of-evidence clearly do not support the descriptors “carcinogenic to humans”, “likely to be carcinogenic to humans”, or “inadequate information to assess carcinogenic potential”. For the “suggestive evidence of carcinogenic potential” descriptor, considerations could be looked at in isolation; however, following a thorough integrative weight-of-evidence evaluation of the available data, the database would not support this cancer descriptor. The strongest support is for “not likely to be carcinogenic to humans” at doses relevant to human health risk assessment.

This analysis integrating multiple lines of evidence highlights the need for mechanistic studies to elucidate the MOA/AOP of glyphosate, as well as additional epidemiology studies and updates from the AHS cohort study to further investigate the carcinogenic potential of glyphosate in humans. This evaluation focused on studies on the active ingredient glyphosate; however, additional research could also be performed to determine whether formulation components, such as surfactants, influence the toxicity of glyphosate formulations. The agency has been working on plans to initiate research given these identified data gaps and these plans are described in Section 7.0.

The agency is soliciting advice from the FIFRA SAP on the evaluation and interpretation of the available data for each line of evidence for the active ingredient glyphosate and the weight-of-evidence analysis, as well as how the available data inform cancer classification descriptors according to the agency’s 2005 Guidelines for Carcinogen Risk Assessment.

7.0 Collaborative Research Plan for Glyphosate and Glyphosate Formulations

As previously mentioned, some have believed that glyphosate formulations may be more toxic than glyphosate alone. Glyphosate has been studied in a multitude of studies and there are studies that have been conducted on numerous formulations that contain glyphosate; however, there are relatively few research projects that have attempted to directly compare glyphosate and the formulations in the same experimental design. Furthermore, there are even less instances of studies comparing toxicity across formulations.

The agency has been collaborating with the NTP Division of the National Institute of Environmental Health Sciences to develop a research plan intended to evaluate the role of glyphosate in product formulations and the differences in formulation toxicity. Four objectives were identified that laid out how research by NTP might contribute to these research questions: 1) compare the toxicity of glyphosate vs. formulations, as well as compare formulations vs. formulations, 2) provide publicly available toxicology data on cancer-related endpoints, 3) provide publicly available toxicology data on non-cancer endpoints, and 4) investigate the mechanisms of how glyphosate and formulations cause toxic effects.

As part of the first objective, NTP will investigate the differential biological activity of glyphosate, glyphosate formulations, and the individual components of formulations. . The NTP Laboratory Branch generated preliminary data by exposing human hepatoma cells (HepG2) to five different glyphosate products bought off the shelf. The endpoint in the assay was cell viability, measured by ATP levels. The data, presented in Figure 7.1, demonstrate at-a-glance

that formulations are not equally toxic and that the toxicity is not being driven by the amount of glyphosate in the formulations, at least for the endpoint of cell viability. This observation highlights how informative the data generated from this research can be to the overall research questions.

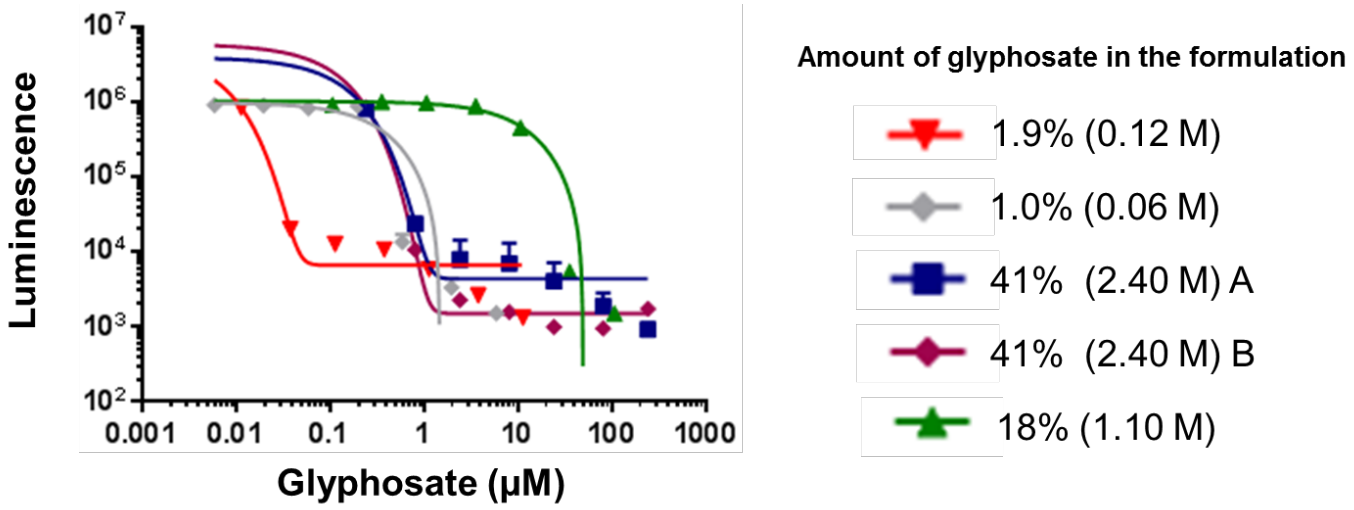

Figure 7.1. Results of HepG2 exposures following 24 hour incubation using different glyphosate formulations.

For the second objective, NTP will contribute to the publicly available knowledge-base describing the biological effects of glyphosate and formulations by conducting guideline studies addressing genotoxicity and studies that evaluate the oxidative stress potential. In order to organize publicly available data on glyphosate and formulations, IARC used 10 key characteristics of carcinogens as a way to help inform their conclusion (Smith *et al.*, 2016). Their review concluded that data were only available for two of these characteristics (genotoxicity and oxidative stress) and little to no information on the remaining characteristics was available. However, when members of a NTP workgroup looked at the available data included in the IARC review, the group did not agree with IARC that the data provided strong or clear evidence for either genotoxicity or induction of oxidative stress given protocol deficiencies that could produce questionable results.

Currently, the publicly available information regarding non-cancer endpoints for glyphosate and glyphosate formulations is limited. To begin to address the third objective, NTP will conduct a screening level analysis of the literature using text mining software, for studies regarding non-cancer endpoints resulting from glyphosate exposure. The resulting scoping report will describe the evidence base for health outcomes investigated in connection to glyphosate, as well as help identify data gaps.

As discussed in Section 6.0, there is a need for mechanistic studies to elucidate the MOA/AOP of glyphosate. Although there are data suggesting glyphosate may be genotoxic or cause oxidative stress, there is little mechanistic information to support these observations. For the last objective, NTP will use *in vitro* screening assays to gain mechanistic information on the effects

of glyphosate and different formulations for a variety of endpoints and allow for direct comparisons among them. The screening approach will also allow for the identification of test substances that would be good candidates for further *in vivo* testing. Since *in vivo* findings in genetic toxicology testing are generally considered as having a greater relevance to humans than *in vitro* findings, it is valuable to confirm the results seen at the cellular level at the whole animal level.

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Appendix A. Journal articles obtained from open literature search

Abstract Only	Cebollero, L. R., et al. (2011). "Glyphosate based herbicides toxicity, a new approach." Toxicology Letters 205, Supplement: S233.
Abstract Only	Monroy, C. M., et al. (2004). "In vitro evaluation of glyphosate-induced DNA damage in fibrosarcoma cells HT1080 and Chinese hamster ovary (CHO) cells." Environ Mol Mutagen 44(3): 216-216.
Abstract Only	Ramos-Morales, P., et al. (2008). "Combined use of multiple biomarkers to evaluate the genotoxic activity of the herbicide Glyphosate." Environ Mol Mutagen 49(7): 577-577.
Abstract Only/Full article already identified	Sorahan, T. (2015). "Multiple Myeloma and Glyphosate Use: A Re-Analysis of US Agricultural Health Study (AHS) Data." Int J Environ Res Public Health 12(2): 1548-1559.
Article not in English	Kwiatkowska, M., et al. (2013). "GLYPHOSATE AND ITS FORMULATIONS - TOXICITY, OCCUPATIONAL AND ENVIRONMENTAL EXPOSURE." Med Pr 64(5): 717-729.
Article not in English	Lawson, R. and E. Estrade-Chapellaz (1999). "Intoxication volontaire par le glufosinate (Basta®)." Annales Françaises d'Anesthésie et de Réanimation 18(9): 1025-1026.
Article not in English	Mañas, F., et al. (2009). "Aberraciones cromosómicas en trabajadores rurales de la Provincia de Córdoba expuestos a plaguicidas." BAG. Journal of basic and applied genetics 20(1): 0-0.
Article not in English	Martinez, A., et al. (2007). "[Cytotoxicity of the herbicide glyphosate in human peripheral blood mononuclear cells]." Biomedica 27(4): 594-604.
Article not in English	Monroy, C. M., et al. (2005). "[Cytotoxicity and genotoxicity of human cells exposed in vitro to glyphosate]." Biomedica 25(3): 335-345.
Article not in English	Pieniazek, D., et al. (2003). "[Glyphosate--a non-toxic pesticide?]." Med Pr 54(6): 579-583.
Article not in English	Saratovskikh, E. A., et al. (2007). "Genotoxicity of the pestiside in Ames test and the possibility to formate the complexeses with DNA." Ekologicheskaya genetika V(3): 46-54.
Article not in English	В статье представлены результаты генотоксико логических, аллергологических и иммунологических исследований, проведенных в рамках медико-биологической оценки безопасности генно-инженерно-моди-фицированной кукурузы линии MON 88017, устойчивой к глифосату и жуку Diabrotica spp. Анализ данных, полученных при изучении уровня повреждений ДНК и уровня хромосомных аберраций, тяжести активного анафилактического шока и интенсивности гуморального иммунного ответа, состояния гуморального и клеточного звеньев иммунитета, не выявил какого-либо генотоксического, аллергенного, иммуномодулирующего и сенсибилизирующего действия ГМ-кукурузы линии MON 88017 по сравнению с ее традиционным аналогом.
Cancer treatment	Parajuli, K. R., et al. (2015). "Aminomethylphosphonic acid and methoxyacetic acid induce apoptosis in prostate cancer cells." Int J Mol Sci 16(5): 11750-11765.
Cancer treatment	Li, Q., et al. (2013). "Glyphosate and AMPA inhibit cancer cell growth through inhibiting intracellular glycine synthesis." Drug Des Devel Ther 7: 635-643.
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Appendix B

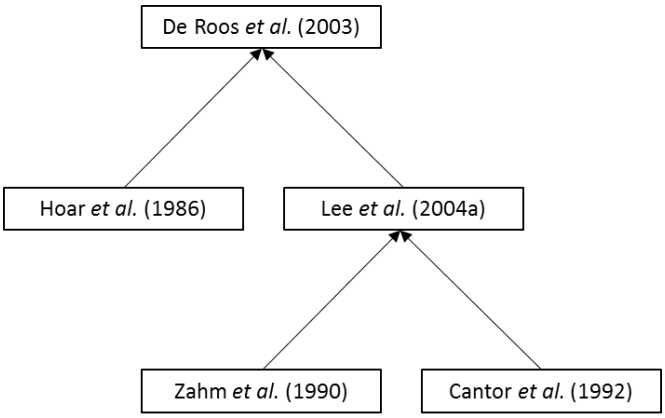

Figure B.1. Visual representation of studies included in De Roos *et al.* (2003).

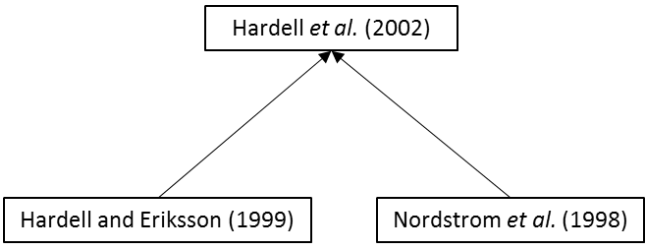

Figure B.2. Visual representation of studies included in Hardell *et al.* (2002).

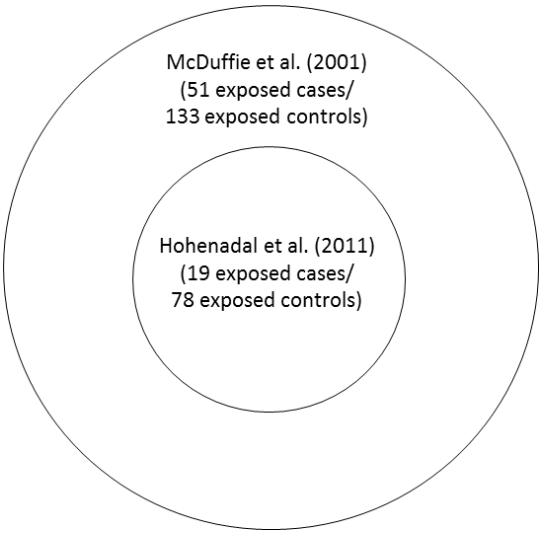

Figure B.3. Visual representation of the association between McDuffie *et al.* (2001) and the follow-up analysis by Hohenadal *et al.* (2011).

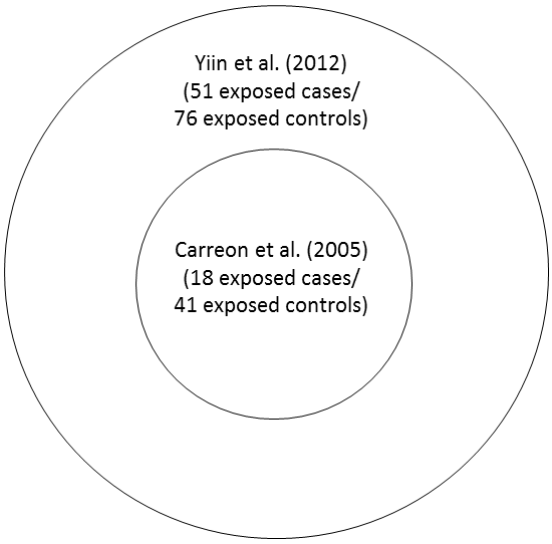

Figure B.4. Visual representation of the association between Carreon *et al.* (2005), which investigated gliomas in women only, and Yiin *et al.* (2012), which investigated both sexes.

Appendix C

Table B.1. Design Characteristics of Epidemiological Studies Evaluated for Study Quality.

Study	Location	Study Years	Case Population	Control Population	Total Number of Subjects	Number of Glyphosate Exposed Cases	Proxy Use
Alavanja *et al.* (2003)	USA: Iowa and North Carolina	Enrollment (1993-1997) through 2001	Males enrolled in AHS; licensed private and commercial applicators	Males enrolled in AHS; licensed private and commercial applicators	566 cases 54,766 controls	not reported	No
Andreotti *et al.* (2009)	USA: Iowa and North Carolina	Enrollment (1993-1997) through 2004	Participants enrolled in AHS; licensed private and commercial applicators and spouses	Participants enrolled in AHS; licensed private and commercial applicators and spouses	93 cases (64 applicators, 29 spouses) 82,503 controls (52,721 applicators, 29,782 spouses)	55 cases 48,461 controls	No
Band *et al.* (2011)	Canada: British Columbia	1983-1990	Male residents in British Columbia identified as cancer patients in British Columbia Cancer Registry (excluding farmers that worked all outside British Columbia)	Male residents in British Columbia identified as cancer patients in British Columbia Cancer Registry (excluding farmers that worked all outside British Columbia) with other cancer sites excluding lung cancer and cancers of unknown primary site	1,153 cases 3,999 controls	25 cases 60 controls	Yes (included in adjustment)
Brown *et al.* (1990)	USA: Iowa and Minnesota	Iowa: 1981-1983; Minnesota: 1980-1982 Initial interview 1981-1984 and supplemental interviews (Iowa only) in 1987	White males (30 years or older) residing in Iowa or Minnesota diagnosed with leukemia	White males without lymphatic or hematopoietic cancer selected by random digit dialing (< age 65), Medicare records (age > 65) and state death certificate files (deceased controls) - frequency matched for 5-year age group, vital status, and state of residence	Initial: 578 cases; 1245 controls Supplemental: 92 cases; 211 controls	15 cases 49 controls	Yes (not evaluated)
Brown *et al.* (1993)	USA: Iowa	Iowa: 1981-1983; Interview 1981-1984	White males (30 years or older) residing in Iowa diagnosed with multiple myeloma	White males without lymphatic or hematopoietic cancer selected by random digit dialing (< age 65), Medicare records (age >	173 cases 650 controls	11 cases 40 controls	Yes (not evaluated)

Table B.1. Design Characteristics of Epidemiological Studies Evaluated for Study Quality.							
Study	**Location**	**Study Years**	**Case Population**	**Control Population**	**Total Number of Subjects**	**Number of Glyphosate Exposed Cases**	**Proxy Use**
				65) and state death certificate files (deceased controls) - frequency matched for 5-year age group, vital status, and state of residence			
Cocco *et al.* (2013)	Czech Republic, France, Germany, Italy, Ireland, and Spain	1998-2004	Adult patients first diagnosed with lymphoma residing in the referral area of the participating centers	Controls from Germany and Italy were randomly selected by sampling from the general population, matched to cases on sex, 5-year age-group, and residence area. The rest of the centers used matched hospital controls, with eligibility criteria limited to diagnoses other than cancer, infectious diseases, and immunodeficient diseases	2,348 cases 2,462 controls	4 cases 2 controls	No
De Roos *et al.* (2003)	USA: Nebraska, Iowa, Minnesota, and Kansas	Nebraska: 1983-1986 Iowa: 1981-1983 Minnesota: 1980-1982 Kansas: 1979-1981	White males diagnosed with NHL in one of the 4 states (21 years or older in Nebraska and Kansas; 30 years or older in Iowa and Minnesota)	Males living in same geographic area obtained by random digit dialing, Medicare records and state mortality files - frequency matched for race, sex, age, and vital status	870 cases 2,569 controls	36 cases 61 controls	Yes (not significant in covariate analysis)
De Roos *et al.* (2005)	USA: Iowa and North Carolina	Enrollment (1993-1997) through 2001	Participants enrolled in AHS; licensed private and commercial applicators and spouses	Participants enrolled in AHS; licensed private and commercial applicators and spouses	54,315 subjects included in this analysis	All cancers – 358 cases Lung – 26 cases Oral cavity – 10 cases Colon – 15 cases Rectum – 14 cases Pancreas – 7 cases Kidney – 9 cases Bladder – 17 cases Prostate – 145 cases Melanoma – 14 cases All lymphohematopoietic cancers – 36 cases NHL – 17 cases Leukemia – 9 cases	No

Table B.1. Design Characteristics of Epidemiological Studies Evaluated for Study Quality.							
Study	**Location**	**Study Years**	**Case Population**	**Control Population**	**Total Number of Subjects**	**Number of Glyphosate Exposed Cases**	**Proxy Use**
						Multiple myeloma – 6 cases (13,280 subjects not exposed to glyphosate used for comparison population)	
Engel *et al.* (2005)	USA: Iowa and North Carolina	Enrollment (1993-1997) through 2000	Wives of applicators enrolled in AHS study with no history of breast cancer	Wives of applicators enrolled in AHS study with no history of breast cancer	309 cases 30,145 controls	82 cases; 10,016 controls	No
Eriksson *et al.* (2008)	Sweden	1999-2002	Patients (18-74 years of age) residing in Sweden and diagnosed with NHL	Swedish residents randomly selected living in same health service regions as cases - frequency matched for age (in 10 years) and sex	910 cases 1,016 controls	29 cases 18 controls	No
Flower *et al.* (2004)	USA: Iowa	1993-1997	Children (born after 1975) of participants enrolled in AHS study who were diagnosed with childhood cancer up to 19 years of age	Children (born after 1975) of participants enrolled in AHS study not diagnosed with childhood cancer up to 19 years of age	50 cases out of 17,357 total study population	Maternal use: 13 cases of 6075 total exposed Paternal use: 6 cases of 3231 total exposed	No
Hardell *et al.* (2002)	Sweden	NHL: 1987-1990 HCL: 1987-1992	NHL: Male residents of one of four northern or three middle counties in Sweden age 25 years and older diagnosed with NHL; identified from regional cancer registries HCL: Living male residents of Sweden age 25 years and older diagnosed with HCl; identified from the Swedish Cancer Registry	NHL: Two male controls for each case matched by age, year of death if deceased, and county HCL: Four male controls for each case matched by age and county	515 cases 1,141 controls	8 cases 8 controls	Yes (not evaluated)
Kachuri *et al.* (2013)	Canada: Alberta, British Columbia, Manitoba, Ontario,	1991–1994	Men aged ≥ 19 years (≥ 30 years in analysis) - pulled from hospital records in Quebec,	Men aged ≥ 19 years (30 years in analysis) - pulled from provincial health insurance records in	342 cases 1,357 controls	32 cases 121 controls	Yes (included in adjustment)

Table B.1. Design Characteristics of Epidemiological Studies Evaluated for Study Quality.							
Study	**Location**	**Study Years**	**Case Population**	**Control Population**	**Total Number of Subjects**	**Number of Glyphosate Exposed Cases**	**Proxy Use**
	Quebec, and Saskatchewan		cancer registries in all other provinces	Alberta, Saskatchewan, Manitoba, and Quebec; computerized telephone listings in Ontario; voter lists in British Columbia			
Karunanayake *et al.* (2012)	Canada: Alberta, British Columbia, Manitoba, Ontario, Quebec, and Saskatchewan	1991–1994	Men aged ≥ 19 years - pulled from hospital records in Quebec, cancer registries in all other provinces	Men aged ≥ 19 years - pulled from provincial health insurance records in Alberta, Saskatchewan, Manitoba, and Quebec; computerized telephone listings in Ontario; voter lists in British Columbia	316 cases 1,506 controls	38 cases 133 controls	No
Koureas *et al.* (2014)	Greece	2010	Inhabitants of the city of Larissa; Eligibility criteria for pesticide sprayers were 1) to personally apply pesticides systematically, and 2) to have recently applied pesticides (no longer than 7 days between last application and sampling).	The rural residents group were occupied in administrative services, public order services, health services, education or trade. Inclusion criteria for this group: absence of any involvement in agricultural activities either as a primary or secondary occupation by participant or any member of household. Also recruited urban residents (mainly blood donors) from the city of Larissa.	80 pesticide sprayers, 85 rural residents, and 121 individuals	Not reported	No
Koutros *et al.* (2013)	USA: Iowa and North Carolina	Enrollment (1993-1997) through 2007	Males enrolled in AHS; licensed private and commercial applicators	Males enrolled in AHS; licensed private and commercial applicators	1,962 incident cases (including 919 aggressive prostate cancers) among 54,412 applicators	1464 cases 42,420 controls	No
Landgren *et al.* (2009)	USA: Iowa and North Carolina	Exposure information: enrollment (1993-1997) and 5-year follow-up interview	Males enrolled in AHS; licensed private and commercial applicators	Males enrolled in AHS; licensed private and commercial applicators	678 participants	27 cases out of 570 total exposed	No

Table B.1. Design Characteristics of Epidemiological Studies Evaluated for Study Quality.							
Study	**Location**	**Study Years**	**Case Population**	**Control Population**	**Total Number of Subjects**	**Number of Glyphosate Exposed Cases**	**Proxy Use**
		Blood samples: 2006-2007 (Iowa) and 2008 (North Carolina)					
Lee *et al.* (2004b)	USA: Nebraska	1988-1993	White residents of 1 of 66 Nebraska counties age 21 years or older with a newly confirmed case of adenocarcinoma of the stomach or Cases identified from the Nebraska Cancer Registry (1988–1990) or from discharge diagnosis and pathology records from 14 Nebraska hospitals (1991–1993)	Frequency matched by age and sex to the combined distribution of glioma, stomach, and esophageal cancer cases from a control group from a previous study (1986–1987) that selected controls from the general population by random digit dialing for those under 65 years, Health Care Financing Administration Medicare files for those over 65 years, mortality records for deceased and matched by race, sex, vital status (or year of death if deceased)	Stomach: 170 cases Esophagus: 137 cases 502 Controls	12 cases 46 controls	Yes (analysis showed differences)
Lee *et al.* (2005)	USA: Nebraska	1988-1993	White residents of 1 of 66 Nebraska counties age 21 years or older with confirmed adult glioma. Cases identified from Nebraska Cancer Registry or from participating hospitals in Lincoln and Omaha, Nebraska	Frequency matched by age, sex, and vital status to the combined distribution of glioma, stomach, and esophageal cancer cases from a control group from a previous study (1986–1987) that selected controls from the general population by random digit dialing for those under 65 years, Medicare files for those over 65 years, mortality records for deceased and matched by race, sex, vital status (or year of death if deceased), and 5-year age groups to the overall case distribution. Additional	251 glioma cases 498 controls	17 cases 32 controls	Yes (analysis showed differences, included in adjustment)

Table B.1. Design Characteristics of Epidemiological Studies Evaluated for Study Quality.							
Study	**Location**	**Study Years**	**Case Population**	**Control Population**	**Total Number of Subjects**	**Number of Glyphosate Exposed Cases**	**Proxy Use**
				younger controls were brought into the study through random digit dialing and from death certificates			
Lee *et al.* (2007)	USA: Iowa and North Carolina	1993-97; follow-up to 2002	Agricultural Health Study participants: private and commercial applicators licensed in Iowa or North Carolina with no history of colorectal cancer at enrollment. Followed through 2002 for incident colorectal cancer	Agricultural Health Study participants: private and commercial applicators licensed in Iowa or North Carolina with no history of colorectal cancer at enrollment. Followed through 2002 for incident colorectal cancer	56,813 licensed pesticide applicators 305 incident colorectal cancer cases (212 colon, 93 rectum) 56,508 controls	Colon - 151 cases; 49 controls Rectum - 74 cases; 18 controls Colorectal - 225 cases; 67 controls	No
McDuffie *et al.* (2001)	Canada: Alberta, British Columbia, Manitoba, Ontario, Quebec, and Saskatchewan	1991-1994	Male residents of six Canadian provinces age 19 years and older diagnosed with STS, HD, NHL, or MM; this study only evaluated those with NHL. Cases were identified from Canadian Cancer Registries; in Quebec, hospital ascertainment was used	Random control subject selection using Health Insurance records, computerized telephone listings, and voters' lists; males 19 years and older from same six Canadian provinces as cases matched by age (within 2 years)	517 cases 1506 controls	Univariate analysis: 51 cases; 133 controls (multivariate analysis also conducted - glyphosate exposed numbers not reported)	No
Orsi *et al.* (2009)	France	2000-2004	Men aged 20–75 years living in the catchment areas of the main hospitals in Brest, Caen, Nantes, Lille, Toulouse, and Bordeaux, with no history of immunosuppression or taking immunosuppressant drugs. Cases ascertained from hospital records.	Patients from the same hospital catchment area as the cases. Patients were hospitalized for orthopedic or rheumatological conditions (89.3%), gastrointestinal or genitourinary tract diseases (4.8%), cardiovascular diseases (1.1%), skin and subcutaneous tissue disease (1.8%), and infections (3.0%), excluding patients admitted for cancer or a disease directly related to	491 cases 456 controls	NHL: 12 cases 24 controls HL: 6 cases 15 controls Lymphoproliferative syndromes: 4 cases 18 controls Multiple myeloma: 5 cases;18 controls Lymphoid neoplasms: 27 cases; 24 controls	No

Table B.1. Design Characteristics of Epidemiological Studies Evaluated for Study Quality.							
Study	**Location**	**Study Years**	**Case Population**	**Control Population**	**Total Number of Subjects**	**Number of Glyphosate Exposed Cases**	**Proxy Use**
				occupation, smoking, or alcohol abuse			
Pahwa *et al.* (2011)	Canada (Alberta, British Columbia, Manitoba, Ontario, Quebec, and Saskatchewan)	1991-1994	Men aged ≥ 19 years - pulled from hospital records in Quebec, cancer registries in all other provinces	Men aged ≥ 19 years - pulled from provincial health insurance records in Alberta, Saskatchewan, Manitoba, and Quebec; computerized telephone listings in Ontario; voter lists in British Columbia	342 cases 1,506 age/resident matched controls	32 cases 133 controls	No
Pahwa *et al.* (2012)	Canada (Alberta, British Columbia, Manitoba, Ontario, Quebec, and Saskatchewan)	1991-1994	Men aged ≥ 19 years - pulled from hospital records in Quebec, cancer registries in all other provinces	Men aged ≥ 19 years - pulled from provincial health insurance records in Alberta, Saskatchewan, Manitoba, and Quebec; computerized telephone listings in Ontario; voter lists in British Columbia	342 cases 1506 age/resident matched controls	32 cases 133 controls	No
Yiin *et al.* (2012)	USA: Upper Midwest Health Study (Iowa, Michigan, Minnesota and Wisconsin)	1995-1997	Age 18–80 (at ascertainment or diagnosis in 1995 through January 1997) residing in counties where the largest population center had fewer than 250,000 residents. Referral by physicians or through state cancer registries with cases verified by histological evaluation.	Controls age 18–64 randomly selected from state driver's license/nondriver ID records, and those age 65–80 were selected from Health Care Financing Administration's (HCFA) Medicare data within 10-year age group strata, with the proportion/stratum determined by the age distribution of glioma cases in that state from 1992 to 1994. Controls were frequency-matched within a state but not by county of residence. Selected even if they had a self-reported history of cancer other than glioma.	798 glioma cases; 1,175 controls	12 cases 19 controls	Yes (analysis showed no differences)

Appendix D. List of studies assigned a low quality ranking and not evaluated in detail

As described in Section 3.2, if studies did not collect exposure information on glyphosate from all subjects, did not assess an outcome (e.g., biomonitoring studies), and/or did not provide a quantitative measure of an association between glyphosate and a cancer outcome, then these studies were assigned a low quality ranking and were not further evaluated in detail. These studies included the following 32 studies:

Acquavella *et al.* 2006; Andre *et al.*, 2007; Baker *et al.* 2005; Benedetti *et al.*, 2013; Bolognesi *et al.*, 2002; Bolognesi *et al.*, 2004; Bolognesi *et al.* 2009; Bortoli *et al.*, 2009; Costa *et al.*, 2006; Da Silva *et al.* 2014; Dennis *et al.* 2010; Firth *et al.* 2007; Gomez-Arroyo *et al.*, 2013; Gregio D'Arce *et al.*, 2000; El-Zaemey *et al.*, 2013; Fortes *et al.*, 2016; Fritschi *et al.*, 2005; Hernandez *et al.*, 2006; Kaufman *et al.* 2009; Khayat *et al.*, 2013; Lebailly *et al.*, 2003; Mandel *et al.* 2005; Martinez-Valenzuela *et al.*, 2009; Monge *et al.*, 2007; Pastor *et al.*, 2003; Paz-y Mino *et al.*, 2007; Paz-y Mino *et al.* 2011; Ruder *et al.* 2004; Shaham *et al.*, 2001; Silva Kahl *et al.* 2016; Simoniello *et al.*, 2008; Vlastos *et al.*, 2006.

Appendix E

Chronic Dietary Exposure

The agency uses Dietary Exposure Evaluation Model- Food Consumption Intake Database (DEEM-FCID; version 3.16), which incorporates consumption data from United States Department of Agriculture (USDA) National Health and Nutrition Examination Survey, What We Eat in America (NHANES/WWEIA; 2003-2008) to calculate potential chronic dietary exposures. In an unrefined chronic dietary analysis, several conservative assumptions are used to generate high end estimates of potential exposure. These assumptions include tolerance-level residues for all registered commodities, 100% crop treated, and drinking water values from a direct application to water scenario, as well as DEEM default processing factors. For glyphosate, the highest exposure value for any population subgroup in an unrefined chronic dietary analysis would be 0.23 mg/kg/day for children 1-2 years old (Table E.1; DEEM inputs and results attached below).

Table E.1. Chronic dietary exposure estimates

Population Subgroup	Exposure (mg/kg/day)
General U.S. Population	0.091515
All Infants (< 1 year old)	0.142826
Children 1-2 years old	**0.230816**
Children 3-5 years old	0.214117
Children 6-12 years old	0.149269
Youth 13-19 years old	0.089636
Adults 20-49 years old	0.076396
Adults 50-99 years old	0.062987
Females 13-49 years old	0.071057

Post-application Incidental Oral and Dermal Exposure

Glyphosate has residential uses, including application to turf, which would result in the highest potential post-application exposures; therefore, there is potential for children to be exposed via incidental oral and dermal routes from playing on treated lawns. For this assessment, the agency evaluates exposures from hand-to-mouth behavior, object-to-mouth behavior, incidental soil ingestion, and dermal contact using the 2012 Standard Operating Procedures for Residential Pesticide Exposure Assessment[29]. Incidental oral exposures from hand-to-mouth, object-to-mouth, and incidental soil ingestion are considered inter-related and, therefore, not combined. To calculate high end estimates of exposures, the following is assumed according to the 2012 SOP to be health-protective: 1) maximum label rates are applied to the turf, 2) exposures are assumed to occur every day to the residue values on the day of application (i.e., no dissipation), and 3) individuals engage in post-application activities for the maximum amount of time represented by data for children spending time outdoors and not specifically engaged in activities

[29] Available: http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

on turf, when in actuality children do not spend all of their outdoor time on turf. The highest exposure from incidental oral scenarios using the maximum application rate for turf applications would be 0.16 mg/kg/day from hand-to-mouth behaviors by children (1 to <2 years old). Dermal post-application to children 1 to <2 years old would be 0.08 mg/kg/day.

Table E.2. Post-application Exposure Estimates for Application of Glyphosate to Turf[1].

Lifestage	Post-application Exposure Scenario		Exposure (mg/kg/day)
Children 1 to <2 year old	Turf – sprays	Hand-to-Mouth	0.16
		Object-to-Mouth	0.005
		Incidental Soil Ingestion	0.0003
		Dermal (high contact activities)	0.08

[1] Based on Roundup® Weed & Grass Super Concentrate, EPA Reg. No. 71995-25.

DEEM-FCID™ Chronic Residue File.

```
Filename: C:\Users\tbloem\Documents\work\glyphosate\registration review\417300C.R08
Chemical: Glyphosate
RfD(Chronic): 1 mg/kg bw/day  NOEL(Chronic): 100 mg/kg bw/day
RfD(Acute): 0 mg/kg bw/day  NOEL(Acute):  0 mg/kg bw/day
Date created/last modified: 06-09-2016/10:37:44       Program ver. 3.16, 03-08-d
Comment: THIS R98 FILE WAS GENERATED USING THE CONVERT TO R98 UTILITY VERSION 1.1.2.
-------------------------------------------------------------------------------------
   EPA     Crop                                    Def Res     Adj.Factors   Comment
   Code     Grp  Commodity Name                     (ppm)       #1    #2
---------- ---- -------------------------------  ----------  ------ ------  -------
0101050000 1AB  Beet, garden, roots                 0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0101050001 1AB  Beet, garden, roots-babyfood        0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0101052000 1A   Beet, sugar                        10.000000   1.000  1.000  P 7F04
            Full comment: P 7F04886
0101052001 1A   Beet, sugar-babyfood               10.000000   1.000  1.000  P 7F04
            Full comment: P 7F04886
0101053000 1A   Beet, sugar, molasses             10.000000   1.000  1.000  P 7F04
            Full comment: P 7F04886
0101053001 1A   Beet, sugar, molasses-babyfood    10.000000   1.000  1.000  P 7F04
            Full comment: P 7F04886
0101067000 1AB  Burdock                             0.200000   1.000  1.000
0101078000 1AB  Carrot                              5.000000   1.000  1.000  P 8E36
            Full comment: P 8E3676  7F2016
0101078001 1AB  Carrot-babyfood                     5.000000   1.000  1.000  P 8E36
            Full comment: P 8E3676  7F2016
0101079000 1AB  Carrot, juice                       5.000000   1.000  1.000  P 8E36
            Full comment: P 8E3676  7F2016
0101084000 1AB  Celeriac                            0.200000   1.000  1.000
0101100000 1AB  Chicory, roots                      0.200000   1.000  1.000
0101168000 1AB  Ginseng, dried                      0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0101190000 1AB  Horseradish                         0.200000   1.000  1.000  P 8E36
            Full comment: P 8E3676
0101250000 1AB  Parsley, turnip rooted              0.200000   1.000  1.000
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0101251000 1AB  Parsnip                              0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0101251001 1AB  Parsnip-babyfood                     0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0101314000 1AB  Radish, roots                        0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0101316000 1AB  Radish, Oriental, roots              0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0101327000 1AB  Rutabaga                             0.200000   1.000  1.000
0101331000 1AB  Salsify, roots                       0.200000   1.000  1.000
0101388000 1AB  Turnip, roots                        0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103015000 1CD  Arrowroot, flour                     0.200000   1.000  1.000
0103015001 1CD  Arrowroot, flour-babyfood            0.200000   1.000  1.000
0103017000 1CD  Artichoke, Jerusalem                 0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103082000 1CD  Cassava                              0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103082001 1CD  Cassava-babyfood                     0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103139000 1CD  Dasheen, corm                        0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103166000 1CD  Ginger                               0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103166001 1CD  Ginger-babyfood                      0.200000   1.000  1.000
0103167000 1CD  Ginger, dried                        0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103296000 1C   Potato, chips                        0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103297000 1C   Potato, dry (granules/ flakes)      0.200000   6.500  1.000
0103297001 1C   Potato, dry (granules/ flakes)-b    0.200000   6.500  1.000
0103298000 1C   Potato, flour                        0.200000   6.500  1.000  P 7F20
            Full comment: P 7F2016
0103298001 1C   Potato, flour-babyfood               0.200000   6.500  1.000  P 7F20
            Full comment: P 7F2016
0103299000 1C   Potato, tuber, w/peel                0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103299001 1C   Potato, tuber, w/peel-babyfood       0.200000   1.000  1.000
0103300000 1C   Potato, tuber, w/o peel              0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103300001 1C   Potato, tuber, w/o peel-babyfood     0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103366000 1CD  Sweet potato                         3.000000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103366001 1CD  Sweet potato-babyfood                3.000000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103371000 1CD  Tanier, corm                         0.200000   1.000  1.000
0103387000 1CD  Turmeric                             0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103406000 1CD  Yam, true                            0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0103407000 1CD  Yam bean                             0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016
0200051000 2    Beet, garden, tops                   0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0200101000 2    Chicory, tops                        0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016 & 8E2122
0200140000 2    Dasheen, leaves                      0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0200315000 2    Radish, tops                         0.200000   1.000  1.000
0200317000 2    Radish, Oriental, tops               0.200000   1.000  1.000
0200332000 2    Salsify, tops                        0.200000   1.000  1.000
0301165000 3A   Garlic, bulb                        0.200000   1.000  1.000  P 8E36
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            Full comment: P 8E3676
0301165001 3A   Garlic, bulb-babyfood              0.200000   1.000  1.000  P 8E36
            Full comment: P 8E3676
0301237000 3A   Onion, bulb                        0.200000   1.000  1.000  P 8E36
            Full comment: P 8E3676
0301237001 3A   Onion, bulb-babyfood               0.200000   1.000  1.000  P 8E36
            Full comment: P 8E3676
0301238000 3A   Onion, bulb, dried                 0.200000   9.000  1.000  P 8E36
            Full comment: P 8E3676
0301238001 3A   Onion, bulb, dried-babyfood        0.200000   9.000  1.000  P 8E36
            Full comment: P 8E3676
0301338000 3A   Shallot, bulb                      0.200000   1.000  1.000
0302103000 3B   Chive, fresh leaves                0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
0302198000 3B   Leek                               0.200000   1.000  1.000  P 8E36
            Full comment: P 8E3676
0302239000 3B   Onion, green                       0.200000   1.000  1.000  P 8E36
            Full comment: P 8E3676
0302338500 3B   Shallot, fresh leaves              0.200000   1.000  1.000
0401005000 4A   Amaranth, leafy                    0.200000   1.000  1.000
0401018000 4A   Arugula                            0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0401104000 4A   Chrysanthemum, garland             0.200000   1.000  1.000
0401133000 4A   Cress, garden                      0.200000   1.000  1.000
0401134000 4A   Cress, upland                      0.200000   1.000  1.000
0401138000 4A   Dandelion, leaves                  0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0401150000 4A   Endive                             0.200000   1.000  1.000  P 7F20
            Full comment: P 7F2016 & 8E2122
0401204000 4A   Lettuce, head                      0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0401205000 4A   Lettuce, leaf                      0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0401248000 4A   Parsley, leaves                    0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0401313000 4A   Radicchio                          0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0401355000 4A   Spinach                            0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0401355001 4A   Spinach-babyfood                   0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0402076000 4B   Cardoon                            0.200000   1.000  1.000
0402085000 4B   Celery                             0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0402085001 4B   Celery-babyfood                    0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0402086000 4B   Celery, juice                      0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0402087000 4B   Celtuce                            0.500000   1.000  1.000
0402152000 4B   Fennel, Florence                   0.500000   1.000  1.000
0402322000 4B   Rhubarb                            0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0402367000 4B   Swiss chard                        0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0501061000 5A   Broccoli                           0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0501061001 5A   Broccoli-babyfood                  0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0501062000 5A   Broccoli, Chinese                  0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0501064000 5A   Brussels sprouts                   0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0501069000 5A   Cabbage                            0.200000   1.000  1.000  P 8E21
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            Full comment: P 8E2122
0501071000 5A   Cabbage, Chinese, napa             0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0501072000 5A   Cabbage, Chinese, mustard          0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0501083000 5A   Cauliflower                        0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0501196000 5A   Kohlrabi                           0.500000   1.000  1.000
0502063000 5B   Broccoli raab                      0.200000   1.000  1.000
0502070000 5B   Cabbage, Chinese, bok choy         0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0502117000 5B   Collards                           0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0502194000 5B   Kale                               0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0502229000 5B   Mustard greens                     0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0502318000 5B   Rape greens                        0.200000   1.000  1.000
0502389000 5B   Turnip, greens                     0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
0600347000 6    Soybean, seed                     20.000000   1.000  1.000  P 5F15
            Full comment: P 5F1536
0600349000 6    Soybean, soy milk                 20.000000   1.000  1.000  P 5F15
            Full comment: P 5F1536
0600349001 6    Soybean, soy milk-babyfood or in  20.000000   1.000  1.000
0600350000 6    Soybean, oil                      20.000000   1.000  1.000  P 5F15
            Full comment: P 5F1536
0600350001 6    Soybean, oil-babyfood             20.000000   1.000  1.000  P 5F15
            Full comment: P 5F1536
0601043000 6A   Bean, snap, succulent              5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0601043001 6A   Bean, snap, succulent-babyfood     5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0601257000 6A   Pea, edible podded, succulent      5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0601349500 6AB  Soybean, vegetable                 5.000000   1.000  1.000
0602031000 6B   Bean, broad, succulent             5.000000   1.000  1.000
0602033000 6B   Bean, cowpea, succulent            5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0602037000 6B   Bean, lima, succulent              5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0602255000 6B   Pea, succulent                     5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0602255001 6B   Pea, succulent-babyfood            5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0602259000 6B   Pea, pigeon, succulent             5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0603030000 6C   Bean, black, seed                  5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0603032000 6C   Bean, broad, seed                  5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0603034000 6C   Bean, cowpea, seed                 5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0603035000 6C   Bean,  great northern, seed        5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0603036000 6C   Bean, kidney, seed                 5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0603038000 6C   Bean, lima, seed                   5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0603039000 6C   Bean, mung, seed                   5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
0603040000 6C   Bean, navy, seed                   5.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
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0603041000	6C	Bean, pink, seed	5.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
0603042000	6C	Bean, pinto, seed	5.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
0603098000	6C	Chickpea, seed	8.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
0603098001	6C	Chickpea, seed-babyfood	8.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
0603099000	6C	Chickpea, flour	8.000000	1.000	1.000	
0603182000	6C	Guar, seed	8.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
0603182001	6C	Guar, seed-babyfood	8.000000	1.000	1.000	
0603203000	6C	Lentil, seed	8.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
0603256000	6C	Pea, dry	8.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
0603256001	6C	Pea, dry-babyfood	8.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
0603258000	6C	Pea, pigeon, seed	8.000000	1.000	1.000	
0603348000	6C	Soybean, flour	20.000000	1.000	1.000	P 5F15
		Full comment: P 5F1536				
0603348001	6C	Soybean, flour-babyfood	20.000000	1.000	1.000	P 5F15
		Full comment: P 5F1536				
0801374000	8A	Tomatillo	0.100000	1.000	1.000	
0801375000	8A	Tomato	0.100000	1.000	1.000	
0801375001	8A	Tomato-babyfood	0.100000	1.000	1.000	
0801376000	8A	Tomato, paste	0.100000	5.400	1.000	
0801376001	8A	Tomato, paste-babyfood	0.100000	5.400	1.000	
0801377000	8A	Tomato, puree	0.100000	3.300	1.000	
0801377001	8A	Tomato, puree-babyfood	0.100000	3.300	1.000	
0801378000	8A	Tomato, dried	0.100000	14.300	1.000	
0801378001	8A	Tomato, dried-babyfood	0.100000	14.300	1.000	
0801379000	8A	Tomato, juice	0.100000	1.500	1.000	
0801380000	8A	Tomato, Tree	0.100000	1.000	1.000	
0802148000	8BC	Eggplant	0.100000	1.000	1.000	
0802234000	8BC	Okra	0.500000	1.000	1.000	P 9E60
		Full comment: P 9E6003				
0802270000	8B	Pepper, bell	0.100000	1.000	1.000	
0802270001	8B	Pepper, bell-babyfood	0.100000	1.000	1.000	
0802271000	8B	Pepper, bell, dried	0.100000	1.000	1.000	
0802271001	8B	Pepper, bell, dried-babyfood	0.100000	1.000	1.000	
0802272000	8BC	Pepper, nonbell	0.100000	1.000	1.000	
0802272001	8BC	Pepper, nonbell-babyfood	0.100000	1.000	1.000	
0802273000	8BC	Pepper, nonbell, dried	0.100000	1.000	1.000	
0901075000	9A	Cantaloupe	0.500000	1.000	1.000	P 3E28
		Full comment: P 3E2845				
0901187000	9A	Honeydew melon	0.500000	1.000	1.000	P 3E28
		Full comment: P 3E2845				
0901399000	9A	Watermelon	0.500000	1.000	1.000	P 3E28
		Full comment: P 3E2845				
0901400000	9A	Watermelon, juice	0.500000	1.000	1.000	
0902021000	9B	Balsam pear	0.500000	1.000	1.000	
0902088000	9B	Chayote, fruit	0.500000	1.000	1.000	
0902102000	9B	Chinese waxgourd	0.500000	1.000	1.000	
0902135000	9B	Cucumber	0.500000	1.000	1.000	P 3E28
		Full comment: P 3E2845				
0902308000	9B	Pumpkin	0.500000	1.000	1.000	P 3E28
		Full comment: P 3E2845				
0902309000	9B	Pumpkin, seed	0.500000	1.000	1.000	
0902356000	9B	Squash, summer	0.500000	1.000	1.000	P 3E28
		Full comment: P 3E2845				
0902356001	9B	Squash, summer-babyfood	0.500000	1.000	1.000	P 3E28
		Full comment: P 3E2845				

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0902357000 9B   Squash, winter                    0.500000   1.000  1.000  P 3E28
            Full comment: P 3E2845
0902357001 9B   Squash, winter-babyfood           0.500000   1.000  1.000  P 3E28
            Full comment: P 3E2845
1001106000 10A  Citron                            0.500000   1.000  1.000  P 4F43
            Full comment: P 4F4338
1001107000 10A  Citrus hybrids                    0.500000   1.000  1.000
1001108000 10A  Citrus, oil                       0.500000   1.000  1.000
1001240000 10A  Orange                            0.500000   1.000  1.000  P 4F43
            Full comment: P 4F4338
1001241000 10A  Orange, juice                     0.500000   1.800  1.000  P 4F43
            Full comment: P 4F4338
1001241001 10A  Orange, juice-babyfood            0.500000   1.800  1.000  P 4F43
            Full comment: P 4F4338
1001242000 10A  Orange, peel                      0.500000   1.000  1.000  P 4F43
            Full comment: P 4F4338
1001369000 10A  Tangerine                         0.500000   1.000  1.000  P 4F43
            Full comment: P 4F4338
1001370000 10A  Tangerine, juice                  0.500000   2.300  1.000  P 4F43
            Full comment: P 4F4338
1002197000 10B  Kumquat                           0.500000   1.000  1.000
1002199000 10B  Lemon                             0.500000   1.000  1.000  P 4F43
            Full comment: P 4F4338
1002200000 10B  Lemon, juice                      0.500000   2.000  1.000  P 4F43
            Full comment: P 4F4338
1002200001 10B  Lemon, juice-babyfood             0.500000   2.000  1.000  P 4F43
            Full comment: P 4F4338
1002201000 10B  Lemon, peel                       0.500000   1.000  1.000  P 4F43
            Full comment: P 4F4338
1002206000 10B  Lime                              0.500000   1.000  1.000  P 4F43
            Full comment: P 4F4338
1002207000 10B  Lime, juice                       0.500000   2.000  1.000  P 4F43
            Full comment: P 4F4338
1002207001 10B  Lime, juice-babyfood              0.500000   2.000  1.000  P 4F43
            Full comment: P 4F4338
1003180000 10C  Grapefruit                        0.500000   1.000  1.000  P 4F43
            Full comment: P 4F4338
1003181000 10C  Grapefruit, juice                 0.500000   2.100  1.000  P 4F43
            Full comment: P 4F4338
1003307000 10C  Pummelo                           0.500000   1.000  1.000
1100007000 11   Apple, fruit with peel           0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
1100008000 11   Apple, peeled fruit               0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
1100008001 11   Apple, peeled fruit-babyfood      0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
1100009000 11   Apple, dried                      0.200000   8.000  1.000  P 6F18
            Full comment: P 6F1861
1100009001 11   Apple, dried-babyfood             0.200000   8.000  1.000  P 6F18
            Full comment: P 6F1861
1100010000 11   Apple, juice                      0.200000   1.300  1.000  P 6F18
            Full comment: P 6F1861
1100010001 11   Apple, juice-babyfood             0.200000   1.300  1.000  P 6F18
            Full comment: P 6F1861
1100011000 11   Apple, sauce                      0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
1100011001 11   Apple, sauce-babyfood             0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
1100129000 11   Crabapple                         0.200000   1.000  1.000
1100173500 11   Goji berry                        0.100000   1.000  1.000
1100210000 11   Loquat                            0.200000   1.000  1.000
1100266000 11   Pear                              0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
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1100266001 11   Pear-babyfood                      0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
1100267000 11   Pear, dried                        0.200000   6.250  1.000  P 6F18
            Full comment: P 6F1861
1100268000 11   Pear, juice                        0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
1100268001 11   Pear, juice-babyfood               0.200000   1.000  1.000  P 6F18
            Full comment: P 6F1861
1100310000 11   Quince                             0.200000   1.000  1.000
1201090000 12A  Cherry                             0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1201090001 12A  Cherry-babyfood                    0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1201091000 12A  Cherry, juice                      0.200000   1.500  1.000  P 2600
            Full comment: P 260044
1201091001 12A  Cherry, juice-babyfood             0.200000   1.500  1.000  P 2600
            Full comment: P 260044
1202012000 12B  Apricot                            0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1202012001 12B  Apricot-babyfood                   0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1202013000 12B  Apricot, dried                     0.200000   6.000  1.000  P 2600
            Full comment: P 260044
1202014000 12B  Apricot, juice                     0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1202014001 12B  Apricot, juice-babyfood            0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1202230000 12B  Nectarine                          0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1202260000 12B  Peach                              0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1202260001 12B  Peach-babyfood                     0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1202261000 12B  Peach, dried                       0.200000   7.000  1.000  P 2600
            Full comment: P 260044
1202261001 12B  Peach, dried-babyfood              0.200000   7.000  1.000
1202262000 12B  Peach, juice                       0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1202262001 12B  Peach, juice-babyfood              0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1203285000 12C  Plum                               0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1203285001 12C  Plum-babyfood                      0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1203286000 12C  Plum, prune, fresh                 0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1203286001 12C  Plum, prune, fresh-babyfood        0.200000   1.000  1.000  P 2600
            Full comment: P 260044
1203287000 12C  Plum, prune, dried                 0.200000   5.000  1.000  P 2600
            Full comment: P 260044
1203287001 12C  Plum, prune, dried-babyfood        0.200000   5.000  1.000
1203288000 12C  Plum, prune, juice                 0.200000   1.400  1.000  P 2600
            Full comment: P 260044
1203288001 12C  Plum, prune, juice-babyfood        0.200000   1.400  1.000  P 2600
            Full comment: P 260044
1301055000 13A  Blackberry                         0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1301056000 13A  Blackberry, juice                  0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1301056001 13A  Blackberry, juice-babyfood         0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1301058000 13A  Boysenberry                        0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
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1301208000 13A  Loganberry                          0.200000   1.000  1.000
1301320000 13A  Raspberry                           0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1301320001 13A  Raspberry-babyfood                  0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1301321000 13A  Raspberry, juice                    0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1301321001 13A  Raspberry, juice-babyfood           0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1302057000 13B  Blueberry                           0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1302057001 13B  Blueberry-babyfood                  0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1302136000 13B  Currant                             0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1302137000 13B  Currant, dried                      0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1302149000 13B  Elderberry                          0.200000   1.000  1.000
1302174000 13B  Gooseberry                          0.200000   1.000  1.000
1302191000 13B  Huckleberry                         0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1303227000 13C  Mulberry                            0.200000   1.000  1.000
1304175000 13D  Grape                               0.200000   1.000  1.000  P 5F15
            Full comment: P 5F1560
1304176000 13D  Grape, juice                        0.200000   1.200  1.000  P 5F15
            Full comment: P 5F1560
1304176001 13D  Grape, juice-babyfood               0.200000   1.200  1.000  P 5F15
            Full comment: P 5F1560
1304179000 13D  Grape, wine and sherry              0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1304195000 13D  Kiwifruit, fuzzy                    0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2929
1307130000 13G  Cranberry                           0.200000   1.000  1.000  P 0E24
            Full comment: P 0E2421
1307130001 13G  Cranberry-babyfood                  0.200000   1.000  1.000  P 0E24
            Full comment: P 0E2421
1307131000 13G  Cranberry, dried                    0.200000   1.000  1.000  P 0E24
            Full comment: P 0E2421
1307132000 13G  Cranberry, juice                    0.200000   1.100  1.000  P 0E24
            Full comment: P 0E2421
1307132001 13G  Cranberry, juice-babyfood           0.200000   1.100  1.000  P 0E24
            Full comment: P 0E2421
1307359000 13G  Strawberry                          0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1307359001 13G  Strawberry-babyfood                 0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1307360000 13G  Strawberry, juice                   0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1307360001 13G  Strawberry, juice-babyfood          0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2930
1400003000 14   Almond                             1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
1400003001 14   Almond-babyfood                     1.000000   1.000  1.000
1400004000 14   Almond, oil                         1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
1400004001 14   Almond, oil-babyfood                1.000000   1.000  1.000
1400059000 14   Brazil nut                          1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
1400068000 14   Butternut                           1.000000   1.000  1.000
1400081000 14   Cashew                              1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
1400092000 14   Chestnut                            1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
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1400155000 14   Hazelnut                          1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
1400156000 14   Hazelnut, oil                     1.000000   1.000  1.000
1400185000 14   Hickory nut                       1.000000   1.000  1.000
1400213000 14   Macadamia nut                     1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
1400269000 14   Pecan                             1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
1400278000 14   Pine nut                          1.000000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1400282000 14   Pistachio                         1.000000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1400391000 14   Walnut                            1.000000   1.000  1.000  P 7F18
            Full comment: P 7F1893
1500025000 15   Barley, pearled barley           30.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
1500025001 15   Barley, pearled barley-babyfood  30.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
1500026000 15   Barley, flour                    30.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
1500026001 15   Barley, flour-babyfood           30.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
1500027000 15   Barley, bran                     30.000000   1.000  1.000  P 2E41
            Full comment: P 2E4118
1500065000 15   Buckwheat                        30.000000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500066000 15   Buckwheat, flour                 30.000000   1.000  1.000
1500120000 15   Corn, field, flour                5.000000   1.000  1.000  P 8F36
            Full comment: P 8F3673
1500120001 15   Corn, field, flour-babyfood       5.000000   1.000  1.000  P 8F36
            Full comment: P 8F3673
1500121000 15   Corn, field, meal                 5.000000   1.000  1.000  P 8F36
            Full comment: P 8F3673
1500121001 15   Corn, field, meal-babyfood        5.000000   1.000  1.000
1500122000 15   Corn, field, bran                 5.000000   1.000  1.000  P 8F36
            Full comment: P 8F3673
1500123000 15   Corn, field, starch               5.000000   1.000  1.000  P 8F36
            Full comment: P 8F3673
1500123001 15   Corn, field, starch-babyfood      5.000000   1.000  1.000  P 8F36
            Full comment: P 8F3673
1500124000 15   Corn, field, syrup                5.000000   1.500  1.000  P 8F36
            Full comment: P 8F3673
1500124001 15   Corn, field, syrup-babyfood       5.000000   1.500  1.000  P 8F36
            Full comment: P 8F3673
1500125000 15   Corn, field, oil                  5.000000   1.000  1.000  P 8F36
            Full comment: P 8F3673
1500125001 15   Corn, field, oil-babyfood         5.000000   1.000  1.000  P 8F36
            Full comment: P 8F3673
1500126000 15   Corn, pop                         0.100000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500127000 15   Corn, sweet                       3.500000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500127001 15   Corn, sweet-babyfood              3.500000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500226000 15   Millet, grain                    30.000000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500231000 15   Oat, bran                        30.000000   1.000  1.000  P 6E46
            Full comment: P 6E4645
1500232000 15   Oat, flour                       30.000000   1.000  1.000  P 6E46
            Full comment: P 6E4645
1500232001 15   Oat, flour-babyfood              30.000000   1.000  1.000  P 6E46
            Full comment: P 6E4645
1500233000 15   Oat, groats/rolled oats          30.000000   1.000  1.000  P 6E46
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            Full comment: P 6E4645
1500233001 15   Oat, groats/rolled oats-babyfood  30.000000   1.000  1.000  P 6E46
            Full comment: P 6E4645
1500323000 15   Rice, white                        0.100000   1.000  1.000
1500323001 15   Rice, white-babyfood               0.100000   1.000  1.000
1500324000 15   Rice, brown                        0.100000   1.000  1.000
1500324001 15   Rice, brown-babyfood               0.100000   1.000  1.000
1500325000 15   Rice, flour                        0.100000   1.000  1.000
1500325001 15   Rice, flour-babyfood               0.100000   1.000  1.000
1500326000 15   Rice, bran                         0.100000   1.000  1.000
1500326001 15   Rice, bran-babyfood                0.100000   1.000  1.000
1500328000 15   Rye, grain                        30.000000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500329000 15   Rye, flour                        30.000000   1.000  1.000
1500344000 15   Sorghum, grain                    30.000000   1.000  1.000
1500345000 15   Sorghum, syrup                    30.000000   1.000  1.000
1500381000 15   Triticale, flour                  30.000000   1.000  1.000
1500381001 15   Triticale, flour-babyfood         30.000000   1.000  1.000
1500401000 15   Wheat, grain                      30.000000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500401001 15   Wheat, grain-babyfood             30.000000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500402000 15   Wheat, flour                      30.000000   1.000  1.000
1500402001 15   Wheat, flour-babyfood             30.000000   1.000  1.000
1500403000 15   Wheat, germ                       30.000000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500404000 15   Wheat, bran                       30.000000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1500405000 15   Wild rice                          0.100000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1800002000 18   Alfalfa, seed                      0.500000   1.000  1.000
1901028000 19A  Basil, fresh leaves                0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1901028001 19A  Basil, fresh leaves-babyfood       0.200000   1.000  1.000
1901029000 19A  Basil, dried leaves                0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1901029001 19A  Basil, dried leaves-babyfood       0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1901102500 19A  Chive, dried leaves                0.200000   1.000  1.000
1901118000 19A  Cilantro, leaves                   0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1901118001 19A  Cilantro, leaves-babyfood          0.200000   1.000  1.000
1901144000 19A  Dillweed                           0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1901184000 19A  Herbs, other                       0.200000   1.000  1.000
1901184001 19A  Herbs, other-babyfood              0.200000   1.000  1.000
1901202000 19A  Lemongrass                         0.200000   1.000  1.000
1901220000 19A  Marjoram                           0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1901220001 19A  Marjoram-babyfood                  0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1901249000 19A  Parsley, dried leaves              0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1901249001 19A  Parsley, dried leaves-babyfood     0.200000   1.000  1.000  P 8E21
            Full comment: P 8E2122
1901334000 19A  Savory                             0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1902105000 19B  Cinnamon                           7.000000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1902105001 19B  Cinnamon-babyfood                  7.000000   1.000  1.000  P 9E60
            Full comment: P 9E6003
1902119000 19B  Coriander, seed                    7.000000   1.000  1.000  P 9E60
            Full comment: P 9E6003
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1902119001	19B	Coriander, seed-babyfood	7.000000	1.000	1.000	
1902143000	19B	Dill, seed	7.000000	1.000	1.000	P 9E60
		Full comment: P 9E6003				
1902274000	19B	Pepper, black and white	7.000000	1.000	1.000	P 9E60
		Full comment: P 9E6003				
1902274001	19B	Pepper, black and white-babyfood	7.000000	1.000	1.000	P 9E60
		Full comment: P 9E6003				
1902354000	19B	Spices, other	7.000000	1.000	1.000	
1902354001	19B	Spices, other-babyfood	7.000000	1.000	1.000	
2001163000	20A	Flax seed, oil	40.000000	1.000	1.000	00ND00
		Full comment: 00ND0025 (S18)				
2001319000	20A	Rapeseed, oil	20.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
2001319001	20A	Rapeseed, oil-babyfood	20.000000	1.000	1.000	P 2E41
		Full comment: P 2E4118				
2001336000	20A	Sesame, seed	40.000000	1.000	1.000	P 9E60
		Full comment: P 9E6003				
2001336001	20A	Sesame, seed-babyfood	40.000000	1.000	1.000	
2001337000	20A	Sesame, oil	40.000000	1.000	1.000	P 9E60
		Full comment: P 9E6003				
2001337001	20A	Sesame, oil-babyfood	40.000000	1.000	1.000	
2002330000	20B	Safflower, oil	40.000000	1.000	1.000	P 9E60
		Full comment: P 9E6003				
2002330001	20B	Safflower, oil-babyfood	40.000000	1.000	1.000	P 9E60
		Full comment: P 9E6003				
2002364000	20B	Sunflower, seed	40.000000	1.000	1.000	P 6F34
		Full comment: P 6F3408				
2002365000	20B	Sunflower, oil	40.000000	1.000	1.000	P 6F34
		Full comment: P 6F3408				
2002365001	20B	Sunflower, oil-babyfood	40.000000	1.000	1.000	P 6F34
		Full comment: P 6F3408				
2003114001	20C	Coconut, oil-babyfood	0.100000	1.000	1.000	P 2F26
		Full comment: P 2F2680				
2003128000	20C	Cottonseed, oil	40.000000	1.000	1.000	
2003128001	20C	Cottonseed, oil-babyfood	40.000000	1.000	1.000	
3100046000	31	Beef, meat byproducts	5.000000	1.000	1.000	
3100046001	31	Beef, meat byproducts-babyfood	5.000000	1.000	1.000	
3100048000	31	Beef, kidney	5.000000	1.000	1.000	P 4F43
		Full comment: P 4F4312				
3100049000	31	Beef, liver	5.000000	1.000	1.000	P OF23
		Full comment: P OF2329				
3100049001	31	Beef, liver-babyfood	5.000000	1.000	1.000	P OF23
		Full comment: P OF2329				
3200170000	32	Goat, meat byproducts	5.000000	1.000	1.000	
3200172000	32	Goat, kidney	5.000000	1.000	1.000	
3200173000	32	Goat, liver	5.000000	1.000	1.000	
3400291000	34	Pork, skin	5.000000	1.000	1.000	
3400292000	34	Pork, meat byproducts	5.000000	1.000	1.000	
3400292001	34	Pork, meat byproducts-babyfood	5.000000	1.000	1.000	
3400294000	34	Pork, kidney	5.000000	1.000	1.000	
3400295000	34	Pork, liver	5.000000	1.000	1.000	P 0F23
		Full comment: P 0F2329				
3500340000	35	Sheep, meat byproducts	5.000000	1.000	1.000	
3500342000	35	Sheep, kidney	5.000000	1.000	1.000	
3500343000	35	Sheep, liver	5.000000	1.000	1.000	
4000093000	40	Chicken, meat	0.100000	1.000	1.000	P 9F50
		Full comment: P 9F5096				
4000093001	40	Chicken, meat-babyfood	0.100000	1.000	1.000	P 9F50
		Full comment: P 9F5096				
4000094000	40	Chicken, liver	1.000000	1.000	1.000	P 9F50
		Full comment: P 9F5096				
4000095000	40	Chicken, meat byproducts	1.000000	1.000	1.000	P 9F50
		Full comment: P 9F5096				

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4000095001 40   Chicken, meat byproducts-babyfoo   1.000000   1.000  1.000  P 9F50
            Full comment: P 9F5096
4000097000 40   Chicken, skin                       1.000000   1.000  1.000
4000097001 40   Chicken, skin-babyfood              1.000000   1.000  1.000
5000382000 50   Turkey, meat                        0.100000   1.000  1.000  P 0F23
            Full comment: P 0F2329
5000382001 50   Turkey, meat-babyfood               0.100000   1.000  1.000  P 0F23
            Full comment: P 0F2329
5000383000 50   Turkey, liver                       1.000000   1.000  1.000
5000383001 50   Turkey, liver-babyfood              1.000000   1.000  1.000
5000384000 50   Turkey, meat byproducts             1.000000   1.000  1.000  P 0F23
            Full comment: P 0F2329
5000384001 50   Turkey, meat byproducts-babyfood    1.000000   1.000  1.000  P 0F23
            Full comment: P 0F2329
5000386000 50   Turkey, skin                        1.000000   1.000  1.000
5000386001 50   Turkey, skin-babyfood               1.000000   1.000  1.000
6000301000 60   Poultry, other, meat                0.100000   1.000  1.000  P 9E60
            Full comment: P 9E6003
6000302000 60   Poultry, other, liver               1.000000   1.000  1.000
6000303000 60   Poultry, other, meat byproducts     1.000000   1.000  1.000
6000305000 60   Poultry, other, skin                1.000000   1.000  1.000
7000145000 70   Egg, whole                          0.050000   1.000  1.000  P  9F5
            Full comment: P  9F5096
7000145001 70   Egg, whole-babyfood                 0.050000   1.000  1.000  P  9F5
            Full comment: P  9F5096
7000146000 70   Egg, white                          0.050000   1.000  1.000  P  9F5
            Full comment: P  9F5096
7000146001 70   Egg, white (solids)-babyfood        0.050000   1.000  1.000
7000147000 70   Egg, yolk                           0.050000   1.000  1.000  P  9F5
            Full comment: P  9F5096
7000147001 70   Egg, yolk-babyfood                  0.050000   1.000  1.000  P  9F5
            Full comment: P  9F5096
8000157000 80   Fish-freshwater finfish             0.250000   1.000  1.000  P 9F21
            Full comment: P 9F2163
8000158000 80   Fish-freshwater finfish, farm ra    0.250000   1.000  1.000  P 9F21
            Full comment: P 9F2163
8000159000 80   Fish-saltwater finfish, tuna        0.250000   1.000  1.000  P 9F21
            Full comment: P 9F2163
8000160000 80   Fish-saltwater finfish, other       0.250000   1.000  1.000  P 9F21
            Full comment: P 9F2163
8000161000 80   Fish-shellfish, crustacean          3.000000   1.000  1.000  P 3F29
            Full comment: P 3F2956
8000162000 80   Fish-shellfish, mollusc             3.000000   1.000  1.000  P 3F29
            Full comment: P 3F2956
8601000000 86A  Water, direct, all sources          0.159000   1.000  1.000
8602000000 86B  Water, indirect, all sources        0.159000   1.000  1.000
9500000500 O    Acai berry                          0.200000   1.000  1.000
9500001000 O    Acerola                             0.200000   1.000  1.000
9500001500 O    Agave                               0.500000   1.000  1.000
9500016000 O    Artichoke, globe                    0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
9500019000 O    Asparagus                           0.500000   1.000  1.000  P 8E36
            Full comment: P 8E3648
9500019500 O    Atemoya                             0.200000   1.000  1.000
9500020000 O    Avocado                             0.200000   1.000  1.000  P 8F20
            Full comment: P 8F2021
9500022000 O    Bamboo, shoots                      0.500000   1.000  1.000  P 9E60
            Full comment: P 9E6003
9500023000 O    Banana                              0.200000   1.000  1.000  P 9F22
            Full comment: P 9F2223
9500023001 O    Banana-babyfood                     0.200000   1.000  1.000  P 9F22
            Full comment: P 9F2223
9500024000 O    Banana, dried                       0.200000   3.900  1.000  P 9F22
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            Full comment: P 9F2223
9500024001 O    Banana, dried-babyfood            0.200000   3.900  1.000  P 9F22
            Full comment: P 9F2223
9500060000 O    Breadfruit                        0.200000   1.000  1.000  P 9E37
            Full comment: P 9E3754
9500073000 O    Cactus                            0.500000   1.000  1.000
9500074000 O    Canistel                          0.200000   1.000  1.000
9500077000 O    Carob                             0.200000   1.000  1.000
9500089000 O    Cherimoya                         0.200000   1.000  1.000
9500109000 O    Cocoa bean, chocolate             0.200000   1.000  1.000  P 0E38
            Full comment: P 0E3857
9500110000 O    Cocoa bean, powder                0.200000   1.000  1.000  P 0E38
            Full comment: P 0E3857
9500111000 O    Coconut, meat                     0.100000   1.000  1.000  P 2F26
            Full comment: P 2F2680
9500111001 O    Coconut, meat-babyfood            0.100000   1.000  1.000  P 2F26
            Full comment: P 2F2680
9500112000 O    Coconut, dried                    0.100000   2.100  1.000  P 2F26
            Full comment: P 2F2680
9500113000 O    Coconut, milk                     0.100000   1.000  1.000  P 2F26
            Full comment: P 2F2680
9500114000 O    Coconut, oil                      0.100000   1.000  1.000  P 2F26
            Full comment: P 2F2680
9500115000 O    Coffee, roasted bean              1.000000   1.000  1.000  P 6E18
            Full comment: P 6E1809
9500116000 O    Coffee, instant                   1.000000   1.000  1.000  P 6E18
            Full comment: P 6E1809
9500141000 O    Date                              0.200000   1.000  1.000  P 9E37
            Full comment: P 9E3754
9500151000 O    Feijoa                            0.200000   1.000  1.000
9500153000 O    Fig                               0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2929
9500154000 O    Fig, dried                        0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2929
9500177000 O    Grape, leaves                     0.200000   1.000  1.000
9500178000 O    Grape, raisin                     0.200000   4.300  1.000  P 5F15
            Full comment: P 5F1560
9500183000 O    Guava                             0.200000   1.000  1.000  P 1E24
            Full comment: P 1E2443
9500183001 O    Guava-babyfood                    0.200000   1.000  1.000
9500188000 O    Hop                               7.000000   1.000  1.000
9500193000 O    Jackfruit                         0.200000   1.000  1.000
9500209000 O    Longan                            0.200000   1.000  1.000
9500211000 O    Lychee                            0.200000   1.000  1.000
9500212000 O    Lychee, dried                     0.200000   1.850  1.000
9500214000 O    Mamey apple                       0.200000   1.000  1.000
9500215000 O    Mango                             0.200000   1.000  1.000  P 1E24
            Full comment: P 1E2490
9500215001 O    Mango-babyfood                    0.200000   1.000  1.000  P 1E24
            Full comment: P 1E2490
9500216000 O    Mango, dried                      0.200000   1.000  1.000  P 1E24
            Full comment: P 1E2490
9500217000 O    Mango, juice                      0.200000   1.000  1.000  P 1E24
            Full comment: P 1E2490
9500217001 O    Mango, juice-babyfood             0.200000   1.000  1.000  P 1E24
            Full comment: P 1E2490
9500235000 O    Olive                             0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2929
9500236000 O    Olive, oil                        0.200000   1.000  1.000  P 3E29
            Full comment: P 3E2929
9500243000 O    Palm heart, leaves                0.500000   1.000  1.000  P 9E60
            Full comment: P 9E6003
9500244000 O    Palm, oil                         0.100000   1.000  1.000  P 6H51
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            Full comment: P 6H5115
9500244001 O    Palm, oil-babyfood                0.100000   1.000  1.000  P 6H51
            Full comment: P 6H5115
9500245000 O    Papaya                            0.200000   1.000  1.000  P 1E24
            Full comment: P 1E2443
9500245001 O    Papaya-babyfood                   0.200000   1.000  1.000
9500246000 O    Papaya, dried                     0.200000   1.800  1.000  P 1E24
            Full comment: P 1E2443
9500247000 O    Papaya, juice                     0.200000   1.500  1.000  P 1E24
            Full comment: P 1E2443
9500252000 O    Passionfruit                      0.200000   1.000  1.000  P 9E37
            Full comment: P 9E3715
9500252001 O    Passionfruit-babyfood             0.200000   1.000  1.000
9500253000 O    Passionfruit, juice               0.200000   1.000  1.000  P 9E37
            Full comment: P 9E3715
9500253001 O    Passionfruit, juice-babyfood      0.200000   1.000  1.000
9500254000 O    Pawpaw                            0.200000   1.000  1.000
9500263000 O    Peanut                            0.100000   1.000  1.000  P 0F23
            Full comment: P 0F2329
9500264000 O    Peanut, butter                    0.100000   1.890  1.000
9500265000 O    Peanut, oil                       0.100000   1.000  1.000  P 0F23
            Full comment: P 0F2329
9500275000 O    Peppermint                      200.000000   1.000  1.000
9500276000 O    Peppermint, oil                 200.000000   1.000  1.000
9500277000 O    Persimmon                         0.200000   1.000  1.000  P 9E37
            Full comment: P 9E3754
9500279000 O    Pineapple                         0.200000   1.000  1.000  P 2F26
            Full comment: P 2F2634
9500279001 O    Pineapple-babyfood                0.200000   1.000  1.000  P 2F26
            Full comment: P 2F2634
9500280000 O    Pineapple, dried                  0.200000   5.000  1.000  P 2F26
            Full comment: P 2F2634
9500281000 O    Pineapple, juice                  0.200000   1.700  1.000  P 2F26
            Full comment: P 2F2634
9500281001 O    Pineapple, juice-babyfood         0.200000   1.700  1.000  P 2F26
            Full comment: P 2F2634
9500283000 O    Plantain                          0.200000   1.000  1.000  P 9F22
            Full comment: P 9F2223
9500284000 O    Plantain, dried                   0.200000   3.900  1.000  P 9F22
            Full comment: P 9F2223
9500289000 O    Pomegranate                       0.200000   1.000  1.000  P 1E39
            Full comment: P 1E3978
9500311000 O    Quinoa, grain                     5.000000   1.000  1.000
9500333000 O    Sapote, Mamey                     0.200000   1.000  1.000
9500346000 O    Soursop                           0.200000   1.000  1.000
9500351000 O    Spanish lime                      0.200000   1.000  1.000
9500352000 O    Spearmint                       200.000000   1.000  1.000
9500353000 O    Spearmint, oil                  200.000000   1.000  1.000
9500358000 O    Starfruit                         0.200000   1.000  1.000  P 6E34
            Full comment: P 6E3424
9500361000 O    Sugar apple                       0.200000   1.000  1.000
9500362000 O    Sugarcane, sugar                  2.000000   1.000  1.000
9500362001 O    Sugarcane, sugar-babyfood         2.000000   1.000  1.000
9500363000 O    Sugarcane, molasses              30.000000   1.000  1.000  P 9H51
            Full comment: P 9H5196
9500363001 O    Sugarcane, molasses-babyfood     30.000000   1.000  1.000  P 9H51
            Full comment: P 9H5196
9500368000 O    Tamarind                          0.200000   1.000  1.000
9500372000 O    Tea, dried                        1.000000   1.000  1.000  P 1H53
            Full comment: P 1H5310 & 8H5568
9500373000 O    Tea, instant                      7.000000   1.000  1.000  P 1H53
            Full comment: P 1H5310 & 8H5568
9500373500 O    Teff, flour                       5.000000   1.000  1.000
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9500398000 O    Watercress                        0.200000   1.000  1.000  P 9E60
            Full comment: P 9E6003
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Attachment 2: DEEM-FCID™ Chronic Exposure Estimates.

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US EPA                                                          Ver. 3.16, 03-08-d
DEEM-FCID Chronic analysis for GLYPHOSATE                  NHANES 2003-2008 2-day
Residue file name: C:\Users\tbloem\Documents\work\glyphosate\registration
review\417300C.R08
                                                   Adjustment factor #2 NOT used.
Analysis Date 06-09-2016/10:40:23     Residue file dated: 06-09-2016/10:37:44
COMMENT 1: THIS R98 FILE WAS GENERATED USING THE CONVERT TO R98 UTILITY VERSION 1.1.2.
===============================================================================
                     Total exposure by population subgroup
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Population Subgroup	Total Exposure mg/kg body wt/day
Total US Population	0.091530
Hispanic	0.094838
Non-Hisp-White	0.091452
Non-Hisp-Black	0.086606
Non-Hisp-Other	0.095659
Nursing Infants	0.072309
Non-Nursing Infants	0.174388
Female 13+ PREG	0.076716
Children 1-6	0.218895
Children 7-12	0.139417
Male 13-19	0.097324
Female 13-19/NP	0.082295
Male 20+	0.077524
Female 20+/NP	0.064402
Seniors 55+	0.061294
All Infants	0.142873
Female 13-50	0.070729
Children 1-2	0.230916
Children 3-5	0.214174
Children 6-12	0.149290
Youth 13-19	0.089645
Adults 20-49	0.076405
Adults 50-99	0.062993
Female 13-49	0.071066

Note: The reference dose (RfD) and percent of RfD have been removed from this file because these are based on non-cancer endpoints and non-cancer endpoints are not the focus of this SAP.

Appendix F

Genotoxicity Studies with Glyphosate Based Formulations

While the focus of this analysis to determine the genotoxic potential of glyphosate, the agency has identified numerous studies conducted with glyphosate-based formulations that contain various concentrations of the glyphosate as well as other components of the end use products and are presented in Tables F.1-F.5.

Table F.1. *In vitro* Test for Gene Mutations in Bacteria: Glyphosate Formulations.						
Test/Endpoint	**Test System**	**Concentrations**	**Test Material/ Concentration**	**Results**	**Reference**	**Comments**
Bacterial Reverse Mutation	*S. typhimurium* TA1535, TA1537, TA1538, TA98 and TA100; *E. coli* WP2 *uvrA* pKM101 ± S9	1.6-5000 µg/plate ± S9 (plate incorporation)	ICIA 0224 57.6% in water	Negative ± S9	Callander (1988)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537*; E. coli* WP2P and *uvrA* ± S9	100-5000 µg/plate ±S9 plate incorporation & pre-incubation protocols	TMSC (tri-methyl-sulfonium chloride) 95% purity	Negative ± S9	Callander (1993)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	26, 43, 72, 120, 200 µg/plate	Glyphosate liquid formulation (480 g/L isopropylamine salt)	Negative ± S9	Camolesi (2009)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	26, 43, 72, 120, 200 µg/plate	MON 77280 equivalent of glyphosate acid: 495 g/L	Negative ± S9	Camolesi (2010)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	0.2-2000 µg/plate	MON 76190 53.2% glyphosate	Negative ± S9	Catoyra (2009)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA97a, TA98, TA100 and TA102± S9	2 µg/plate (toxic)	Perzocyd 10 SL formulation	Negative ± S9	Chruscielska *et al.* (2000)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	0.03-3.0 µL/plate	MON 8080 (87.6%)	Negative ± S9	Flowers (1981)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	3.16-1000 µg/plate	TROP M (Glyphosate 480); 35.84% purity based on acid, 48.46% pure based on IPA salt	Negative ± S9	Flügge (2010a)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	0.316-100	Glyphosate 757 g/kg granular formulation (76.1%	Negative ± S9	Flügge (2010d)[1]	

Table F.1. *In vitro* Test for Gene Mutations in Bacteria: Glyphosate Formulations.						
Test/Endpoint	**Test System**	**Concentrations**	**Test Material/ Concentration**	**Results**	**Reference**	**Comments**
			monoammonium glyphosate salt)			
Bacterial Reverse Mutation	*S. typhimurium* TA97a, TA98, TA100, and TA1535 ± S9	1-5000 µg/plate	Roundup WG 784 g/kg ammonium salt equivalent	Negative ± S9	Gava (1998)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537± S9	50-5000 µg/plate	Rodeo® (containing IPA salt and water only); 40% glyphosate (acid equivalent)	Negative ± S9	Kier *et al.*, (1992)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 ± S9	5-500 µg/plate (-S9)/ 15-1500 µg/plate (+S9)	MON 2139 (Roundup®) 31% Glyphosate (acid equivalent)	Negative ± S9	Kier *et al.*, (1992)	Cytotoxic at top concentrations
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 ± S9	5-500 µg/plate (-S9)/ 15-1500 µg/plate (+S9)	MON 14445 (Direct®); 75% Glyphosate (acid equivalent)	Negative ± S9	Kier *et al.*, (1992)	Cytotoxic at the top concentrations, occasionally at lower concentrations
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 ± S9	0.2-2000 µg/plate	MON 79672 (Roundup Ultramax); 74.7% monoammonium glyphosate salt; 68.2% glyphosate	Negative ± S9	Lope (2008)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA1535, TA1537, TA1538, TA98 and TA100 ± S9	0.617-50 µL/plate ± S9	SC-0224, 19.2% purity	Negative ± S9	Majeska (1982)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* ± S9	TA strains: 10 - 5000 µg/plate (+S9); 3.33-3330 µg/plate (-S9); E. coli: 33.3-5000 µg/plate (+/- S9)	MON 78239 36.6% glyphosate (44.9% potassium salt of glyphosate)	Negative	Mecchi (2003a)	Increase in revertants seen in TA98 and TA1535 -S9 on first trial, not conc-dep; however no increase in revertants seen in repeat in those strains; overall negative.

Table F.1. *In vitro* Test for Gene Mutations in Bacteria: Glyphosate Formulations.						
Test/Endpoint	**Test System**	**Concentrations**	**Test Material/ Concentration**	**Results**	**Reference**	**Comments**
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* ± S9	TA strains: 3.33-3330 µg/plate (+S9); 1.0-1000 µg/plate (-S9); E. coli: 33.3-5000 µg/plate (+/- S9)	MON 78634 65.2% w/w glyphosate (71.8% w/w as monoammonium salt of glyphosate)	Negative	Mecchi (2003b)	
Bacterial Reverse Mutation	*S. typhimurium* TA 98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* ± S9	10 - 5000 µg/plate (+/-S9)	MON 79864 38.7% glyphosate acid (wt %)	Negative	Mecchi (2008a)	Inhibited growth seen at ≥2000 -S9
Bacterial Reverse Mutation	*S. typhimurium* TA 98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* ± S9	33.3-5000 µg/plate	MON 76313 30.9% glyphosate acid	Negative	Mecchi (2008b)	
Bacterial Reverse Mutation	*S. typhimurium* TA 98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* ± S9	10-5000 µg/plate (+/-S9)	MON 76171 31.1% glyphosate	Negative	Mecchi (2008c)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA 98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* ± S9	10-5000 µg/plate (+/-S9)	MON 79991 71.6% glyphosate acid	Negative	Mecchi (2009a)	
Bacterial Reverse Mutation	*S. typhimurium* TA 98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* ± S9	10-5000 µg/plate (+/-S9)	MON 76138 38.5% glyphosate	Negative	Mecchi (2009b)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA97a, TA98, TA100, and TA1535 ± S9	1-5000 µg/plate	MON 77280 646.4 g/L salt equivalent	Negative	Perina (1998)	

Table F.1. *In vitro* Test for Gene Mutations in Bacteria: Glyphosate Formulations.						
Test/Endpoint	**Test System**	**Concentrations**	**Test Material/ Concentration**	**Results**	**Reference**	**Comments**
Bacterial Reverse Mutation	*S. typhimurium* TA98 and TA100 ± S9	0-1440 µg/plate (calculated as glyphosate IPA salt)	Roundup, 480 g/L glyphosate isopropylamine salt	Negative – S9, Equivocal +S9	Rank *et al.* (1993)	Stat significant increase at 360 µg/plate for TA98 (-S9) and 720 µg/plate for TA100 (+S9). Not significant at higher concentrations and were not replicated. Effects occurred at close to toxic levels.
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	500-5000 µg/plate;	495 g/L glyphosate isopropylamine salt; 371.0 g/L (equivalent of glyphosate acid)	Negative ± S9	Silvino (2011)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	1.5-5000 µg/plate	MON 8709 495 g/L glyphosate isopropylamine salt; 371.0 g/L (equivalent of glyphosate acid)	Negative ± S9	Silvino (2011)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, and TA1537 ± S9	15-5000 µg/plate	MON 76313 468 g/L glyphosate isopropylamine salt (351 g/L glyphosate acid equivalent)	Negative ± S9	Silvino (2012)	Cytotoxic at 5000 µg/plate for some strains
Bacterial Reverse Mutation	*S. typhimurium* TA97a, TA98, TA100 and TA1535 ± S9	1-5000 µg/plate	Glifos formulation (glyphosate isopropylammonium salt , Berol 907 and water)	Negative ± S9	Vargas (1996)	Cytotoxic at the two upper concentrations

Table F.1. *In vitro* Test for Gene Mutations in Bacteria: Glyphosate Formulations.

Test/Endpoint	Test System	Concentrations	Test Material/ Concentration	Results	Reference	Comments
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA102, TA1535, TA1537± S9	3.16-316 µg/plate	FSG 3090-H1 360 g/L	Negative ± S9	Uhde (2004)[1]	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100 ± S9	0.01-100 µg/plate	64% (glyphosate Isopropylammonium salt)	Negative ± S9	Wang *et al.* (1993)	
Bacterial Reverse Mutation	*S. typhimurium* TA98, TA100, TA1535, TA1537 and *E. coli* WP2 *uvrA* ± S9	All strains: 33.3-5000 µg/plate (+S9); 10-3330 µg/plate (-S9)	MON 78910 30.3% glyphosate acid	Negative ± S9	Xu (2006)	Cytotoxic ≥1000 µg/plate (-S9)

[1] Study was cited in Kier and Kirkland (2013). Supplementary information about the study was provided online including test guideline, test material purity, control chemicals and summary data tables.

Table F.2. *In Vitro* Tests for Chromosome Damage in Mammalian Cells- Glyphosate Formulations						
Test/Endpoint	**Test System**	**Concentrations**	**Test Material/ Concentration**	**Results**	**Reference**	**Comments**
***In vitro* Chromosomal Aberration using fluorescent in situ hybridization (FISH)**	Bovine lymphocytes (from two 6-8 month old calves) -whole chromosome (1) painting probe	28-1120 µM 24 h exposure	62% Isopropylamine salt of glyphosate (38% inert ingredients)	Negative.	Holeckova (2006)	Small but significant increase in polyploidy seen at 56µM No positive control reported.
***In vitro* Cytokinesis Block Micronucleus Assay (with FISH analysis)**	TR146 cells (human-derived buccal epithelial cell line)	0, 10, 15 and 20 mg/L; 20 minute exposure.	Roundup Ultra Max (450 g/l glyphosate acid)	Positive Increase in MN at all test concentratio ns	Koller *et al*. (2012)	No apoptosis observed at any conc. Necrosis reported at 20 mg/L. Increase in NB and NPB seen at all concentrations

MI= mitotic index. FISH= fluorescent in situ hybridization, MN= micronuclei; NB= nuclear buds; NPB= nucleoplasmic bridges.

Table F.3. *In Vivo* Tests for Chromosomal Aberrations in Mammals- Glyphosate Formulations.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Chromosomal Aberration	Swiss albino mice (males only) Vehicle: DMSO	Intraperitoneal injection; sampling 24, 48 and 72 h	0, 25 and 50 mg/kg (5/dose)	Roundup (>41% isopropylamine glyphosate)	Positive Increase in MN at all time points at both doses	Prasad *et al.* (2009)	Significant decrease in mitotic index seen at all doses and time points
Bone Marrow Chromosomal Aberration	C57BL mice (males only) Vehicle: water	Oral administration; sampling 6, 24, 48, 72, 96 and 120 h	0.05, 0.01, 0.5 and 1.0% (8/dose)	Roundup	Negative	Dimitrov *et al.* (2006)	
Bone Marrow Chromosomal Aberration	New Zealand white rabbits (males only) Vehicle:	Drinking water for 60 days	0, 750 ppm (5/dose)	Roundup	Positive	Helal and Moussa (2005)	

BM= bone marrow, SC= spermatocyte.

Table F.4. *In Vivo* Tests for Micronuclei Induction in Mammals- Glyphosate Formulations.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Micronucleus Test	Swiss CD1 mice (males only)	Intraperitoneal injection; 2 injections of half the dosage of 135 mg/kg 24 h apart; sampling at 6 and 24 h	0, 450 mg/kg roundup, equiv. to 135 kg glyphosate (3/dose)	Roundup, 30.4% glyphosate	Positive	Bolognesi *et al.* (1997)	Stat significant increase in MN at 6 and 24 h
Bone Marrow Micronucleus Test	C3H mice (males only) Vehicle: water	Intraperitoneal Injection (single treatment); sampling after 24, 48 and 72 h	0, 90 mg/kg	Not reported	Negative	Chruscielska *et al.* (2000)	
Bone Marrow Micronucleus Test	Swiss mice (males and females) Vehicle: water	Intraperitoneal Injection (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 50, 100 and 200 mg/kg	480g/L Isopropylamine salt of glyphosate	Negative	Grisolia (2002)	
Bone Marrow Micronucleus Test	CD-1 mice (males and females)	Intraperitoneal injection; sampling 24, 48 and 72 h	0, 140, 280, and 555 mg/kg	Roundup (31% glyphosate salt)	Negative	Kier (1992)	Some deaths observed at high dose (HD), ↓PCE/NCE ratio at HD at 48 h in males.
Bone Marrow Micronucleus Test	Swiss albino mice (males and females)	Intraperitoneal Injection (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 212.5, 425 and 637.5 mg/kg	MON 77280 646.4 g/L glyphosate salt equivalent	Negative	Monma (1998)	Doses tested corresponded to 25%, 50% and 75% LD50

Table F.4. *In Vivo* Tests for Micronuclei Induction in Mammals- Glyphosate Formulations.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Micronucleus Test	NMRI-Bom mice	Intraperitoneal Injection (single treatment); sampling after 24 h	0, 133 and 200 mg/kg (4/sex/dose)	Roundup, 480 g glyphosate isopropylamine salt per liter	Negative	Rank *et al.* (1993)	BM toxicity indicated by %PCE decreased at 200 mg/kg
Bone Marrow Micronucleus Test	Swiss albino mice (males only[2]) Vehicle: water	Oral gavage (two treatments, 24 h apart); sampled at 18 and 24 h after last dose	0, 2000 mg/kg	MON 8709494.7 g/L salt of isopropylamine (371.0 glyphosate acid)	Negative	Claro (2011)	OECD 474 Guideline No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	C57BL mice (males only) Vehicle: water	Oral administration; sampling 6, 24, 48, 72, 96 and 120 h	0.05, 0.01, 0.5 and 1.0% (1%=1080 mg/kg) (8/dose)	Roundup	Negative	Dimitrov *et al.* (2006)	Toxicity seen in 1.0% dose group
Bone Marrow Micronucleus Test	Crl:CD-1(ICR) BR mice (males only[2]) Vehicle: water	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 (mg/kg) (5/dose)	MON 78239 (36.6% glyphosate)	Negative	Erexson (2003a)	EPA Guideline (84-2) No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	Crl:CD-1(ICR) BR mice (males only[2]) Vehicle: water	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 (mg/kg) (5/dose)	MON 78634 (65.2% glyphosate)	Negative	Erexson (2003b)	EPA Guideline (84-2) No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	Crl:CD-1(ICR) BR mice (males only[2]) Vehicle: water	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 (mg/kg) (5/dose)	MON 78910 (30.3% glyphosate)	Negative	Erexson (2006)	EPA Guideline (84-2) No significant signs of toxicity observed in main study.

Table F.4. *In Vivo* Tests for Micronuclei Induction in Mammals- Glyphosate Formulations.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Micronucleus Test	NMRI mice (males and females) Vehicle: 0.8% hydroxypropylmethyl cellulose	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 mg/kg (5/sex/dose)	TROP M (Glyphosate 480); 358.4 g/L glyphosate acid; 483.6 g/L IPA salt	Negative	Flügge (2010c)[1]	OECD Guideline 474 No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	Swiss mice (males only[2]) Vehicle: water	Oral gavage (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 2000 mg/kg (6/dose)	A17035A 289.7 g/L glyphosate	Negative	Negro Silva (2009)[1]	OECD Guideline 474 No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	Swiss mice (males only[2]) Vehicle: water	Oral gavage (2 treatments, 24 h apart); sampling after 24 h (last treatment)	0, 2000 mg/kg (6/dose)	Glyphosate SL (499.35 g/L glyphosate)	Negative	Negro Silva (2011)[1]	OECD Guideline 474 No significant signs of toxicity observed in main study
Bone Marrow Micronucleus Test	Hsd:CD-1(ICR) mice (males only[2]) Vehicle: water	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 (mg/kg) (5/dose)	MON 79864 (38.7% glyphosate)	Negative #	Xu (2008a)	EPA Guideline (84-2) /OECD 474 No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	CD-1(ICR)BR mice (males only[2]) Vehicle: water	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 (mg/kg) (5/dose)	MON 76171 (31.1% glyphosate)	Negative	Xu (2008b)	EPA Guideline (84-2) /OECD 474 No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	CD-1(ICR)BR mice (males only[2]) Vehicle: water	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 (mg/kg) (5/dose)	MON 79991 (71.6% glyphosate)	Negative	Xu (2009a)	EPA Guideline (84-2) /OECD 474 No significant signs of toxicity observed in main study.

Table F.4. *In Vivo* Tests for Micronuclei Induction in Mammals- Glyphosate Formulations.

Test/Endpoint	Test System	Route of Administration	Doses	Test Material Purity	Results	Reference	Comments
Bone Marrow Micronucleus Test	CD-1(ICR)BR mice (males only[2]) Vehicle: water	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 (mg/kg) (5/dose)	MON 76138 (38.5% glyphosate)	Negative	Xu (2009b)[1]	EPA Guideline (84-2) /OECD 474 No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	Hsd:CD-1(ICR)BR mice (males only[2]) Vehicle: water	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 (mg/kg) (5/dose)	MON 76313 (30.9% glyphosate)	Negative	Xu (2009c)[1]	EPA Guideline (84-2) /OECD 474 No significant signs of toxicity observed in main study.
Bone Marrow Micronucleus Test	CD rats (males and females) Vehicle: 0.8% hydroxypropylmethyl cellulose	Oral gavage (single treatment); sampling after 24 and 48 h (high dose only)	0, 500, 1000, and 2000 mg/kg (5/sex/dose)	757 g/kg granular formulation (69.1% glyphosate acid)	Negative	Flügge (2010e)[1]	OECD Guideline 474 No significant signs of toxicity observed in main study

[1] Study was cited in Kier and Kirkland (2013). Supplementary information about the study was provided online including test guideline, test material purity, control chemicals and summary data tables.

[2] Only males tested; report indicated that there were no difference between sexes seen in range finding study.

BM= bone marrow, CA= chromosomal aberrations, MN= micronucleated erythrocytes, NCE= normochromatic erythrocytes, PCE=polychromatic erythrocytes.

Table F.5. Other Assays for Detecting DNA Damage- Glyphosate Formulations.

Test/Endpoint	Test System	Route of Administration	Doses/ Concentrations	Test Material/ Concentration	Results	Reference	Comments
Bacterial SOS Chromotest	*Escherichia coli* PQ37 strain	NA (*in vitro*)	0.25µg/sample	Roundup BIO formulation;	Positive	Raipulis *et al.* (2009)	
DNA Adducts ^{32}P-postlabeling	Swiss CD1 mice (males and females) Liver and kidney evaluated	Intraperitoneal injection	0, 400, 500 and 600 mg/kg, corresponding to 122, 152 and 182 mg/kg glyphosate salt	Roundup (30.4% isopropylammonium salt of glyphosate)	Positive (liver and kidney)	Peluso *et al.* (1998)	
DNA oxidative damage: 8-OHdG formation	Swiss CD-1 mice (males) liver and kidney evaluated	Intraperitoneal injection (single dose); sampling 4 and 24 h after injection	900 mg/kg corresponding to 270 mg/kg glyphosate (3/dose)	900 mg/kg corresponding to 270 mg/kg glyphosate	Kidney: positive at 8 and 24 h Liver: negative	Bolognesi *et al.* (1997)	
Single-cell gel electrophoresis (SCGE) assays-COMET assay	TR146 cells (human-derived buccal epithelial cell line). Alkaline conditions	NA (*in vitro*)		Roundup Ultra Max (450 g/l glyphosate acid)	Induced DNA migration at >20 mg/L	Koller *et al.* (2012)	Also measured multiple cellular integrity parameters to assess cytotoxicity. Formulation was more toxic than technical. Significant increase in LDHe at all concentrations tested. Cytotoxic ≥ 60 mg/L
Sister Chromatid Exchange (SCE)	Bovine lymphocytes	NA (*in vitro*)	28 - 1112 µM;; ±S9; sampling at 24 and 48 h	62% Isopropylamine salt of glyphosate	Positive	Sivikova & Dianovsky (2006)	

Table F.5. Other Assays for Detecting DNA Damage- Glyphosate Formulations.

Test/Endpoint	Test System	Route of Administration	Doses/ Concentrations	Test Material/ Concentration	Results	Reference	Comments
Sister Chromatid Exchange (SCE)	Human lymphocytes (2 donors)	NA (*in vitro*)	250, 2500 and 25000 µg/mL	Roundup; Isopropylamine salt of glyphosate (purity not stated)	Stat. significant increase ($p<0.001$) at 250 µg/mL in both donors, and in one donor at 2500 µg/mL	Vigfusson and Vyse (1980)	No growth seen at highest concentration (25 mg/mL)
Sister Chromatid Exchange (SCE)	Human lymphocytes	NA (*in vitro*)	-S9: 0, 0.1 and 0.33 mg/mL; 72 h exposure	Roundup, 30.4% glyphosate	Positive	Bolognesi *et al.* (1997)	Stat significant increase in SCE/cell at ≥ 0.1 mg/mL
Alkaline elution assay- DNA single strand breaks	Swiss CD-1 mice (males) liver and kidney evaluated	Intraperitoneal injection (single dose); sampling 4 and 24 h after injection	900 mg/kg corresponding to 270 mg/kg glyphosate (3/dose)	900 mg/kg corresponding to 270 mg/kg glyphosate	Positive (Increased elution rate) at 4 hours in liver and kidney At 24 h, returned to control levels	Bolognesi *et al.* (1997)	Return to control values at 24 h may indicate DNA repair or reflect rapid elimination of compound

h= hour, NA= not applicable, SCE= sister chromatid exchange, LDHe= extracellular lactate dehydrogenase

Appendix G

The following studies were considered during the systematic review, but were excluded from the analysis.

Amer S.M. et al (2006). In vitro and in vivo evaluation of the genotoxicity of the herbicide glyphosate in mice. Bulletin of the National Research Centre (Cairo) 31 (5): 427-446.

Aboukila, R.S. et al. (2014). Cytogenetic Study on the Effect of Bentazon and Glyphosate Herbicide on Mice. Alexandria Journal of Veterinary Sciences, 41: 95-101.

Majeska (1982d) MRID 00126616

Majeska (1982e) MRID 00126614

Majeska (1982f) MRID 00126615

Michigan Historic Cemeteries Preservation Guide

Gregg G. King with
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PHOTOGRAPH AND ILLUSTRATION CREDITS

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Preface

There are hundreds of historic cemeteries in the state of Michigan. However, until publication of this manual, anyone wishing to undertake conservation and preservation of these historic cemeteries had to search through numerous and often conflicting sources for information. There was no comprehensive source outlining sound conservation and preservation practices. With publication of this manual, endorsed by the State Historic Preservation Office, individuals and communities now have one reliable source.

This manual outlines the preservation and conservation process in a step by step manner. It facilitates the process by offering chapters on organizing efforts, surveying and documenting, and conservation of the cemetery. In addition, a chapter on management and maintenance assists in planning for the future care of the cemetery. A final chapter offers suggestions for optimal utilization of the historic cemetery property.

An extensive appendix offers documentation forms, readings, websites, and a glossary of terms that will help add to the body of knowledge of conservators, and community officials and guide them in their efforts. Information from sources such as the National Park Service, The Association for Gravestones Studies, the National Preservation Institute, the Chicora Foundation, the Michigan State Historic Preservation Office and the National Trust for Historic Preservation; interviews with conservators as well as years of practical conservation practice add to the usefulness of the manual. Though technologies change and new products and practices evolve the concepts presented in the manual will serve as a solid foundation for preservation and conservation projects.

Introduction

Many small cemeteries in rural and urban areas throughout Michigan are in need of urgent care. They are often neglected and vandalized, and sometimes abandoned. This manual is intended for municipalities, civic groups, historical societies, genealogists or any others interested in the proper methods of conservation and maintenance of these small cemeteries. It will serve as a readily accessible guide to resources and methods that will enable communities, civic groups and others to document, preserve, and maintain their historic burying grounds. It is not, however, meant for those wishing to conserve large cemetery sculpture or architecture, work that is best left to trained and experienced professionals. Varying levels of skills are required to perform cleaning, repair and documentation of a cemetery. The following three skill levels will be used throughout the manual to make it apparent who can be called upon to perform indicated tasks.

LEVEL ONE	LEVEL TWO	LEVEL THREE
1	2	3
some training (workshops, on-site training, or under the guidance of trained personnel)	experienced, trained personnel	professional

Although specifically written for a Michigan audience, the methodology, the resources, the very description of these cemeteries is much more regional. The practices set forth in this manual are acceptable anywhere and follow sound preservation theory.

For the purpose of this manual we shall call these cemeteries *historic cemeteries*. Other terms such as *rural, country* and *pioneer* are inadequate and misleading, even though many of these cemeteries are found in very country-like or rural settings. Many of these small historic cemeteries exist within the city limits of small towns. Others are located in the midst of urban and suburban development, lost among the new housing stock and adjacent to heavily traveled roadways. No single term exists that completely describes these small historic cemeteries, but they are readily recognizable as an important part of Michigan's rural and rapidly urbanizing landscape.

The term "Rural Cemetery" is often used to describe another type of property typified by Mt. Auburn Cemetery near Boston, one of America's first designed, garden cemeteries.

> In 1831 the Massachusetts Horticultural Society created Boston's Mt. Auburn, the first "rural cemetery" and prototype for many others. Gen. Henry A. S. Dearborn designed its original 72 acres based on the model of Pere Lachaise in Paris. Dr. Jacob Bigelow was responsible for Mt. Auburn's Egyptian gate, Gothic chapel and Norman tower, inspired by structures in English Gardens. (Tishler, p. 121)

Unlike the Rural Cemeteries of the nineteenth century, some of Michigan's small historic cemeteries are unplanned. Others employed a simple grid pattern of layout. Still others were a vernacular adaptation of the design principles of the Rural Cemetery Movement. They may have layouts of curving roadways, planned vistas and other elements found in the Rural Cemetery, or more commonly perimeter trees, a central avenue, a circle for a memorial, and formal plantings. They have changed and developed with their communities while maintaining much of their historic layout, monuments, plantings, and character.

Perhaps the closest definition of a historic cemetery is the one offered by Kenneth T. Jackson. In his book, *Silent Cities: Evolution of the American Cemetery*, Jackson refers to this type of burial ground as a "country graveyard."

> The county cemetery is a familiar site along the highways of the United States. The outskirts of every city and small town seem to include space for at least one burial ground. Such cemeteries are smaller, more open and more egalitarian than their counterparts in the city. Sometimes on top of a hill, sometimes in a clearing surrounded by woods, they tend to cover less than a dozen acres. Rarely do they include the mausoleums, large obelisk, elaborate statuary, high fences, and ethnic markers so common in urban cemeteries. Their typically unpretentious homemade or mail order markers commemorate a cross section of the citizenry, the first settlers, the foreign-born, and some of the "local boys" killed in battle. Tourists, finding the plots historical and picturesque, stop to read the dates when the area was settled, and the names, origins and religions of the local residents. (Jackson, p. 12)

Michigan historic cemeteries sometimes have an ethnic origin bearing grave markers that reflect the language and traditions of the area's settlers. In Washtenaw County, for example, there are several such cemeteries with German inscriptions attesting to their establishment by the local German immigrants. A particularly picturesque example exists in Cheboygan County with Swedish markers. The cemetery's layout and many monuments reflect this ethnicity. These cemeteries are and always have been local in nature. Old trees and other historic plant material are often a part of the setting. Small buildings, mausoleums and other structures are common. Many cemeteries sport decorative fencing, signage and gates typically added in the late nineteenth or early twentieth century. In still-active cemeteries, newer burials are set behind or to one side of the oldest graves. The main similarities of Michigan's small historic cemeteries are their age and their size. In Michigan most originated in the earlier decades of the nineteenth century or more precisely at settlement time. Although each historic cemetery is unique in character, these cemeteries have many commonalties.

- They are usually quite small, often less than ten acres.
- Often they began as a family burying place and expanded over time.
- Frequently the land was set aside by some of the earliest settlers either by donation or direct purchase.
- Many are associated with small country churches or township centers.
- Headstones are less massive and ornate than those found in urban cemeteries.
- If there are historic buildings or structures associated with them, they are typically small in scale and likely to be vernacular rather than high style architecture.

As conscientious members of society it is our responsibility to care for these burial sites of our respected dead. Benjamin Franklin said, “Show me your burial grounds and I’ll show you a measure of the civility of a community.” Accepting this responsibility we help to preserve a resource that will benefit not only us but future generations.

Historic cemeteries are important cultural, architectural and archaeological resources. They provide us with information on our community’s history. Often a cemetery is the only remnant left from early settlements and as such is a vital link with the past. They are an invaluable educational tool whether we seek to research genealogy, educate our youth or delve into local history. They provide quiet places to commemorate the deceased, whether it be of a most personal nature, or on a local, regional, or even national scale. Originally located in agricultural areas that are now becoming more urbanized, early cemeteries can provide a place for quiet reflection and solitude and much needed open space. Buildings, fencing and other ancillary features are artifacts that demonstrate historic stylistic trends and construction methods. Archaeological excavations in cemeteries, whether they are Native American or Euro-American, are extremely controversial. They should only be undertaken if the cemetery is being formally vacated and the interments moved to other burial locations and NEVER without necessary permits and appropriate consultation with descendents of those interred. Simple abandonment of a cemetery does not make it an appropriate venue for archaeological study.

These important places may provide us with some of the earliest written local history. Headstones reveal names and dates for locally significant persons. They offer glimpses into local illness and epidemics and tell of a community’s sacrifices in our nation’s wars. The same headstones provide us with samples of local folk art and, particularly after the Civil War, reflect a substantial amount of popular cultural standardization of monument forms and motifs. They were transmitted through such sources as design books and catalogs. Extant historic plant materials can be collected for study and can be reintroduced in other gardens.

Old cemeteries provide valuable information to those interested in their family histories, information that may not be available elsewhere. Early graveyards remind us of the fragility of life in earlier times and of how the area’s pioneers created lives for themselves against tremendous odds. Sometimes they provide us with more than the bare facts of birth and death; they provide us with tender, tragic or humorous glimpses into the lives of earlier generations. They tell us about the struggle to survive childhood diseases, childbirth, wars and epidemics. But most of all they tell us about the recurring cycle of birth, life, and death and how we are all a part of that cycle.

Cemeteries are integral parts of the cultural landscape. School children and other members of a community may use them as outdoor museums dedicated to an area's history and cultural traditions. Site visits enable visitors to observe first hand important community artifacts. Volunteers trained in maintenance and conservation techniques can learn while providing an important local service. They can assist in the conservation and preservation of cultural artifacts for the education of future generations.

An area's architectural history is evident in its cemeteries. Churches that are associated with historic cemeteries and small buildings such as chapels, mausoleums, and storage sheds all reflect the taste, architectural styles and ethnicity common in the community at the time of their construction. They reflect the architectural preferences of their time and can show a greater connection to the tastes of the nation. Many mid to late nineteenth century cemeteries have small Gothic Revival, Richardsonian Romanesque, or Neoclassical buildings, styles taken from medieval and classical sources and popularized by trendsetters like Andrew Jackson Downing, a nineteenth century architect, horticulturist, and writer. Others have early twentieth century style buildings from Egyptian Revival to Colonial Revival. All these styles borrow motifs commonly associated with age-old funeral and burial practices.

While major repair and rehabilitation of mausoleums and other buildings are beyond the scope of this manual and should be left to professionals, we include a section on repointing masonry. Documentation and repair of artifacts such as monuments, fencing and gates are an important focus of this work. Often these valuable cultural artifacts are in great jeopardy from weathering, environmental damage, vandalism, and neglect. They are in urgent need of conservation and preservation and provide communities, civic organizations, and others a tremendous opportunity to become involved in the "monumental" effort of cemetery preservation.

This manual takes a multi-topic approach to preservation and conservation efforts. While we use the term "preservation" to mean maintaining the historic integrity of a cemetery's site, we use the term "conservation" to refer to those processes used in caring for damaged gravestones and artifacts. Topics are discussed from the general to the specific. The manual begins with verifying ownership, conducting preliminary reconnaissance and preparing a plan. It then continues with identifying, photographing, mapping, and documenting cemetery features.

The next level encompasses conservation of cemetery elements and features and discusses the actual process used in conserving landscape, grave markers, and other features. This approach uses the Secretary of the Interior's *Standards for the Treatment of Historic*

Properties with Guidelines for the Treatment of Cultural Landscapes. The Secretary's *Guidelines* suggest four treatments: preservation, rehabilitation, restoration, and reconstruction.

> Of the four, Preservation standards require retention of the greatest amount of historic fabric, including the landscape's historic form, features, and details as they have evolved over time. Rehabilitation standards acknowledge the need to alter or add to a cultural landscape to meet continuing or new uses while retaining the landscape's historic character. Restoration standards allow for the depiction of a landscape at a particular time in its history by preserving materials from the period of significance and removing materials from other periods. Reconstruction standards establish a framework for recreating a vanished or non-surviving landscape with new materials, primarily for interpretive purposes. (Secretary of the Interior's *Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*, Introduction)

The final discussion concerns planning for educational and recreational activities geared to a variety of ages and interests. This step allows a community to optimize the use of its cemetery, minimize vandalism, and utilize its historic property. The manual concludes with a detailed list of sources for both information and materials pertinent to historic cemeteries.

Chapter 1

ORGANIZING EFFORTS

Organizing efforts should be a step by step process. The process will vary from community to community due to the availability of funds and manpower to perform the necessary tasks. Communities that have limited funding should choose to complete Plan A (below), which will stabilize the historic cemetery, and then develop a plan to implement actions as funds become available. Three flexible plans for cemetery preservation are suggested here, followed by more detailed suggestions to implement them.

Plan A would serve a community volunteer group or private individual with limited resources. This plan provides only the basics to stabilize and document the cemetery.

- Establish ownership and get permission to act. (Chapter1)
- Reconnaissance level survey (with a sketch map and documentary photography to determine needs). (Chapter 2)
- Basic cleaning and stabilization of grounds and stones. (Chapter 3)
- Routine maintenance. (Chapter 4)

Plan B would serve the individual or community that has some funding and trained volunteers.

- Establish ownership and get permission to act.
- Reconnaissance level survey followed by setting short and long-term goals. (Chapter 2)
- Cleaning and stabilization of grounds and stones. (Chapter 3)
- Document cemetery features with a detailed map and photographs. (Chapter 2)
- Research the cemetery's history. (Chapter 1)
- Plan for and implement complete repairs of all tombstones, fences, roads, and other features. (Chapter 3)
- In addition to routine maintenance, make long-term plans for preservation of landscape features. (Chapter 4)

Plan C is the ideal and would serve an individual or municipality with plentiful resources and access to trained professionals.

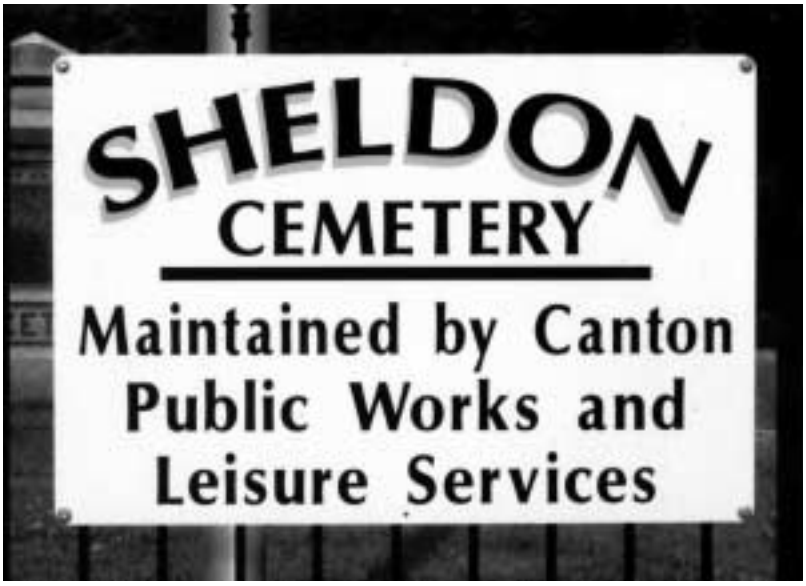
- Establish ownership and get permission to act.
- Reconnaissance level survey followed by setting short and long-term goals.
- Clean and stabilize grounds and stones.
- Form a citizen's group to help with fund raising, educating the public, and other goals.
- Detailed mapping, photography, cleaning of stones, and some maintenance.
- Repair all artifacts.
- Restore landscape (ponds, roads, vegetation).
- Plan for and implement long term maintenance goals.
- Put in place cemetery-related programs such as tours, nature talks, genealogy, etc. (Chapter 4)
- List cemetery in the National Register of Historic Places. (Chapter 1)

All three plans contain some of the following steps. The first two steps, establishing ownership and knowing the legal parameters, however, are steps that everyone must complete before beginning any work in the cemetery. Other steps can often be undertaken simultaneously and do not necessarily demand completion of one step before the commencement of the next.

Communities should exercise caution that initial enthusiasm for clean-up and repair does not precipitate unwise preservation actions. Reign in enthusiasm until suggested actions can be reviewed to make sure that actions do not harm the cemetery.

ESTABLISH OWNERSHIP

The first task to be completed prior to undertaking fieldwork in a historic cemetery conservation project is to establish the ownership of the cemetery. Often a historic cemetery has a sign that is prominently posted giving the hours of operation and naming the entity that has authority over the property. Many cemeteries are located adjacent to religious properties. Even though the cemetery may not be affiliated with the religious property, inquiring there will often produce the information needed to identify the owner. Further inquiries can be made at the local city, village or township hall, or at the county clerk or assessor's office. The county recorder of deeds or assessor's office will provide a legal description of the property. Researching records at the same offices might produce historic legal descriptions, providing a picture of how the property has changed over time. In Michigan, when small, private cemeteries in rural areas are abandoned and are no longer maintained, they become the property of the current landowner.



Often the cemetery will have a sign identifying who is responsible for its care.

KNOW THE LAWS AND REGULATIONS

Once ownership is established, the next step is to become aware of any existing laws or ordinances that might relate to the cemetery and the project. Cemetery associations often have regulations that are in effect. There also may be federal laws that relate to military and Native American burial grounds. This information can sometimes be garnered from the owner of the cemetery.

Most of the Michigan laws relating to cemeteries are contained in the Michigan Compiled Laws (MCL), Chapter 128. Cemetery corporations are covered in MCL 456.1 et seq. Transfer of rights to a municipal corporation is covered in MCL 456.181 to 184.

Act 113 (Chapter 128.61) of 1915 states that "The Township Board of each township shall have the authority and it shall be its duty to cause all cemeteries within its township, except private cemeteries and cemeteries owned by cities and villages located in such

townships, to be properly taken care of." Public Act 293 of 1966 as amended MCL section 45.515, subsection D affords responsibilities in part to the counties within the state (can be found on the Michigan Legislature web site). Chapter 5 includes a discussion on creating a local cemetery ordinance or an historic cemetery ordinance, a recommended step in future planning.

AWARENESS AND TEAM BUILDING

Having established ownership and verified legal restrictions, the next step is to build community awareness of the importance of the resource and the need for its preservation. Conduct a tour for interested citizens; if the cemetery is municipally owned be sure to include city / township officials. Be armed with reasons why this project is worthwhile and necessary for the community. Cite the problems that exist in the cemetery. Point out specific areas needing attention. To get people to support a project they must be convinced there is a need. Some suggestions for raising awareness are:

- Publicize your effort through local newspapers
- Get the local cable TV station interested in the project
- Establish a web site with photographs of headstones in need of attention
- Partner with local schools, scouting, and other organizations to make as many people as possible aware of the project
- Appeal to local church groups and garden clubs
- Garner support from historical and genealogical societies
- Demonstrate to local officials that there is something in the project for them

The last point is especially important because, if there is a local government body responsible for the upkeep of a cemetery, they are often not overly enthusiastic to expend funds on a restoration project. A cemetery is often a non-revenue generating property and funds for maintenance and upkeep can be scarce in tight budgets. If a proposed project offers a more diverse use of the property and a chance to build civic pride it will more readily gain the support of local officials. Municipal support can go a long way towards a continued maintenance program and may even increase resource allotment.

Initially the response may be slow but with persistent effort the project will gain momentum. A wide range of skills is needed in the effort to conserve a historic cemetery. Establishing a broad base of support, expertise and labor is necessary to achieve success.

Step 1: Get Permission

With enthusiasm and a team ready, it is time to approach the owner and request permission to conduct a reconnaissance level survey. It is extremely important that no work of any kind be conducted in the cemetery without first obtaining permission

from the owner. Be prepared to demonstrate that the resources and manpower are available to conduct such a survey. The sample form in Appendix A can be used or adapted to obtain written permission from the owner / governing authority. **It is important to keep this form on file.**

Step 2: Conduct a Reconnaissance Survey

With permission granted, it is time to begin the initial reconnaissance survey. A reconnaissance survey is a quick look at the property and requires little documentation. This survey will provide an overview of existing conditions, features, and landscape elements.

It is essential before any repair or replacement work is undertaken. The survey will aid in setting goals and determining funding needs. The reconnaissance level survey includes the following items:

- **A sketch map that contains the location of:**
  - present boundaries
  - fencing
  - gates
  - buildings
  - roads and pathways
  - water features
  - vegetation such as trees, flowers, shrubs
  - family plots
- An assessment of damaged artifacts and problems with landscape features, such as erosion and fallen branches
- Photography that records each of the above elements

During this survey, disturb nothing. Something as simple as moving rocks could alter the historic integrity of the cemetery. Mowing could destroy historic plant material. What at first appears to be debris could later prove to be of significance.

Along with the reconnaissance site survey it is important to research all former repair, restoration, and documentary projects. This will save duplicating efforts and help in accessing what should be done or undone. Perhaps a prior effort has documented inscriptions on stones. Roads, pathways, and access gates might have been altered or relocated to accommodate modern vehicles and equipment. New plantings, removal of downed trees and other historic plantings, new fencing or expansions of the cemetery's boundaries are often documented. Cemeteries maintained by local governmental bodies, cemetery associations, and by religious organizations might have records of prior efforts that can be used to determine how the cemetery changed over time.

In Michigan the township often has authority over cemeteries within its boundaries. Searching in the township records might reveal important data. Another avenue to pursue might be the records of local service organizations. In the early decades of the twentieth century a strong interest in national, local, and family history led to cemetery research. If organizations such as women's clubs, the Daughters of the American Revolution or other such civic or military groups were active in the area at the time, their records could lead to information about former efforts to document the cemetery. Old newspaper articles often will report community projects such as installation of monuments, cleanup efforts, and changes in cemetery boundaries. Locating existing documentation will save duplication of effort that equates to time and money in any project.

Step 3: Prepare an Action Plan

With the completion of the reconnaissance survey and research, the team is ready to prepare a plan of action. This plan should include setting goals, recruiting volunteers, finding funding, and establishing safeguards and security measures for resources and workers.

Setting Goals

Perhaps the most important first step in preparing the action plan is to delineate and prioritize goals. This will bring the project into focus and clarify which actions are the most pressing. In the process of setting goals, address the following questions. What are the project's priorities? What type of workforce is needed? Can volunteers provide some of the work? What is the minimum that needs to be done to stabilize the cemetery? Will a preservation planner be helpful? After answering these initial questions determine short and long term goals.

These are examples of short-term goals that might be included in an action plan:

1. Form a "Cemetery Friends" group (see The Association for Gravestone Studies' Guide to Forming a *Cemetery Friends* organization).
2. Make a Master Plan.
3. Identify funding sources.
4. Hire a coordinator if needed.
5. Create safety guidelines for both workers and material artifacts.
6. Clarify legal considerations to determine liability for both volunteers and visitors.
7. Address security, vandalism, and theft issues.
8. Retain the original form and fabric of the burial ground by adopting the Secretary of Interior's *Standards for the Treatment of Historic Properties and the Guidelines for the Treatment of Cultural Properties.*

9. Analyze current conditions. Follow up by emergency stabilization of markers and landscape. Once features that may be unsafe have been uncovered, such as loose headstones or deteriorated roads, incorporate these items as priorities in the master plan.
10. Determine which professionals will be needed and at approximately what stages. Make a list of recommended experts.
11. Conduct an intensive level survey of the site using photography, mapping, and forms to document markers, buildings, and landscape. At this point plan to delve into the history of the site to uncover cultural traditions, changes over time, and site features such as historic plant material or buildings.
12. Undertake initial cleanup of the cemetery.
13. Expand public awareness.

Examples of long-term goals:

1. Clean and conserve all markers.
2. Evaluate and repair ancillary features.
3. Prepare a plan for landscape preservation and future maintenance using appropriate materials and techniques.
4. Continue research.
5. Provide educational tools such as tours, lectures, brochures, a newsletter, information posted on the community web site, and documentation of findings in the local library.
6. Prepare regulations concerning site management.
7. Enact a local cemetery or historic cemetery ordinance if none exists.
8. Designate the property as an historic site.

Step 4: Establish Funding

After delineating goals, begin the search for funding sources. First, solicit support from the owner/governing body of the cemetery. Perhaps the governing body will agree to channel the needed funds into the project; however, it will usually be necessary to supplement any small amount provided by an owner or municipality. When no association or municipality will be responsible for managing funds it is important to create an organization that can serve this purpose.

To help with both plans and funding, there are several organizational options to be considered:

- Establish an organizational hierarchy with well defined responsibilities.

- Establish the group as a non-profit Cemetery Association or Cemetery Maintenance District (see Saving Graves web site, an international organization committed to the preservation of historic cemeteries).
- Become a tax exempt entity. (See Saving Graves web site)
- Open a checking account.
- Obtain a tax ID number.
- Consider establishing an endowment account to fund ongoing conservation and preservation efforts.

For a project to reach its potential a budget must be prepared and maintained. Designate a responsible person or entity to handle finances. By operating in a businesslike manner those wishing to donate can do so with the assurance that there is a stable process in place for the allocation of donated funds.

There are many ways to raise both large and small amounts of money for a project. Having the support of the local authorities or historical society is beneficial. Fund raising, enlisting workers and raising awareness are related components of the total project. From the beginning establish "partnerships" with local groups and organizations for potential sources of money, expertise and hands on labor. Some partnership suggestions are:

- The local historical society.
- Programs such as "Adopt a Cemetery" or "Adopt a Statue" where one or more groups become responsible for continued care or a financial commitment.
- Approach the developer of a local real estate project. Sometimes there are requirements that the developer "give back" to the community. This might be a source of essential "seed money" to get the project started or a way to fund a large improvement, such as restoration of a fence or statue.
- A local college may have programs in historic preservation, landscape architecture, archaeology, or history that could provide advice and students for work projects.
- Approach local businesses and corporations for funding and "in-kind" donations of products.
- Enlist local Boy Scout or Girl Scouts to volunteer for projects to earn community service badges.
- Groups such as local genealogy societies, Daughters of the American Revolution, and Veterans of Foreign Wars may be interested in volunteering.
- Local school groups.
- Pro bono contributions from lawyers, CPAs and other professionals.
- Explore the use of volunteers as an "in-kind" match for grants.
- Families of those buried in the cemetery.

By enlisting the help of a local real estate developer, Canton Township was able to replace a worn and broken cyclone fence with a safe, aesthetically pleasing aluminum fence at no cost to the township parks department, which maintains the property.

In addition to the above, seek large benefactors. Appealing to local business owners, corporations or a civic-minded philanthropist could provide for on-going financial assistance. Having non-profit status, (501)(c)(3), is a must for raising money from corporations and foundations as it allows them to use the contribution as a tax deduction (*Fundraising for Non-Profit Groups: How to get money from foundations, and government*, p. 20).

When seeking funding, grants are another avenue to pursue. Obtaining grants for the project could begin with visiting the Funding Research Guide at the Saving Graves web site. A *Foundation Directory* is available at the Grant Information Center of many large public and university libraries. These participating libraries offer access to the Foundation Center web site without charge. This site is privately accessible for a fee. This directory provides information on the types of projects that are funded by each agency. Other sources of grant funding information are: the *Corporate Giving Index*, which specifies the focus of each business's corporate donations, and the *Michigan Foundation Directory*. Most granting agencies will want assurance that the organization is able to raise money locally, some may require matching funds. Be sure to target those funding agencies that have an interest in the type of project proposed and that sponsor projects in the local area.

Check with local foundations for grant awarding possibilities. Some cities have a Community Foundation that awards grants for specific purposes. Regional foundations, such as the Southeastern Michigan Community Foundation, provide grants for arts and humanities projects in specified geographic areas. Local groups such as Questers (an organization that performs community service projects focusing on local history and culture) often provide grants for projects that relate to history and antiquities.

Communities that are participating in the National Park Service's Certified Local Government Program (CLG) are eligible to apply for competitive grant funds through the State Historic Preservation Office (SHPO) in the Department of History, Arts and Libraries (HAL). For more information on Michigan's CLG grants and on other governmental organization grants visit the State Historic Preservation Office on the web at *www.michigan.gov/shpo*.

Although some grants may require a lot of paperwork, others do not. All have definite deadlines for submission. Most granting agencies require the following information:

- Background information – name, purpose, board of directors, copy of the operating budget, and IRS letter of determination (federal tax-exempt status 501(c)(3). (See Saving Graves web site)
- Assurance that the group has been in existence for at least two years.
- Names of key people involved in the project.
- Letters of support from affiliated agencies such as: State Historic Preservation Office, National Trust for Historic Preservation, Michigan Historic Preservation Network, and The Association for Gravestone Studies.

Many agencies offer conferences and seminars on writing grants. The Association for State and Local History offers a grant writing session at their annual conference. The Michigan State Housing Development Authority (MSHDA) and continuing education programs offered through colleges and universities also offer grant writing courses.

Step 5: The Work Force

Well-trained volunteers bring both enthusiasm and hands-on assistance to the venture; however, as the process advances beyond the preliminary effort, it is recommended that a coordinator, preferably a paid position, lead the effort. It is a large undertaking to see that the formal preservation plan unfolds smoothly while coordinating funding, volunteers, and professionals. An organizational person is necessary to set timetables, train volunteers, follow up on various projects, and in general keep everything on track. This person can also coordinate volunteers and their efforts in the cemetery.

Before anyone is allowed to work in the cemetery it is a good idea to have written, specific rules and regulations. Specifying "dos and don'ts" protects workers, the project coordinator and the historic property. Some guidelines for volunteers are:

- Never go into the cemetery alone. There is always the possibility of a falling limb or other unforeseen accident.
- Bring a first aid kit and cell phone, and tell the person in charge what project will be done and when it will be done.
- Wear long pants, a long sleeve shirt, gloves, and sturdy shoes to prevent harmful plants, insects and other wildlife from harming you. Bring insect repellant and put anti-bee sting medication in the first aid kit.
- Be on guard for broken glass, sharp stones, and rusty metal. In the case of any injury that breaks the skin, a tetanus shot needs to be updated if the last one was over five years ago.
- If possible point out any known toxic plants in the cemetery. Poison ivy and oak especially like to grow on fences and trees. An awareness of what they look like and protective clothing are helpful.
- Avoid working during the hottest part of the day, wear sunscreen, and have water available.
- Pay attention to the area traversed. A sunken grave, wet stones or vegetation in the path might precipitate a fall.
- Use proper lifting techniques when working with stones. For heavy stones use a tripod with heavy-duty chain, winch and straps.

Volunteers

Volunteers can be used for the initial cleanup of the cemetery. Cleanup is often the activity that has the greatest attendance and is best publicized. It is also where a significant amount of damage can be done to the landscape by well-intentioned volunteers and staff members, who fail to appreciate the historic context and burial practices of the past.

In the initial cleanup, the first important consideration is to protect and preserve that which has survived on the site. A very conservative approach should be taken. Something as simple as the removal or reuse of rocks found in a cemetery could alter the integrity of a particular area. Rocks, like plants, were often used as markers of loved ones' gravesites. Sometimes a large stone would be placed at the head of a grave with a smaller one at the foot. In other instances fieldstones were used to outline the grave. During the initial cleanup only removal of litter such as large branches and trash (broken bottles, cans, and paper) should be done. Do not mow the grass, or remove plants, broken headstones or any type of marker.

All volunteers should receive some training before working in the cemetery. Training volunteers through workshops, or an extended workshop, is recommended. In Canton Township volunteers from Civitan, Boy and Girl Scouts, historical societies, and students from local schools have participated in tasks such as tree trimming, removal of bushes, leaf clean up, grass trimming, and cleaning of markers. In Canton Township, Michigan, in conjunction with *Make a Difference Day*, a local Eagle Scout (aided by his parents and Canton staff) plotted Downer Cemetery into ten foot- by ten foot squares, recorded all data, and photographed the cemetery. The project took over two hundred hours to complete and as a result, all of the semi-covered and covered stones were located and a complete photographic record of the cemetery was made.

Documenting gravestones by photography, mapping, surveying, and the completion of a form for each grave requires patience and precision. Probing for and cleaning gravestones takes special knowledge and requires specialized skills. In the long run, money will be saved if volunteers have an in-depth orientation to each task. If the community does not provide workshops, there are various organizations that offer them: the Chicora Foundation, the National Park Service, the Center for Historical Cemeteries Preservation, Indiana Pioneer Cemeteries Restoration Project, and the Association for Gravestone Studies, that has a yearly conference that includes workshops. Contact these organizations for more information. With education, the volunteers will gain enough information to discern which tasks can be accomplished and those which must be left to a professional.

Hiring Professionals

Depending on the size of the cemetery, the extent of the damage, and the need for restoration, professional help may be required in addition to volunteers. A historic preservation consultant with planning experience may be the first professional that is needed in order to give a condition assessment, formulate a plan, set priorities, and protect the historical integrity of the site. Other professionals that might be considered are horticulturalists, archeologists, landscape historians, historic site engineers, structural engineers, architectural conservators, restoration artisans, monument dealers, and if the cemetery is within a municipality that cares for burial grounds, the Department of Parks and Recreation. The State Historic Preservation Office maintains a list of architects that specialize in work on historic buildings. They may be able to offer assistance as well in locating professionals with appropriate expertise for the project. The Michigan Historic Preservation Network (MHPN) offers a list of contractors belonging to its Construction Trades Council.

Points to consider when selecting a conservator:

- Inquire about qualifications, types of insurance, experience with similar cemetery conservation projects and membership in the American Institute of Conservators (AIC) or other professional conservator groups.
- Ask about the size of their firm, length of time in business, employee training and experience, and supervision of employees.
- Be sure that the conservator is willing to provide documentation of the work being done. Ask that photographs be taken before, during, and after the work. Be sure that all of the products used are specified in written work orders and estimates, and that Material Safety Data Sheets (MSDS) are supplied.
- Develop a timeframe for the project and get it in writing. Discuss with the conservator what will happen if the project takes longer than anticipated or if there are cost overruns.
- Discuss any concerns the conservator might have, such as overnight site security, questions about utilities or permits.
- Ask if the conservator is willing to train others involved in the project, such as cemetery staff or volunteers. Are they willing to return for routine maintenance? What sort of actions will be taken in the event of a repair failure?
- Be sure to indicate that all OSHA regulations must be followed. Indicate that it will be necessary to use appropriate safety equipment to minimize the risk of accident or injury.
- Inform a contractor that because of the fragile nature of the landscape in which preserving old plants, buildings and markers is a priority, the work in a historic cemetery is handled differently than a residential account.
- Let contractors know that it may be necessary to delay conservation or maintenance in the event of a funeral or burial.

The quality of work that is received from the contractor is directly related to the concerns discussed before the work begins. Be certain to indicate the standards that will be used to judge the completed work, and in most cases the extra effort will be worthwhile. Getting a bid from more than one professional is a good idea.

Step 6: Listing in the National Register of Historic Places

If listing the cemetery in the National Register of Historic Places is considered, contact the state National Register coordinator. The State Historic Preservation Office (SHPO) web site lists the criteria that must be met in order to list a property in the National Register. A summary of the criteria as they relate to cemeteries is:

- **Criterion A:** Properties can be eligible for the National Register if they are associated with events that have made a significant contribution to the broad patterns of our history. A cemetery might be eligible for listing in the National Register under Criterion A in relation to events for various reasons– for example, if it contains the graves of many of the community's early settlers where other properties, such as the early settlers' houses no longer survive to represent this period of the community's history; if it is important for its association with an ethnic group or settlement important in the community's history; or if it is associated with one or more important events, such as a mining disaster that resulted in a substantial number of interments.
- **Criterion B:** Properties can be considered eligible under Criterion B if they are associated with the lives of persons significant in our past. The persons with whom the burial place is associated must be of outstanding importance to the community, state, or nation.
- **Criterion C:** Properties can be eligible for the National Register under Criterion C if they embody the characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction. A cemetery may be eligible under Criterion C as a representative example of a cemetery whose layout and features reflect an important movement in landscape design, such as the Romantic Movement; as an important example of the work of a significant landscape architect or designer; because of the architectural and / or artistic importance of the funerary architecture and / or art present there; or because the cemetery as a whole possesses significance because the entire cemetery, including its planning and landscaping, and its architecture and monuments display high artistic value.
- **Criterion D:** Properties can be eligible for the National Register if they have yielded, or may be likely to yield, information important in pre-history or history. Burial places may be eligible for their potential to yield information about cultural and ethnic groups and burial practices. Such information is generally obtained through archeological investigation.

Contact the SHPO if you are seeking to nominate a cemetery to the National Register. Nomination forms are available at no charge from the State Historic Preservation Office (SHPO) or the National Register of Historic Places. Michigan's SHPO submits all nominations of properties in Michigan– except federal properties– to the National Register. Submitting a *National Register of Historic Places Preliminary Questionnaire* is the first step in nominating a cemetery property to the National Register. The questionnaire is available

(PDF format) on the Michigan SHPO web site. The SHPO staff will review this form and offer an opinion about the property's eligibility.

If the cemetery is deemed eligible by the SHPO, the next step is preparation of the nomination forms and accompanying documentation for submission to the SHPO. Once the final version is approved by the SHPO, it is presented to the State Historic Preservation Review Board for its approval before being submitted to the National Register, National Park Service, U.S. Department of the Interior, for formal listing in the National Register of Historic Places. Forms are available on the web site or by mail by writing to:

State Historic Preservation Office
Michigan Historical Center
Box 30740
720 W. Kalamazoo Street
Lansing, Michigan 48909-8240
preservation@michigan.gov

Chapter 2

SURVEY METHODOLOGY
AND DOCUMENTATION

OVERVIEW OF CEMETERY DEVELOPMENT

The following overview of cemetery development is intended to put the historic cemetery in context as a beginning point for documentation. Cemeteries, along with grave markers, changed as a result of the evolution of society's religious and cultural attitudes toward death. Understanding how the cemetery changed over time will help to place it in its historical context.

In America whenever an area was newly settled, whether in New England or Michigan, the need for burial soon followed. The deceased was usually buried near the place of death and often in an unmarked grave. America's earliest burial grounds were not attractive, tranquil places. Graves were not located in neat rows and maintenance was minimal. Sometimes cemeteries were located on a piece of land that could not be used for farming. The grass was allowed to grow long and animals grazed on the site. It was a utilitarian place, a highly visible reminder to everyone of the brevity of life and the uncertainty of the afterlife. When settlements had progressed beyond the pioneer stage burials became more ritualized.

The family burying ground, with its tall, flat, rectangular stones, was a familiar sight in rural areas, as was the churchyard or community cemetery in villages or township centers.

Often cemeteries that began as family burying grounds later were deeded for use as community cemeteries. The evolution of styles can often be seen. Others, however, were originally platted as cemeteries and had an administrative body for the day-to-day management.

While Michigan was still in the process of settlement during the early 1800s, the Rural Cemetery Movement had already begun in the eastern United States. Several factors led to the development of this movement. One of these factors was public health. Increased urbanization and its accompanying population density caused problems with the air and water in large cities and resulted in epidemics of small pox, cholera, diphtheria, and other life threatening diseases. It was believed that cemeteries contributed to the contamination of the water supply. New cemeteries were thus located on the outskirts of urban centers. (*Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries*, p. 6-7)

A second factor in the development of the Rural Cemetery Movement occurred as cemeteries were being relocated to the urban fringe; the new generation of cemeteries became planned landscapes. Among the first planned cemeteries were New Haven's New Burying Ground and Pere Lachaise in Paris. New Burying Ground was nonsectarian and free from church and municipal management. Features that were copied by later cemeteries:

- locations outside the city in order not to be a health hazard
- geometric pattern layout
- family plots
- roadways wide enough for carriages
- planted with trees (poplars and willows)

A third factor was the rise of the Romantic Movement in Europe. The Romantic Movement was a revolt against the eighteenth century's cultural emphasis on rationality and order in favor of a "romantic" appeal to the senses in the later eighteenth and nineteenth centuries. It was characterized in literature and the arts by liberalism in form and subject matter. It emphasized feeling and originality, and an interest in nature, medievalism and the mystical. The Romantic age influenced all the arts and eventually filtered down to cemetery design. In cemetery design this translated into the development of a picturesque aesthetic that encouraged maintaining and enhancing the natural environment rather than overcoming it.

Mount Auburn Cemetery in Cambridge, Massachusetts, established by the Massachusetts Horticultural Society in 1831, is generally considered the first of the new

generation of Romantic Movement rural cemeteries in the United States. Mt. Auburn was unique in that it was designed to encourage public use for healthful recreation. Its design served as a model for the "pleasure grounds" and public parks built in the late nineteenth century. Key principles that were later imitated:

- it was outside the city limits in a rural area
- park-like character with an informal plan and winding roads that took advantage of topography, natural features and trees
- emulated romantic character of estate design popular at the time
- careful balance of art and nature through use of architecture features and view sheds
- served a quasi-public function (*Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries*, p. 7-8)

Most larger non-Catholic cemeteries established from the 1840s to the 1870s emulated Mt. Auburn in their picturesque planning and landscape. With the evolution of the designed cemetery the earlier term "burial ground" was replaced with "cemetery" from the Latin "to sleep." In 1869 New York art critic Clarence Cook agreed with Andrew Jackson Downing, a horticulturalist and author, in that cemeteries were "all the rage." They were "famous over the whole country and thousands of people visited them annually." (Tishler, p. 121)

Spring Grove Cemetery in Cincinnati, Ohio, marks the beginning of another development in cemetery planning, the "lawn-park cemetery." Spring Grove Cemetery was originally developed in the rural cemetery style in 1845. A change of administrators in 1856 brought about a change in design philosophy and Spring Grove began to evolve in the lawn-park cemetery style under the direction of Adolph Strauch. The lawn-park cemetery had more structured regulation than rural cemeteries. It eliminated the use of small features and family plot boundaries in favor of an open sweep of green lawn with plantings organized to frame or create vistas. Strauch's ideas, for what he called the "landscape lawn plan," influenced cemetery design for the next half century. (Linden, p. 16 and p. 30)

Lawn-park cemeteries were characterized by:

- a balance in formalism and naturalism
- elimination of fencing and fewer, larger monuments rather than a "forest" of large and small monuments
- the use of grouped ornamental planting to frame large expanses of lawn, lakes and monuments to create vistas (Tishler, p. 121-122)

Technological advances, among them the invention of the lawn mower, led to progressively simpler cemetery designs. The memorial park cemetery, which gained popularity in the mid to late twentieth century, forbade the use of upright gravestones, in favor of small flat markers imbedded in the ground. These cemeteries were typically privately owned and well maintained. In the twentieth century cemeteries were designed by cemetery professionals rather than landscape architects and / or horticulturists. Forest Lawn Cemetery in Glendale, California, (1916), is an example of evolving cemetery design. It is considered America's first memorial park cemetery.

Characteristics of memorial park cemeteries:

- Highly planned and regulated
- Monuments are flush with the ground
- Emphasis on lawns
- Sense of openness and spaciousness
- Minimal decorations with few buildings, features or plantings
- Plantings are backdrop for large memorials that emphasize community rather then the individual. ("Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries", p. 10)

After World War II, as the population became more mobile often leaving no family members to care for graves, the professional maintenance and "perpetual care" offered by privately owned memorial parks helped result in their proliferation.

SURVEY AND DOCUMENTATION

1 2 There are two types of surveys. A **reconnaissance survey** is a quick overview of the site, done simply to note significant features on a map and to get a general understanding of the cemetery's design or layout. The reconnaissance survey serves as the foundation for the second type of survey, the more in-depth, **intensive level survey**. An intensive level survey requires researching the site and documenting individual features. A survey is comprised of two elements: research and fieldwork. Fieldwork entails taking a thorough look at the cemetery as it presently exists, noting and recording on maps and through photographs all pertinent features within its boundaries. Research requires gathering historical and present data to document the cemetery's history, its landscape, and its artifacts. The survey process consists of:

- Research and compiling data
- Mapping
- Photographing
- Recording information on survey forms

Research and compiling data

Research consists of investigating a variety of sources of historic data:

- Microfilm copies of old newspapers and other data at local libraries and historical societies
- Deed books at the county register of deeds
- Local and county histories, atlases and maps, and genealogy information
- Records of the cemetery association and/or a church associated with the cemetery
- Archive and library collections such as those in the State Archives of Michigan and the Library of Michigan in Lansing, the Bentley Historical Collection in Ann Arbor and the Burton Historical Collection at the main Detroit Public Library

Data collected is not only an important historical record, but can be used for future planning and maintenance of the cemetery. The documentation should be collected in a systematic way, presented in a professional format and be accessible to both professionals and lay researchers. Appendix A contains the forms recommended by the State Historic Preservation Office for surveying the cemetery as a whole, individual gravestones, and vegetation. These forms can be copied for field use. Afterward the information that is gathered should be entered into an electronic data base.

Surveying the Cemetery's Features

Looking at a landscape through the eyes of both a historian and a horticulturist will help put together the pieces of the cemetery story. Ask the following questions:

- Was the site originally located in a small village, in a rural area, part of a crossroads hamlet, settled by a particular ethnic group, or part of a religious site?
- Where is the cemetery sited? On a rolling countryside? Is the site plain and sparsely planted, or is it covered by a canopy of mature trees?
- What are the basic elements of the cemetery's design or layout? Does it have the romantic elements of Victorian era cemeteries, such as picturesque rolling terrain and artistically designed monuments? Does it show the characteristics of a lawn park cemetery?
- Is it a designed landscape?
- When was the cemetery established?
- What are the dates of additions?

Often the organization or agency in charge of the cemetery's maintenance will have maps showing the existing boundaries and plan. Both old and new county atlases often show

the boundaries of cemetery parcels. If early maps exist, they may help with the analysis of the cemetery's development.

- The survey process requires a site analysis that results in a record of the physical features of the cemetery. *National Register Bulletin No. 41: Guidelines for Evaluating and Registering Cemeteries and Burial Places* (available from the National Park Service) recommends that "Characteristic plant materials, layout of burial plots and circulation features, acreage encompassed, and the purpose or function of areas and features within the site boundaries also are important." The following list of features to be documented is taken from the National Register *Guidelines*:
  - general topography, including slope and elevation, both within the burial ground and in relation to its larger setting;
  - natural features such as streams, hills and native vegetation, and naturalistic features such as ponds, lakes and land forms;
  - plat, or layout of cemetery plots, whether a rigid gridiron imposed on the site or an organization of plots conforming to natural contours;
  - circulation system of roads, driveways, pathways, noting whether such features have axial alignment or are winding or curving; structural features of the system, such as bridges and drainage systems; and distinctive materials, such as cobble gutters or stone paths; views and vistas within the site from principal access points; views and vistas external to the site;
  - characteristic vegetation, including overstory of trees, understory of shrubs and grasses, exotic plant materials used as filler in burial plots, ornamental flower beds, and specimen plantings;
  - gateways, fences, and hedges used for boundary and spatial definition;
  - typical plot defining features such as wooden palings, iron fencing, and concrete curbing;
  - prevalence of individual plot mausoleums, vaults, or above-surface tombs, and indication of the range and variety of individual grave markers;
  - entrance signs, directional markers, outdoor lighting features, and small-scale site furnishings such as benches, planters, ornamental sculpture, and fountains;
  - maintenance and service features such as soil disposal and waste storage areas, greenhouses, tool sheds, and pump houses;
  - buildings such as churches, memorial chapels, gate houses, offices, residences, crematories, mausoleums, and columbaria. (Walton-Potter, Elisabeth, and Beth M. Boland, p. 2-3)

By recording the features listed above, a picture of the cemetery, changed over time, will evolve. The most basic and useful forms of documentation are photographs, survey data forms and a map of all features showing their location.

Interpretation of the site and plans for future use should be based on this information. The Association for Gravestone Studies (AGS) leaflet, titled *Analyzing Cemetery Data*, may be helpful in interpreting some of the information that is collected. When cemetery documentation is complete, the local library and AGS should receive copies. See Appendix A for sample forms.

DOCUMENTING THE VEGETATION

With the initial research complete and after defining the site perimeter, one of the first priorities is assessing and documenting vegetation. Preserving plant life is a very important part of cemetery conservation. Looking at some of the plantings through "modern" eyes may cause you to overlook old species that are indeed heirloom varieties. Look beyond the plantings that you recognize. Since most species were introduced during a specific time period, looking at garden books featuring historic plants or old and new seed catalogs may help to document "changes over time" in the cemetery. Common plantings found in Michigan cemeteries might include roses, sedum (the historic variety known as "live forever"), myrtle, pinks, lilacs, iris, and lilies. These old varieties can be very different from today's hybrids. It is also important to remember that some of these plant memorials were symbolic. For example, the lily is associated with purity, the rose with love, and ivy with immortality and fidelity. Trees were associated with meaning, too. The cedar tree was associated with strong faith, evergreen trees with immortality and the willow tree with grief and death. These plantings were part of memorializing those that are interred in the cemetery and should be preserved. In order to preserve historic plant material, documentation should be done before any clean-up or routine maintenance is performed, or before professionals begin work.

During the reconnaissance survey, the examiner may have noted plantings near gravestones or along the fence line where historic plants have spread and survived because the lawnmower couldn't reach them. A more intensive survey and documentation of plant life needs to be undertaken over three seasons, spring, summer, and fall, to make sure both early and late bloomers are found. Look around gravestones, along both the inside and outside of fence lines, beneath shrubs, in compost/refuse piles, and at the base of trees for historic plants. Record their location on the site map.

A plant historian, master gardener, or plant biologist may be helpful at this point. If a historic cultivar is found, it would be worth having a horticulture specialist identify it to preserve both its historical integrity and biological diversity in the cultural landscape. A local college or university may have a horticulture-related staff member who would be willing to donate time and expertise. The Michigan State University Extension Service could also be helpful.

Record each plant type found in the cemetery with photograph and survey form. Modern plants should also be documented.

The form to document the cemetery vegetation is included in Appendix A. It includes:

- Date of observations (over three seasons if possible)
- Plant genus, species, and common name if known
- Size
- Color
- Condition
- Photographic documentation
- Location on cemetery base map
- Reference number to coordinate photograph, map, and plant list / form
- Historical significance, if known (symbolism, family significance or planted to represent an event)
- Evaluation of integrity and significance. Is the plant rare or an old variety? Was the tree planted to commemorate an important event in the community? Does the plant material have an ethnic or symbolic relationship? Was the person buried in the plot once the owner of a local nursery?

While a cemetery may not be the work of a famous landscape architect or master gardener, its horticulture can give important clues to its history and culture, and is a way of honoring the deceased. Scott Kunst, landscape historian, suggests that when documentation of plantings is complete, a plant palette of plants common to area cemeteries, such as "Canton Township Cemetery Plants," could be made. Knowing what species of trees are planted will also help plan for the future development of the cemetery. For example, the presence of acidic trees, such as pine and oak, can be detrimental to marble and limestone markers. Some cemetery associations, such as Canton Township's Cherry Hill Cemetery Association, have adopted a policy of pre-approval of plant material and its location in order to keep roots from interfering with the graves. Several books and web sites that aid in plant identification are listed in Appendix B.

EVALUATION OF THE MONUMENT

Evaluation of the monument is a four part process that requires the documentation of the material used, the form of the stone, carvings and the inscriptions. This evaluation produces information regarding the age of the stone. It may also reveal whether or not the stone was carved by hand or whether mechanical techniques were used. Research may also disclose the cultural preferences of the area and era in which the monuments were erected.

1. Materials

Many early settlers of Michigan emigrated from New England and New York bringing their cultural traditions with them. These traditions greatly influenced Michigan's early burial practices. As in New England the earliest burials were very simple. The deceased was buried in the family plot or local burial ground with very little ceremony, reflecting the Puritan ethic.

By the time Michigan was being settled in the early nineteenth century, stone markers were common in New England, and early Michigan settlers brought this stone monument tradition with them. The early stone monuments in Michigan were often limestone. This material was relatively soft and easily carved by hand. However it deteriorated easily, and in an effort to use a more durable material marble became popular. White marble, available from sources close to home, was universally popular from the 1830s until the 1850s. With the advent of the railroad in the mid-nineteenth century, stonecutters were able to obtain non-indigenous materials such as "blue" marble from Vermont. However, it soon became apparent that marble, too, was soft and subject to weathering. After the Civil War improvements in quarrying technology and machine tooling made granite the material of choice. Granite was available from many sources, including Vermont and Missouri. It was also indigenous to Michigan, available in many colors including Wisconsin Crystal Grey from Iron Mountain, Michigan.

New materials also began to appear after the Civil War, among them "white bronze," more accurately zinc, a bluish grey non-magnetic, durable metal. According to Barbara Rotundo, the author of *Monumental Bronze: a Representative American Company*, almost all historic cast zinc (white bronze) monuments came from the same source, the Monumental Bronze Company of Bridgeport, Connecticut. The company had subsidiaries in the U.S. and Canada but, according to Rotundo, it is not known whether these plants actually cast the metal or whether they simply joined the sections pre-cast in Connecticut. Monumental Bronze Company operated from the mid-1870s to the late 1930s and opened its first subsidiary in Detroit in 1881. This subsidiary was known as the Detroit Bronze Company and the markings from this company appear on numerous Michigan monuments. Zinc

monuments were both inexpensive and durable and have generally worn well over time. The epitaph or inscription on a "white bronze" monument was cast at the foundry and could be chosen from a list provided by the manufacturer or created by the purchaser.

In addition to individual monuments, zinc was also used for large commemorative monuments. Whether individual markers or commemorative statues, all monuments were custom made after being ordered from a catalogue. Several Michigan communities have "white bronze" statues and monuments in their historic cemeteries. A particularly well maintained and excellent example is the Civil War monument located in the Lake View Cemetery in Quincy, Michigan. It bears the foundry marking "Detroit Bronze Company" and is similar in appearance, to the more expensive monuments found in Dexter, Jonesville, Coldwater, Milan, and numerous other Michigan cities. A community, like Quincy, with a strong amount of patriotic zeal, but a small cash flow, was able to commemorate its local heroes in the same grand style as more affluent communities. Even though these monuments were less expensive, they have frequently endured time much better than some of their more expensive look-alikes.

In addition to individual markers, large statues were made of zinc.

Markings identifying the manufacturer are often found on the base of the marker or statue.

2. Forms/Shapes

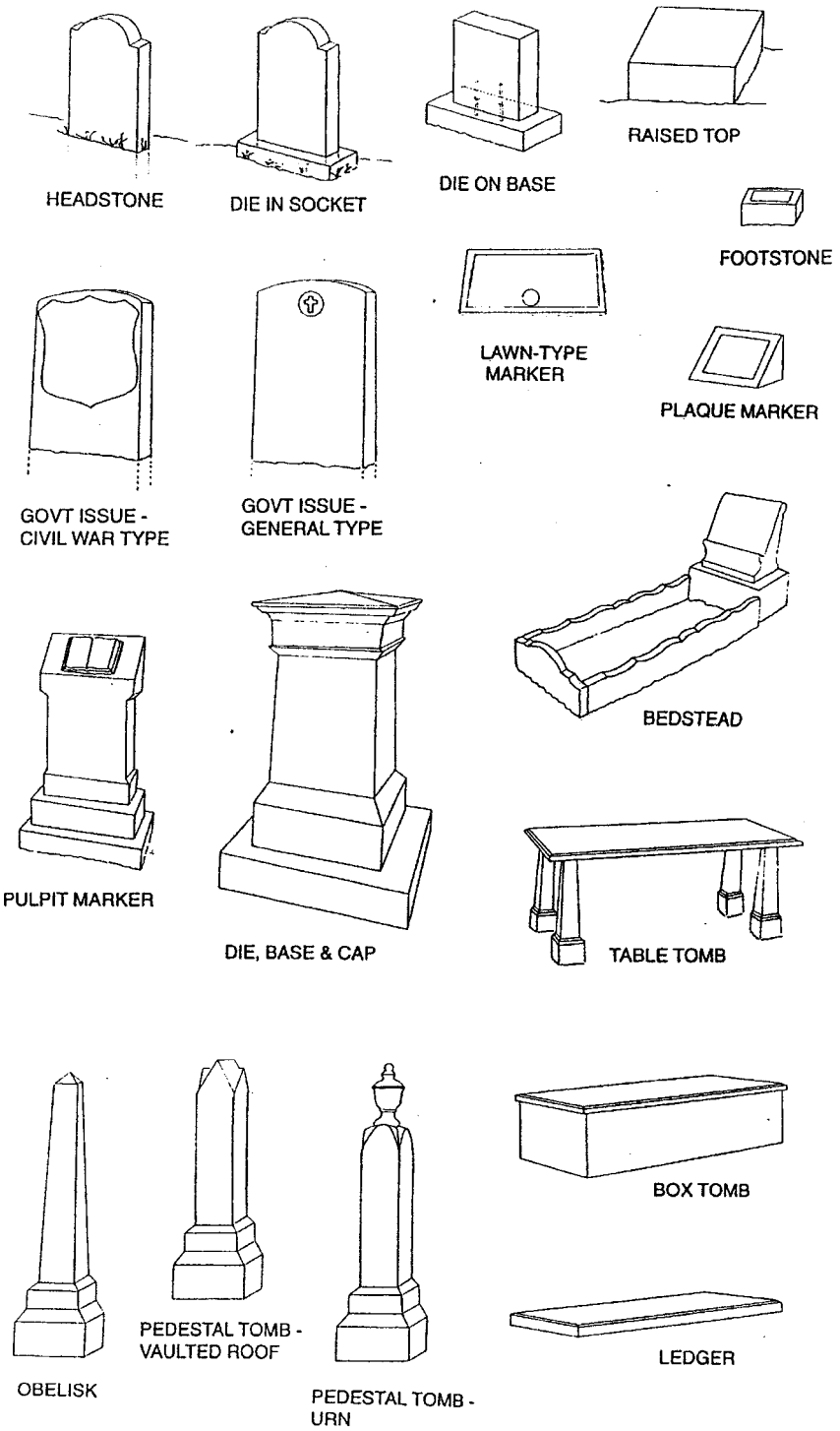
In the early nineteenth century, when Michigan was being settled, headstones were simple rectangular or cambered (curved at the top) shapes. As settlers became established and prosperous, after the mid-nineteenth century, they wanted more elaborate carving and gravestone shapes. Large, three-dimensional, more decorative monument shapes became increasingly common and the carving became more elaborate. Developing technology and transportation improvements allowed for national distribution of monuments. By the late nineteenth century local stone carvers were able to order pre-cut monuments in popular shapes directly from the quarry, and the customer could order from catalogue sources such as Sears Roebuck and Montgomery Ward. Catalogue markers helped to standardize the design of gravestone shape in small cemeteries.

In the last half of the nineteenth century headstones became more ornamental. Three-dimensional shapes were more frequently seen, especially obelisks, pedestals, square planned shafts, and columns. The Romantic Movement, which swept through England and Europe, had spread to America and was influencing literature, art, even headstone design. Gothic (pointed arch) and Romanesque (broad rounded arch) elements taken from medieval themes became prominent in headstone shapes. At the end of the twentieth century laser carving technology was adapted for headstone design. Not only does this allow for very personalized designs including transferred photographs and other biographical information, it also allows for unusual shapes of headstones such as hearts, diamonds, and even semi-trailer trucks.

In the twentieth century, when the lawn park cemetery design became prevalent, headstones, while still three-dimensional, were often smaller in size and simpler in design. Typical twentieth century headstones are rectangular granite markers of varying colors, with epitaphs becoming less common. The memorial park cemetery requires that headstones be flush with the ground for easy maintenance. These markers are usually bronze or a bronze plaque attached to a stone base used because of its durability.

The following headstone shape chart from the Chicora Foundation identifies the most common shapes used for monuments. A copy of this drawing should be provided in fieldwork packets.

QUICK FIELD GUIDE TO MONUMENT TYPES



Though the types of monuments vary greatly, this field guide can serve as a tool to help identify those monuments found in the cemetery. Reprinted with permission by the Chicora Foundation.

3. Inscriptions and Epitaphs

Documenting

An inscription includes all the words and numbers on a gravestone, whereas the epitaph is usually a religious or literary phrase or saying that commemorates the deceased. *Incised* inscriptions are carved into the surface of the stone. *Relief* carving is raised or projects forward from the surface of the stone.

> Different styles of lettering were popular at various times. *Roman* lettering went in and out of fashion. *Roman* lettering fail (sic) out of favor during the early 19th century, when italic lettering became the choice for inscriptions. Due to the ease in reading *Roman*-style lettering, even after weathering, it came back into fashion at the dawn of the Civil War. Both *Roman* and italic lettering from the 19th century was inscribed or cut into the stone. By the 20th century, more raised lettering appeared due to technological advancements in stone carving. (*Grave Concerns, a Preservation Manual for Historic Cemeteries in Arkansas*, no pagination)

The inscriptions on early stone markers were often minimal, usually the name or just the initials of the deceased, his age, and year of death. Later inscriptions were more likely to include the full name, with the month, day, and year of death. Soon inscriptions included epitaphs that often were Latin phrases such as *Memento Mori* (Remember that you must die). (Duval and Rigby, Introduction, p.viii).

Earlier epitaphs, found in New England, reflected the Puritan's belief in predestination and that most humans were destined for Hell. This dire view of life was seen in epitaphs like the following, serving as grim reminders that death would overcome all. (*Deetz*, p. 98)

My youthful mates both small and great
Come here and you may see
An awful sight, which is a type
Of which you soon must be

The aim of later inscriptions, and the type more commonly found in Michigan, was to express the grief of those left behind, and reflect an effort to console and uplift the mourners. (Meyer, p. 249) Epitaphs had evolved from the Puritan dark and dire warnings to the living, to the 1860s cultural tradition aimed at comforting the sorrowful. By then death had come to be viewed as a pathway to a better life. The following is an epitaph on the headstone of a fifteen year old girl (1855) in Canton Township's Cherry Hill Cemetery:

In the morn of life she left us
And her vacant seat is here
Yet how fondly do we cherish
Every emblem of her near.

Epitaphs were often quotations from a religious source, literature, or an original sentiment in remembrance of a specific person.

4. Iconography/decorative carvings

As carved stones became common throughout New England, the same severe Puritan attitude seen in epitaphs was also reflected in the foreboding headstone carvings of winged death's-heads, skeletons, and skull and crossbones. This attitude was already changing by the time Michigan was being settled. The belief that man could earn his salvation through good works gained momentum, thus shifting the focus from hell and damnation to the more positive belief in the resurrection of the soul and eternal reward. (In *Small Things Forgotten* p. 95-98) The cherub motif, which evolved from the winged death's-head, exemplified this change in attitude. James Deetz asserts that the willow tree overhanging an urn is a direct stylistic descendant of the cherub.

In Michigan the earliest carvings were simple, such as the willow tree, which was popular from the 1830s to the 1870s. In southeastern Michigan the willow and urn may be seen separately. The willow as a carved motif and the urn, both a form as well as a motif, had a direct influence on Michigan stone carvers. The willow tree is seen in a variety of forms, and the urn is frequently seen alone and/or partially draped. Also commonly seen from around 1850 to the late nineteenth century was a finger pointing to heaven or hands clasped.

The motifs used on headstones may have several interpretations. The entire stone's inscription should be considered as a whole when interpreting meaning. One interpretation of the willow tree is that it was used to signify the Christian faith because of its ability to survive under the most difficult circumstances. Another was that the willow tree, with its weeping branches, represented the grief of those left behind. The hand pointing upward indicated that the deceased had gone to his/her heavenly reward. The hands clasped meant that God was welcoming the departed, or alternatively, the hope of meeting again in heaven. (*Brown*, p. 25) The finger pointing downward represents that the deceased has been called by God. (Hacker, p. 2 and p. 43) See a more complete list of symbols in Appendix D.

Carving was typically done locally or regionally by skilled craftsman. Motifs were circulated among members of carvers' associations and were used or adapted according to

the carver's skill. One example is the local carver, Joseph L. Arnet, founder of Arnet's Beckers Burrells Monuments (1903) in Ann Arbor. Arnet maintained a studio workroom where both hand and tooled carving were employed.

Ann Arbor stone carvers, among them Joseph L. Arnet of Ann Arbor (right), seated on a newly delivered block of granite ready for sculpting.

In the twentieth century headstones became simpler as society as a whole retreated from sentimentality of the Victorian era. As granite became almost exclusively used for gravestones, mechanized tools were required to work the stone because of its extreme hardness. As a result, carving became more mechanized with deeper lettering and at about the same time design catalogs became available. Thus headstone design became more standardized and simplified. (Linden, p. 107)

At the end of the twentieth century laser carving technology was adapted for headstone design. Not only does this allow for very personalized designs including transferred photographs, symbols of hobbies or interests of the deceased, and other biographical information, it also allows for unusually shaped headstones.

Modern carving tends to be less complicated then that of previous years. Modern technology has produced some very elaborate and often colorful memorials made to specifically address individual characteristics and personalities.

DOCUMENTING THE HEADSTONE

Documenting the four elements of each headstone is a critical part of the survey process. It forms the basis of the conservation / preservation master plan, and will serve as ongoing documentation of all work performed on each headstone. The information recorded is a permanent record. It is the documentation of the exact condition of the stone at a particular point in time, which will be useful in case of future theft, deterioration, or vandalism. Repairs made in the future will also be recorded on this survey form and thus it will serve as a working document for the monument. A headstone survey form can be found in Appendix A.

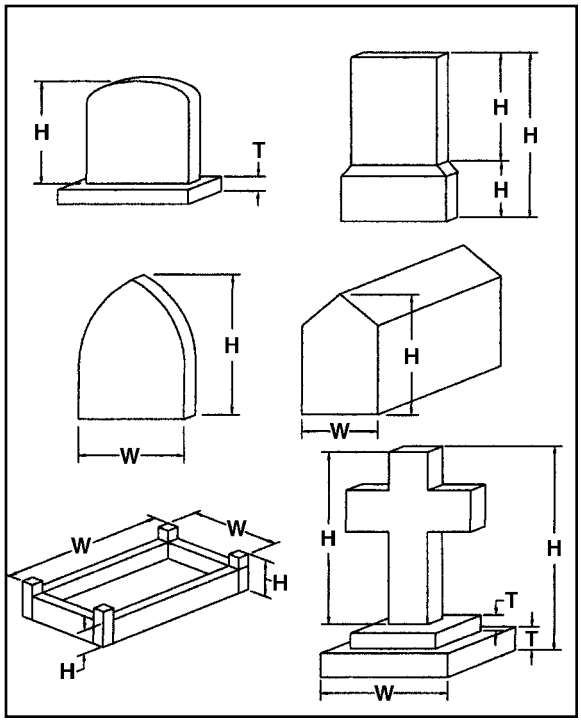
1 2 With training it is possible to utilize volunteers to conduct the monument survey. Prior to beginning fieldwork the volunteers need to be educated about the following:

- the proper method of photographing monuments
- how to use the monument documentation form
- how to identify monument shapes
- how to identify stone types
- describing headstone condition using common terminology
- how to document previous repairs
- techniques for reading inscriptions

When doing survey work it is both more efficient and easier to work with another person– one person to record and one person to photograph, measure, etc. The use of a clipboard and copies of the Michigan Individual Headstone Documentation survey form (Appendix A) will also speed the process. Using a pencil facilitates making changes and pencils will function well in cold weather.

MEASURING MONUMENTS

It is not possible to assess the size of a monument from a photograph; therefore, it is necessary to measure the height, width and thickness of each stone when doing the marker survey. For more complex monuments measure in several places. The drawing to the right has been adapted from the Chicora Foundation to show information needed to accurately measure monuments.



Full and accurate measurements are necessary information. Standardized criteria must be consistently used throughout the process. In this illustration several types of stones and the points of measurement are identified.

Condition

Carefully documenting the condition of each stone is important as this forms the basis of the conservation plan. Note all forms of deterioration, as well as all previous repairs. Employ the following vocabulary of common terms used in cemetery conservation when completing the headstone survey form. (These terms were culled from numerous sources e.g., *Grave Concerns, a Preservation Manual for Historic Cemeteries in Arkansas* and *Landscapes of Memories: a Guide for Conserving Historic Cemeteries, Repairing Tombstones*):

In Situ

A stone that is in its original location.

Displaced

A stone or part of a stone that has been moved from its original location.

Soundness

Condition of a marker that, after reasonable inspection, shows no sign of damage, no improper previous repairs and no excessive deterioration.

Cracks

Narrow fissures or fractures in the stone. Each occurrence should be identified and documented.

Delamination

A condition that occurs when a stone breaks or separates along bedding planes usually resulting in breakage of those areas. This is most prevalent on slate and sandstone, markers not commonly found in Michigan.

Scaling

The peeling away of the outer layer of stone.

Erosion

Gradual wearing away of the surface, resulting in rounded, blurred edges, and damage to carved details. Erosion is caused by the natural abrasion of wind and wind blown particles, and also by dissolution of the surface by acidic rainfall.

Sugaring

A granular, sometimes powdery, condition that is characteristic of some stone, particularly fine-grained marbles and limestone. Sugaring indicates gradual surface disintegration.

Gypsum Crust

Common to marble and limestone. Decay caused by the acidic gases in the air. It is a black crust that, when removed, exposes the softer stone underlayment.

Efflorescence/Subflorescense

Deposits of white salts on the surface of stone. It is an encrustation of soluble salts that could be caused by the use of fertilizers and weed-killers, air or water

pollution, use of gray Portland cement in concrete and mortars, and some cleaning compounds. These salt deposits are called "efflorescence" when they occur on the surface of the stone and "subflorescence" when beneath the surface. Efflorescence is a critical sign that the stone is endangered.

Fallen

Stones that have fallen are susceptible to accelerated damage and deterioration and should be righted.

Tilted/sunken

The extent to which a stone is sunken or tilted will determine the priority it will be given for resetting.

Fragments

Small pieces of broken stone.

Discolored/stained

Discoloration of the stone caused by vegetation, fungus, pollution or chemical reaction should be noted and any indication of the cause of staining should be noted. Different stains require different approaches to cleaning.

Mower Scars

Abrasions caused by grass cutting equipment, usually near the bottom of the stone.

Transcribing Inscriptions

Include the inscription on the headstone survey form. The inscription should be transcribed exactly as it exists on the headstone. Transcribers should work in teams of two with one person reading and one person writing. In the case of transcribing a verse, note the end of one line and the beginning of another. Other things to be noted are capitalization, unusual spellings, and punctuation.

The Chicora Foundation recommends the following standardized method of recording transcriptions:

- A slash / indicates a break in the line.
- Empty brackets [ ] indicate missing information.

Therefore you would transcribe

Here lies /
Our be[ ]ved Son /
John Smith /
D [ ]d 11 Nov[ ]ber 1847

The lettering within the brackets [ ] is worn away or unreadable.

If the actual inscription is known from documented sources, this can also be noted. **In cases where the inscription cannot be read or read only partially, no assumption as to what was carved should be made.** Recording the inscription as it reads at the time of the survey may help to gauge the rate of deterioration of the inscription in the future.

When the inscription is difficult to read, try shining a strong flashlight across the stone from the side to highlight the carving or use a mirror to reflect the sunlight. Another method of reading illegible inscriptions is to peer through a tube about 2 inches in diameter and 12 to 16 inches long. Holding the tube at an angle, place one end of the tube almost onto the stone and let the sunlight enter through the other end. This will help to accentuate the lettering. With extremely difficult inscriptions, have a second team read them and compare the results.

Iconography/Decorative Carving

Many gravestones have decorative carving, known as iconography, that should be documented on the survey form using both written description and photography. If the detail is not sufficiently clear in a photograph, a close-up of the design should be taken. Several photographs may be necessary when the designs are elaborate.

A written description of the carving can be as simple as: "praying hands with fingertips pointing upward" or "a willow tree." A more elaborate description might read: "an open book with flower and fruit garlands cascading around the book and down the sides of the headstone." Having both the photograph and the written description will assure thorough documentation of the headstone carving.

The willow and the lamb were common designs in the 1840s. This photo and the one on page 47 show a well-preserved carving on a memorial and a close-up of the top of the memorial.

Carver/Manufacturer

The name of the local carver, and sometimes the village or city where he/she was located, often appears at the bottom of the headstone. Sometimes the gravestone base will also include the name of the carver or manufacturer. All information should be recorded.

HISTORIC FENCING AND ENCLOSURES

Many small cemeteries are unfenced but it is not uncommon to find historic fencing, gates and entry signs in Michigan cemeteries. Historic fencing materials include wood, woven wire, fieldstone, concrete block, brick and especially ornate ironwork fencing. Beginning around the mid-twentieth century, cemeteries that had been previously unenclosed were surrounded by metal chain link fencing for security purposes. Where historic fencing is extant efforts should be made to repair and maintain it as an important feature of the cemetery. It should be documented along with other ancillary elements and the documentation kept with other cemetery survey data.

Before the Civil War cast iron became readily available and several companies manufactured ornate fencing through the early decades of the twentieth century. Elaborate cast fence posts, entry gates and signs identifying cemeteries were common. Later wrought iron and woven wire became more popular. Many are in disrepair or are deteriorating. Cast ironwork requires special treatment in both repair and maintenance, as it is vulnerable to corrosion and accidental harm from mowers and other equipment. Plans for the conservation and routine maintenance of these metal objects should be made when setting

goals for a conservation project. While it is always advisable to repair historic elements instead of replacing them, historic cast iron requires special handling in both repair and maintenance. See the section in Chapter 3 on conservation of metalwork before beginning any repairs or repainting.

When documenting a cemetery's features try to determine the manufacturer of any ornamental metal work. Often a company placed a plaque on gates or posts that will indicate the manufacturer. Check carefully for any markings on fencing elements. Occasionally a catalogue number will be recorded on a post. This number can be researched through sources such as the Chicora Foundation. Checking local city directories for the late nineteenth century, a time when many of the country's manufacturers of decorative iron work were active, may lead to information about a local company. A good discussion of historic fencing styles and manufacturers can be found at the Chicora Foundation web site. Fence catalogs ranged from nationally known companies such as Sears Roebuck and Company to local Michigan companies like the Page Fence Company of Adrian, Michigan. Chicora's web site gives a brief history of some common Midwestern companies that supplied fencing for cemeteries. The site will be helpful when documenting historic fencing. Identifying the company that manufactured a cemetery's fencing can be helpful when there is a need to replace sections.

In some instances the original company nameplate will remain on the wrought iron fence. This information is valuable when trying to replace or repair fence sections.

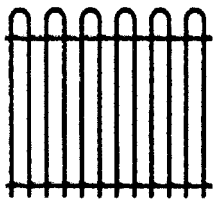
Around the turn of the twentieth century many local fence companies existed in Michigan communities. One example is Adrian, Michigan, which prided itself on being the "fencing capital of the world." Several fencing companies were located in this southeastern Michigan city. And a great deal of Michigan's historic fencing might have come from these sources. Adrian city directories list these companies from about 1889 to 1916:

Page Woven Wire Fence Co.
Lamb Wire Fence Co.
Adrian Wire Fence Co.
Michigan Wire Fence Co.
Monarch Fence Co.
Standard Fence Co.
Bond Steel Post Co.
Peerless Wire Fence Co.

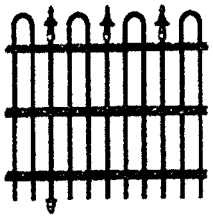
Check the city directory of the community closest to the cemetery for possible sources. The Michigan Gazetteer, published in the nineteenth century, is a good source of information, offering a statewide listing of companies.

On occasion, elaborate fencing and gates can be found surrounding family plots.

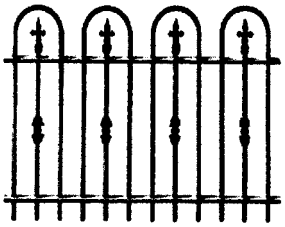
TYPICAL FENCE DESIGNS



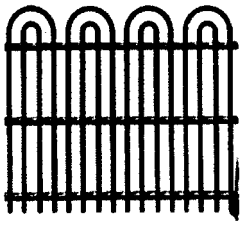
Hairpin



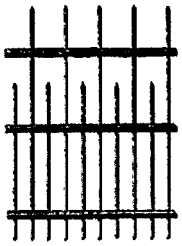
Hairpin & Picket



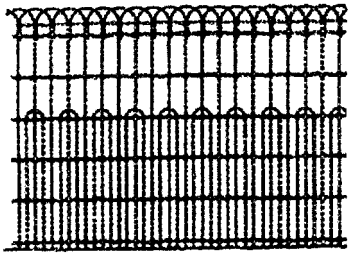
Bow & Picket



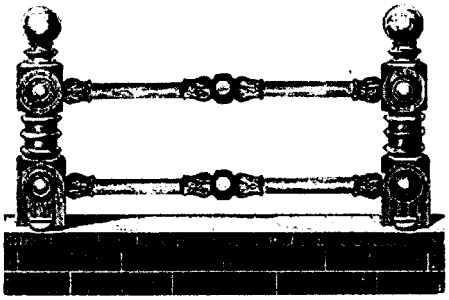
Bow & Hairpin



Milled Point



Woven Wire



Gas Pipe Railing

Drawing used with permission of the Chicora Foundation, Colombia, South Carolina

The above drawings, taken from the Chicora Foundation web site illustrate the most common types of iron fencing. Most of these fences consisted of either two or three wrought iron rails with attached vertical elements in cast iron. "These (fences) are often classified as picket (either beveled or with special picket heads), hairpin, hairpin and picket, bow and picket, and bow and hairpin." Posts were often of three distinct types: line posts, panel, square/solid (usually cast), and open or scroll." (Chicora web site) Pipe fences were common in the early twentieth century. They were less expensive, simple, and durable, and were often used to surround family plots. This type of fencing was fabricated from galvanized pipe with white metal connectors that were usually attached to cement coping. Less common due to its fragility, is the woven fence. While sometimes quite decorative and ornate, it was the least expensive and quickest to corrode. It is also quite susceptible to accidental harm from mowers and other equipment.

Wooden fencing was also used to some extent throughout the state; however, wood deteriorates quickly when left unattended and much of this type of fencing is in poor repair. In the mid-twentieth century chain link fences became common, often as replacements for iron fences.

OTHER BUILDINGS AND STRUCTURES

Chapels, mausoleums, and storage sheds are some of the buildings and structures located within and associated with historic cemeteries. Although worthy of preservation, they are beyond the scope of this manual. Anyone considering repairs and conservation of these elements and structures, other than repointing, should contact appropriate professionals. All structures and their locations should, however, be well documented and noted on any survey form, plan or map prepared for the cemetery.

MAPPING

Mapping is vital to any cemetery plan. Not only does it give a clear picture of existing conditions: a good map will help to document boundary changes over time. The result will be a working document that will be useful in implementing a restoration plan. Before beginning a mapping project gather any existing maps that may already be available.

When preliminary research is completed, it is time to prepare a working map. This is a relatively easy project that can be accomplished using a group of dedicated volunteers. A hand drawn map is the simplest method, and untrained workers can manage this task. The required tools should be gathered before beginning. Little more is needed other than time, a ruler, a pencil, a pad of graph paper, and something to measure with. While a three hundred foot measuring tape should be adequate to the task, an excellent alternative is a measuring wheel, available at home centers or rental companies. The measuring wheel is mounted to a handle and clicks off the measurement as the operator walks behind.

Begin by identifying the parcel using its legal description, making sure that the legal description and the present boundaries coincide. Record on the map. Indicate where changes to these boundaries have occurred over time. Unmarked graves may exist outside of current lines.

Beginning with the accurate boundary map, divide the property into grids. Ten yards by ten yards makes a good workable unit for the grid. Each grid should be represented on a separate piece of graph paper. One approach to mapping these grids is to draw a centerline through the cemetery and draw the grids from this line. If the fence or other perimeter demarcation is adequate, use that edge as a beginning point. Where the size or configuration

of the cemetery renders one base line inadequate, several may be drawn. In using this method take precautions to accurately number and identify grids so that confusion does not arise later.

If a laptop computer is available, there are mapping programs that can be used in the field. See Appendix B for software sources. The advantage of electronic mapping is that it is easy to update. It can also be altered to serve multiple efforts. For example a National Register, state historical marker, or local historic district study committee report will require the inclusion of a sketch map that does not necessarily contain all the information gathered for a working map. Deleting items on an electronically generated map is a simple process. Often communities use GIS mapping and aerial photographs to identify their communities. Maps using these methods can be a valuable starting point. While Global Positioning Satellite (GPS) technology can be used to plot a cemetery map, a unit accurate to six inches to twelve inches or less is required. These units are expensive.

Check with the county or township to see if aerial maps of the cemetery are available.

Cemeteries relatively clear of excessive vegetation can be viewed well from above. Although this sort of accuracy is not necessary, an aerial photograph can be a valuable aid in creating a map.

All maps must include:

- cemetery name
- city, county, township
- north arrow
- date completed
- name of person who created the map
- key

As a guide in preparing a map, the following method is quoted *from Landscapes of Memory; a Guide for Conserving Historic Cemeteries*, published by the Management Board Secretariat Publications, Ontario.

Scale:

Determining the scale of a plan depends upon the size of the cemetery and the number of grave markers to be recorded. The most suitable scales are either one 1/8" = 1' or 1/16" = 1'. Larger scales are better where there are a large number of markers, particularly if they are close together.

Equipment Required:

- Tape measures: Two 100-foot tapes (preferably fiberglass) and one 16-foot hand-held metal tape
- Small hatchet (or hammer and handsaw) for cutting and placing wooden stakes
- A measuring compass
- A hand level: for sloped sites only to keep tapes horizontal for accurate measurement
- Wooden stakes: from 1" x 2" stock, approximately 24 inches long, cut on an angle at one end only
- Nails: 1-1/2"–2" common nails
- Waxed twine
- Cardboard or similar numbering tags (for grave markers)
- Permanent ink felt-tip marker
- Drafting tape
- Drafting paper or film (e.g. Mylar)
- Drafting pencils and sharpener
- Grid (graph paper) paper to use as underlay for sketches
- Drawing surface (e.g. clip-board for small field sketches, or a smooth-faced sheet of plywood)
- Drafting scale

Method

- Select an area free from obstructions.
- Lay down a base line using a 100-foot tape.
- Line up the tape in a straight line and mark the baseline with wooden stakes driven into the ground at even intervals (e.g. every 25 to 30 feet). Subsequent measurements will be greatly simplified if this base line is laid parallel to the majority of the grave markers.
- Attach string to nails driven into the tops of the stakes, to mark the base-line.
- Lay off lines at 90 degrees to this base line, at regular intervals along it (e.g. every 25 to 30 feet). (figure 1)
- Complete the grid by laying off lines at right angles to one another at regular intervals (e.g. 25 to 30 feet), marked by wooden stakes (figure 2)
- Number the wooden stakes, beginning in one corner of the graveyard as shown (figure 3). Mark the numbers on the stakes. Draw the stakes on the graveyard plan, with their numbers. Each square on the grid is identified by the number of the stake. The stake in the lower left-hand corner then identifies each square on the grid.

- Take a compass reading along the base line, and / or measurements from the base line to a permanent feature such as a fence, to record the position of the base-line that was used for the survey.

Measure and Record the Grave Markers and Other Features

Marking the graveyard off with a grid allows different teams to record different squares. Starting at one corner of the cemetery (e.g., A1), record the features in each square, as follows:

- Secure lengths of string along two opposite sides of the grid square, fastened to nails in the top of the wooden grid stakes.
- Lay a measuring tape across the square at 90 degrees to the strings, and at about the same distance along both sides from the grid line. Position the tape as close as practical to a row of grave markers and where it will not touch any markers, bases, fences, etc. Fasten the measuring tape into position on wooden stakes
- Measure the position of the grave markers relative to this tape. Measure along the tape in one direction. Ensure that the hand tape is 90 degrees to the measuring tape on the wooden stakes. Measure to both corners for headstones or footstones, and to all four corners for markers such as box tombs, cairns, or slabs flat on the ground. Also measure the plan dimensions of markers at this time. Show curbstones, walls, fences, trees and other major plantings, as well as grave markers.
- Record the locations and measurements on a sketch plan, drawn in pencil. Show the number of each grave marker. It also helps to show the family name from the marker on this sketch plan, to avoid confusion. Draw the footprint of the marker in the plan. For markers that lie on the ground, the plan view will show the individual shape.

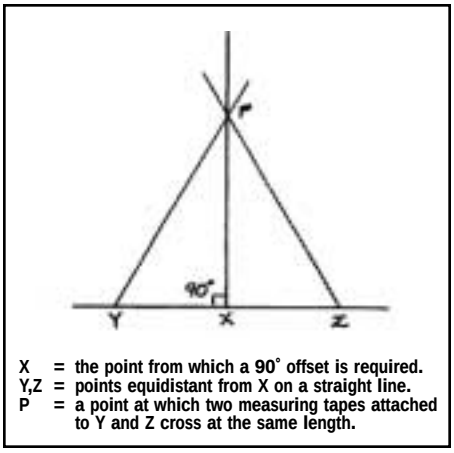


Figure 1: Constructing the Perpendicular. Drawing courtesy of Ontario Ministry of Citizenship, Culture and Recreation.

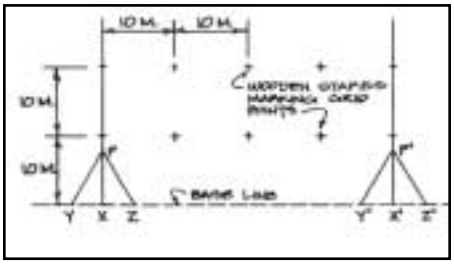


Figure 2: Constructing the Grid. Drawing courtesy of Ontario Ministry of Citizenship, Culture and Recreation.

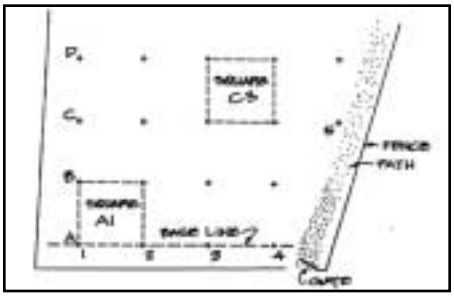


Figure 3: Numbering the Grid. Drawing courtesy of Ontario Ministry of Citizenship, Culture and Recreation.

- Be sure to show the distance of the tape from the grid line–otherwise, the measurements taken do not relate to anything. (*Landscapes of Memory: A Guide for Conserving Historic Cemeteries, Repairing Tombstone*, p. 46-48)

Whether using the above "Ontario Method" or any other to prepare the map, the second step is to identify all the elements of the cemetery. Each marker, ancillary feature, building, and landscape feature, including fencing, signs, family plots, roadways and paths, within the confines of the boundary should be identified on the map. Using the prepared grids, assign each feature a number within the grid, and record it on the map. This number can then be used as that feature's identification number for all survey forms and for referencing a particular item. Include a key with the map that explains the numbering system so that others can readily understand the system. Maps should be generated in such a manner, perhaps using overlays, that adding or deleting items is easily accomplished. For example, being able to remove items such as vegetation, and leaving only markers allows the map to be used for varying purposes. Planning in advance for various uses saves time later on, when the map is used for specific purposes. Using overlays will make it easy to record earlier boundaries and any other changes that may have occurred over time.

IDENTIFYING VOIDS AND VACANT SPACES

A clear picture of the cemetery emerges when the survey and mapping are completed. Often this completed map will show areas where no headstones exist (voids) or where the ground appears to have depressions among existing gravestones. When this is evident, probing (subsurface investigation using specified tools) is called for. See **Probing** below. If probing indicates unmarked graves these too should be identified on the map.

In order to have an accurate survey, it should be determined whether or not voids are actually "vacant" spaces. There are many reasons for open areas in a cemetery:

- A plot may have been purchased and never used
- Headstones may have fallen over and subsequently become overgrown
- Headstones may have been vandalized or stolen
- Some graves may not have been marked with a headstone
- Some plots may not have been sold

The identification of unmarked graves begins with looking for rectangular depressions in the soil that follow the line of existing headstones. Most historic cemetery burials have followed an east to west orientation, which is a reflection of the belief that on judgment day the dead will rise to face the rising sun. Though the east/west orientation is the "norm," it in no way precludes the possibility of a north/south orientation.

Probing

1 2 A simple and economical way to locate a grave without any visible depression is to use a probe. Probing is also an excellent way to locate sunken headstones and headstones that have fallen over (or been broken) and become overgrown. Before beginning to probe ask the local utility companies to mark any electrical or gas lines within the cemetery border. Probing can safely be done by volunteers that have been trained in the practice.

By using a probe like this young volunteer is using, previously broken or covered stones can be found and replaced to their original position.

Plumbing supply stores sell a device called a "smart stick" which is useful for probing. The smart stick is a rod of metal or fiberglass, about three to four feet long, with a handle mounted at one end to form a "T." The rod itself is a one-fourth inch to three-eighths inch dowel. Some commercially available probes have replaceable tips and are available at environmental companies such as Ben Meadows (Appendix B). It is important to remember that the length of the probe should not exceed four feet because older graves are often less than six feet deep and it is necessary to prevent the probe from entering the burial chamber. In addition a probe that is four feet long will afford the greatest "feel." Before beginning, probe marked graves and known open areas in order to tell the difference between undisturbed soil and softer less compacted soil.

When probing for lost stones or graves a methodical approach must be employed. Use the same grid system that was created when mapping the cemetery. Begin probing any suspected voids or depressions in a systematic way, starting at one corner of the grid. Insert the probe into the ground every eight to twelve inches, noting any variances in the resistance. When the probe hits biological material it will produce a duller feel than when contacting a headstone, which produces a higher pitched "tink." Indicate any soft spots with a marking flag, and then continue probing, attempting to delineate the shape of the softer area. Large rectangular shaped areas will often be graves; smaller rectangular areas may be submerged headstones or graves of children. Smaller or rounded areas could be animal burrows or rotted trees. Carefully note the location of newly identified graves or headstones on both the survey form and the cemetery map. Move along one side of the grid and continue probing until all of the area has been investigated.

A more advanced method for locating lost headstones, and one that requires professional training or is done under the direct supervision of a professional, is the use of a Soil Compaction Tester (penetrometer). This device measures the density of the soil. It should be inserted into the ground no more than 6 inches. A gauge or digital readout on the handle indicates the compaction level in psi (pounds per square inch). The shaft has measurements so that one can monitor and record the different changes in compaction levels. As with a probe begin by examining known graves so that the normal density of existing graves is determined. See Appendix C for resources.

A third method of discovering lost graves, requiring professional experts and equipment, is to use ground penetrating radar imagery (GPR). This method is noninvasive and produces a cross sectional profile of subsurface features. It operates by sending pulses of ultra high frequency radio waves into the ground as the GPR unit is pulled over the surface. The radio waves are reflected from various buried objects. The reflected signals return to the GPS unit where they are received by a digital control unit. The signals are plotted on the ground penetrating radar profile as different color bands by the unit. In some instances a three-dimensional image can be made to better define the area where graves are located. Although the cost of a GPR investigation can be expensive, because it requires a trained professional, a great deal of land can be covered in a short period of time. An internet search on "grave locating ground penetrating radar" identifies companies that will perform the survey as well as information on past investigations by agencies such as the National Park Service.

PHOTOGRAPHY

All features in the cemetery, including general views, will need to be photographed. The two types of photographs needed to document a cemetery are:

1. Photographs of individual features such as monuments, plantings, gates, fencing, ponds, roads, and buildings. These features should be depicted with individual photographs that clearly show important details.
2. General views that show how the individual features interrelate in the landscape. Enough views should be taken to give a good sense of the look and feel of the cemetery's significant features.

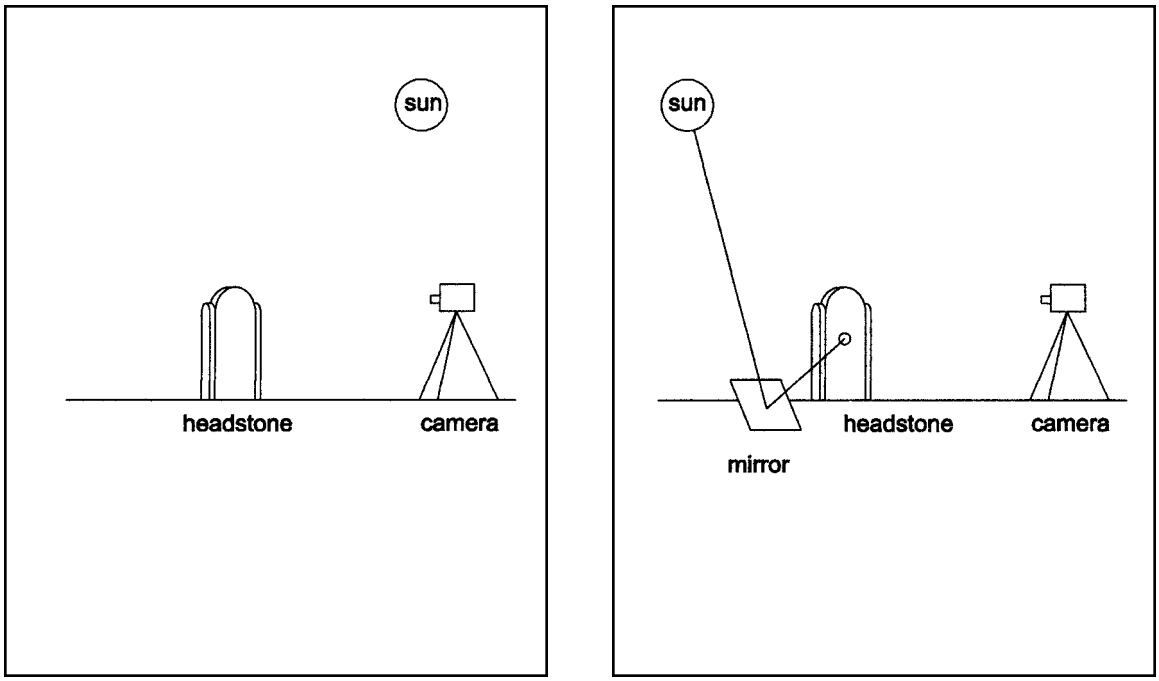
These photographs can be documented on a master survey database and/or inventory form, and number-coordinated with the map.

The National Park Service suggests, "When landscapes are documented in photographs, *registration points* (points of reference) can be set to indicate the precise location and orientation of features. Registration points should correspond to significant forms, features, and spatial relationships within the landscape and its surrounds. The points may also correspond to historic views to illustrate the change in the landscape to date. These locations may also be used as a management tool to document the landscape's evolution, and to ensure that its character-defining features are preserved over time through informed maintenance operations and later treatment and management decisions." (National Park Service Bulletin Number 36, *Protecting Cultural Landscapes*) If the cemetery has been mapped on a grid, photography can be done in sequence using the grid system.

The Association for Gravestone Studies leaflet entitled "Recording Cemetery Data" includes the following suggestions for photographing gravestones such as:

- Know when to photograph. Bright sunlight is best for gravestones. The sun should pass across the face of the stone from side to top at an angle no more than thirty degrees.
- A framed mirror as big as the gravestone can be used when the sun is not bright. Place the mirror in a spot of bright sunlight 100 feet or less from the marker. Try to work with the sunlight behind the stone. Experiment to get the best position. The reflected rays will light up the stone enough to get an accurate photographic record.
- A 1/4 inch piece of plywood painted gray and placed behind the stone will prevent the stone from competing with the background of the cemetery.
- Snow on the ground prevents good photographs.

- Clean the stone with a soft natural-bristle brush and water to remove dirt before you photograph.
- Place a stick with the pointed end facing north on one side of the stone to indicate direction.
- Any camera with a good lens is acceptable. A 35mm camera works well for prints 8"x10" or smaller. Most photographers will find an exposure speed between 1/125 and 1/250 to be adequate. A digital camera also works well. If using a digital camera, have prints made by a professional who uses archival paper.
- Film recommendations include Tri-X (ASA 400 for overcast days and 200 for sunny days) for black and white prints and Ektachrome 200 (ASA 200) for color. Black and white photos are required for a National Register nomination and are more permanent.
- Identify each stone by inserting a numbered marker into the ground beside the stone to be photographed. Renumber the marker for each stone. Do not place the marker on or in front of the stone.
- Tape a coat hanger to a yard stick with some of the wire extending a few inches beyond the length of the yard stick. Put the extended wire in the ground next to the stone so that the yard stick will indicate stone size in the photograph.



Bright direct sunlight is necessary to photograph monuments. Light shining across the marker at a 30° angle produces shadowing that highlights the markings very well. When direct sunlight is difficult to achieve, a mirror can redirect the light to highlight the inscription.

For advice on photographing vegetation, a guide such as the Brooklyn Botanical Garden's handbook, *Garden Photography*, may be helpful.

The photograph should be labeled on the back using a soft lead pencil with the date, identification number assigned to the gravestone or feature (the same number will go on the documentation form), cemetery name, county and township, direction the photographer is facing (i.e. north, south, east, or west), and the photographer's name. Additional information regarding the gravestone, plant, or other artifact can go on the individual documentation form. Sample documentation forms can be found in Appendix A.

If you are interested in nominating the cemetery to the National Register of Historic Places, there are special photography requirements for the application. See p. 63 of National Register Bulletin 16A: "Guidelines for Completing National Register of Historic Places" form. The National Park Service also publishes a bulletin entitled "How to Improve the Quality of Photographs for the National Register Nomination."

The survey product

When the survey and map are completed they should be duplicated and stored in several locations in the area. The local historical museum, historical society, and library are all appropriate places for this documentation. Send one copy of the information to the State Historic Preservation Office and another to the Association for Gravestone Studies where it will be stored in their databases and be accessible nationwide.

Mapping, photography, and transcribed records will form the foundation for a cemetery conservation and maintenance plan. In case of theft, vandalism, accident, or as the result of damaging acts of nature, a detailed record will exist for reference. Continuing to update this documentation with any changes will facilitate future efforts.

Chapter 3

CONSERVATION OF THE CEMETERY

In cemetery conservation there are four major areas to be addressed: landscape, gravestones, ancillary features, and buildings and structures. This manual is intended to provide a guide to conservation of all elements except buildings and structures, which are beyond the scope of this manual. Using the analysis already prepared, set goals to prioritize conservation efforts. Initial stabilization of all areas should be accomplished before any conservation measures are undertaken. Keep in mind these principals:

- Do no harm
- All actions should respect the original fabric of the cemetery
- Use the gentlest and least invasive means possible
- Attempt to do that which can be reversed
- Quick or easy fixes may not always be a reasonable choice
- When in doubt, consult a professional

LANDSCAPE FEATURES

1 2 Look at the landscape to determine its character. In Canton Township and much of southern Michigan, settlement era cemeteries date from the early 1800s to around 1850. Some were the burial ground of extended families and most were sparsely planted and were surrounded by open fields. In the later part of the nineteenth century cemeteries took on a Victorian image with more plantings from that era. Some were associated with ethnic or religious groups. Previous research will shed light on the historic period of the burial ground and which plants are appropriate for that timeframe. This information can be used to make a conservation plan. If the cemetery consists of separate sections added over time, the landscape conservator can preserve each area accordingly. Landscape conservation planning can be difficult because, unlike other cultural artifacts in the cemetery, the vegetation is always changing.

2 One of the first conservation measures is to stabilize and protect plant material and topography, such as an eroded slope or fragile earthwork. If areas of the lawn need reseeding use a low maintenance slow growing, drought resistant seed mix. See the Lawn Maintenance section for a complete listing of grass seed suggestions for both shade and sun. Planting a ground cover is a way to stabilize an area where erosion has washed away the turf or where the slope is such that mowing is difficult. Using a ground cover planting taken from elsewhere in the cemetery is preferred. If there is none, use a compatible plant from the same historic period. For example, for the period of the late nineteenth century, moss phlox (P.subulata), dwarf dianthus (D. chinensis), periwinkle (V.minor and V.major) or lily of the valley would be appropriate choices.

In the National Trust publication, *Preservation of Historic Burial Grounds*, Lynette Strangstad recommends moving monuments slightly (documenting the change) to accommodate significant plants and trees when roots disrupt the grave site. In some cases it is best to remove the vegetation. Base your decision on the plant and the historic significance of the marker, the damage that may be caused by moving either one, or how extensively one intrudes upon the other.

Minimal mowing is historically accurate and to a certain extent helps prevent damage to markers and plants. When community standards do not allow longer grass, installation of historically accurate ground covers can be an alternative. Irrigation systems are not historically correct and may be likely to cause water damage to the stones. Volunteer species should be removed regularly, including volunteer trees and bushes.

Here are some tips suggested by Scott Kunst, historic plant expert and owner of Old House Gardens in Ann Arbor, Michigan:

- Start by educating yourself about historic plants and their importance in the cultural landscape.
- Use weed whips and herbicides carefully and only when necessary. Make sure cemetery cleanups are done judiciously and do not eradicate historic plants.
- If plants need to be moved, only move them a short distance if possible, or move the marker instead — but only as a last resort.
- Propagate historic plants by saving seeds or taking a cutting.
- Avoid using new plants on historic burial grounds, but if this is allowed, be sure to document both plant name and location.

Pathways and Roads

The preservation and maintenance of pathways and road is important in maintaining the historic design of the cemetery. Early nineteenth century burial sites typically had paths of dirt, gravel, cinder, or stone dust. Later in the century brick, concrete, and macadam were used. When conserving roads and pathways, consideration should be given to historic appropriateness as well as cost and maintenance. In the *Preservation of Historic Burying Grounds* Strangstad says:

> Such preservation includes maintaining existing widths and contours, small triangles or small circles often found at intersections, and the original paving surfaces. Brick gutters should be maintained rather than ignored or eliminated. Introduction of asphalt for the convenience of modern vehicles seriously alters the site and erodes its integrity. To preserve certain existing roadways, traffic can sometimes be limited to pedestrians only. Replacement of original crushed stone or early brick with new brick pavers or other paving materials likewise compromises the site. If brick was the original material, roads or paths should be resurfaced with as much of the original brick as possible and reproduction brick that match the original in color, size, texture, and strength. When a custom-made brick is required, restoration brick firms generally have little difficulty in producing good replica brick. (Strangstad, p. 20-21)

Ancillary Features (metalwork, gates, signage, family enclosures, walls and fencing)

Metalwork, including wrought iron, cast iron and zinc (often referred to as white bronze) is frequently found as an ornamental element in cemeteries, and to a lesser extent in grave markers and monuments. The care and maintenance of these materials is an important

part of any conservation and maintenance plan for an historic cemetery. Special care and treatment is required if good preservation practices are to be followed.

Due to environmental concerns and the hazardous materials required, very little can be accomplished in the field or by unskilled volunteers and untrained workers. There are varying opinions, even among the experts, as to which is the best cleaning and repair methods for historic metals. As it is most likely that any but minor cleaning and repairs will require an experienced professional, the following section discusses several methods and techniques in order that an informed selection of a professional is possible. The preferred methods will be discussed first, followed by others that may be useful in particular situations. Talk with a professional and be comfortable with his or her recommendations before contracting any work. Be sure that the contractor shows an understanding of the need to treat historic materials with care. Remember that quick and easy fixes will most likely result in a solution that is short-lived at the best, and at the worst will cause damage to the historic element. The discussion does not include metals such as aluminum or tin as they are seldom encountered in historic cemeteries. Historic bronze requires professional treatment and a professional should always be consulted when dealing with this metal.

Several sources are available that thoroughly discuss preservation methods for historic metalwork, *Caring for Iron Fencing* (Saving Graves web site), *St. Louis Cemetery No. 1 Metalwork Protective Coatings* (University of Pennsylvania web site), *U.S. General Services Administration (GSA): Historic Preservation Technical* Briefs numbers 05010-13, 05010-01, 0700-03, 05523-01, 05010-11, and 05010-04 (GSA website), and *Preservation Briefs 27 and 28* available through the National Parks (NPS) Service website.

METALWORK

Cast and Wrought Iron

The metal most likely to be encountered in Michigan cemeteries is wrought or cast iron. For an understanding of this metal, its use and maintenance, a good beginning point is the National Park Service (NPS) *Preservation Brief Number 27*. It is intended for extensive restoration projects like building façades, but the methods and the considerations are the same for smaller elements such as fencing and decorative work. NPS *Preservation Brief 27* begins by defining cast iron and explaining how it differs in composition from wrought iron.

> Cast iron is an alloy with a high carbon content (at least1.7% and usually 3.0 to 3.7%) that makes it more resistant to corrosion than either wrought iron or steel. In addition to carbon, cast iron contains varying amounts of silicon, sulfur, manganese, and phosphorus.

Molten iron for casting is easily poured into molds, which allows for a broad scope of both decorative and structural objects to be cast. When cooled it becomes a hard, brittle, but strong metal that cannot be worked by hammering (poor tensile strength). It does not buckle easily and therefore was used in building construction where it could support great weight loads (strong compression strength). But it is cast iron's ability to be molded that has produced much of the ornamental fencing, gates and other decorative items found in cemeteries.

Wrought iron, on the other hand, "is relatively soft, malleable, tough and readily worked by forging, bending and drawing." It is much lower in carbon content, usually considerably less than one percent.

When looking at ironwork objects there are several clues to look for that will help to determine which metal it might be.

Cast iron elements are:

- complex in form
- can be very large
- uniform in appearance
- may show mold lines
- may have flashing, casting flaws, and air holes
- frequently repetitive in design (fence sections)
- pieces often bolted or screwed together.
- tends to have a sand-like finish

Wrought iron elements are:

- one of a kind hand-worked
- show hammer or rolling marks
- softer and malleable
- simpler in form and detail
- tend to be smaller objects

Condition Assessment:

Having verified the presence of cast iron elements in the preliminary survey of a cemetery, and before repairs are attempted, a thorough assessment of the type and extent of damage is paramount. NPS *Preservation Brief 27* indicates that in order "to thoroughly access the condition of the ironwork, a close physical inspection must be undertaken of every section of the iron construction including bolts, fasteners and brackets." When performing

an assessment of the condition of historic ironwork keep in mind that most work undertaken will require professionals since hazardous materials are found both in the original finishes and in the chemicals needed to properly clean iron before repainting. These materials are harmful to both the worker and to the environment.

Light brushing and repainting are often the only tasks that can be undertaken in the field. More often iron elements will have to be removed then repaired and recoated in the shop. When disassembling fencing be sure that each piece is marked so that the reassembly process can be done in the reverse order. Where items are to be removed and stored while awaiting repair, proper storage, away from dampness and potential damage is required. Leaving gates or fence sections leaning in a corner of the cemetery awaiting conservation invites problems with exposure to the elements, thieves and vandals.

Deterioration

Although cast iron and wrought iron are two distinct metals, they have problems in common and these problems often share a common solution. The most common problems found in historic ironwork are

- Oxidation (rust, corrosion)
- Missing elements
- Impact damage
- Structural failure
- Broken joints
- Damage to connections
- Loss of anchorage in masonry

Moisture is the number one enemy of damaged, poorly maintained, or untreated ironwork. Moisture, when allowed to penetrate a protective coating, or allowed to pool around elements, will soon take its toll. Once the metal has been allowed to go unpainted, or has been damaged, moisture begins the corrosive procedure and must be properly abated or rust will soon completely destroy the metal.

Corrosion

All iron is susceptible to two main types of corrosive damage, oxidation and galvanic corrosion. The more familiar is oxidation or rust. It occurs when unprotected metal comes into contact with the oxygen in the air and with moisture from rain, fog, dew, and other sources. Other airborne elements such as carbon dioxide, soot, and sulfur compounds will hasten the process.

Oxidation/Rust

The typical deterioration or corrosion process for cast iron is a one-step, straight line process of **oxidation** (or rusting) which begins upon exposure to air and moisture and will continue (unless interrupted) until the metal is gone.

> Rust (ferrous oxide) is an orange colored surface coating, ranging in texture from scaly to powdery. It is loosely bound and the outer layers will usually come off when rubbed by hand or brushed against. It is not a deposit on the surface and the presence of rust indicates that some of the original iron material has been converted to iron oxide and irreversibly lost from the cast iron piece. (U.S. General Services Administration. Historic Preservation Technical Procedures #05010-04, *Cast Iron: Characteristics, Uses and Problems*)

A careful assessment of the iron element will determine if the rust is present on the surface or if seepage into cracks and air holes has done considerable sub-surface damage.

Galvanic or electro-chemical corrosion occurs when two differing metals come into contact with one another and an electrolyte, such as water containing salts or hydrogen ions. Because of their chemical differences, metals such as copper, lead, and wrought iron can cause a galvanic reaction with cast iron. In this type of corrosion the carbon present in the cast iron combines with the other metal and the iron is dissolved as rust. Galvanic corrosion severely alters the strength of cast iron. For both types of corrosion the prevention is the same, protection from moisture with a sealing coating.

Graphitization, although less common, is another type of deterioration seen on cast iron. It occurs when the metal is left unpainted for long periods of time and acidic rainwater is allowed to penetrate joints. It can be tested for by carefully scraping the surface to reveal the crumbling of the iron beneath. If the damage is extensive the only recourse is to replace the effected parts.

Other damage

Since cast iron is brittle, breakage from vandalism, accidents, or neglect is also of a concern. Fencing along busy roads is susceptible to damage from automobile accidents as well as salt or other deicing agents. All of these will lead to damage of the protective coat allowing moisture to penetrate and corrosion to begin.

Cleaning and Paint Removal:

Keep in mind that "Before undertaking any project involving paint removal, applicable state and federal laws on lead paint abatement and disposal must be taken into account and carefully followed. State and Federal requirements may affect options available to owners on both paint removal and repainting." (NPS *Preservation Brief 28*) These restrictions will most likely preclude doing any but the most minimal fieldwork. Be sure when choosing a professional that they have experience with historic resources. The Michigan Historic Preservation Network Construction Trades Council can provide information on experienced contractors.

1 If the condition assessment indicates that damage is **minimal**, hand brushing with a stiff brush may be all that is required and unskilled workers may be able to help with cleaning. Whatever cleaning is undertaken remember to begin with the gentlest means possible. This should always be a first option when working with historic resources. Care should be taken not to damage decorative work. Be thorough, if all rust is not removed and the metal quickly sealed the corrosive process will continue and further deteriorate the metal.

2 3 Restoring historic ironwork, however, will most often require cleaning to the bare metal, removing old paint and corrosion and then sealing and recoating. There are several methods that can be employed. Although they will require skilled workmen or professional curators it is worthwhile to become familiar with the techniques and recommendations. Doing so will help in choosing the proper professional for the job and will help insure that the work performed is satisfactory and will not harm the artifact.

Techniques that can be employed include, (simplest and least expensive)

- Hand scraping, wire brushing and chipping
- Rust conversion (with caution)

Extensive hand scrapping, wire brushing and chipping require craftsmen **(level 2)** in order to protect the metal from scoring and other damage. They are indicated for light rust only since they do not remove rust and paint as effectively as other methods.

> *Note:* The removal of heavy rust, scaling, or corrosion should be left to a trained professional **(level 3)**.

A reasonable and **preferred** alternative to hand removal is the use of a rust converter. This method is recommended in that it removes the least amount of the original fabric from an object and it is considerably less labor intensive than hand removal. The process involves

removing a minimal amount of rust by hand and then applying the converter much like applying paint. A rust converter stabilizes by converting rust into a more stable chemical that when cured, accepts paint well. The use of a converter also assures the user that even tiny cracks and pits are sealed. This is not the case with hand rust removal. After the converter is applied and allowed to cure, two coats of appropriate top-coat should be applied. (See Appendix for sources)

The following treatments are more complex and expensive and can do more damage to historic material. Therefore they are not recommended and should only be used as a last resort when gentler cleaning methods have failed.

- Low pressure grit blasting
- Flame cleaning
- Chemical rust removal

Some conservators do not recommend abrasive or chemical cleaning under any circumstances. The Secretary of the Interior's Standards for Rehabilitation states, "Chemical or physical treatments such as sandblasting that cause damage to the historic materials **shall not be used**. The surface cleaning of structures, if appropriate, shall be taken using the gentlest means possible." According to the Chicora Foundation, the use of abrasives will remove the mill scale, an oily coating, on the metal that serves as a natural protective agent. If however, abrasives are the only alternative a soft abrasive such as ground shell should be used at a low psi of sixty to seventy pounds with a working distance of at least twelve inches. Any type of grit blasting can damage stone or brick, potentially causing damage to nearby gravestones. This must be taken into consideration, as well as the amount of dust generated, before a decision is made to use this method in the field.

Flame cleaning always requires skilled workers. It is an expensive and dangerous treatment that uses an oxyacetylene torch.

Chemical treatments are seldom appropriate. Articles that receive this treatment must be scrupulously cleaned. If not, chemicals left on the surface can seep into crevices and cause damage. If the surface is not completely cleaned the remaining chemicals can interact with the newly painted surface causing it to fail.

Beyond surface cleaning few repairs are suitable for those untrained in the practice. The following list of common repairs and accepted methods will help in the decision as to whether to contract the aid of a professional.

- **Repairing internal areas of balustrades, statues, and other features.** It is **never** recommended to fill cast iron cavities with concrete. Concrete shrinks as it cures leaving a gap that allows moisture to come into contact with the metal. It also does not dry quickly leading to the chance of prolonged moisture contact that will cause corrosion.
- **Repairs requiring welding.** Wrought iron is easy to weld because of its low carbon content. Cast iron tends to melt at a low temperature and should not be welded using modern techniques. Modern welding applies extreme heat over a small area. Cast iron is rigid and when one area is heated the surrounding unheated areas resist and crack. Spot welding produces pitted areas where water can collect and contribute to the corrosive process. Spot welding is **not recommended**. All welds should be continuous and when finished almost invisible.
- **Brazing** (soldering with a metal having a low melting point, especially a nickel alloy) is a suitable alternative to welding and a professional should evaluate the fixture and make the decision.
- **Replacing screws, nuts and bolts.** Replacement should always be with a high quality stainless steel. Screws, nuts and bolts should be coated with the same material as used on the rest of the feature. Where new holes are needed they should be drilled slightly larger in diameter to allow for contraction and expansion.
- **Joining elements** (such as sections of fencing). Slip joints (slotted holes) should be used between connecting rails and embedded elements in fencing so as to allow lateral movement during expansion and contraction in extreme temperatures.
- **Sealing joints.** After cleaning, joints need to be sealed to prevent moisture penetration. A product such as *Silkaflex 1a* or another polyurethane based elastomeric sealant is appropriate.
- **Cleaning.** Lightly soiled cast and wrought iron can be cleaned with water under low pressure. **(Level 1)**
- When more intensive cleaning is required, only a non-ionic cleaner should be used. First test the painted surface to be sure it will hold up under the products application. Non ionic cleansers are available at conservator supply and photographic supply stores. Dilution guidelines are identified later in this chapter, and specific storage and mixing instructions are provided by the manufacturer. Proper precautions must be followed when using these cleaners. If possible it is best is to remove the ironwork and to clean it off-site.

If all cleaning efforts fail and the wrought or cast iron feature must be replaced, then professional help is required. Asking the following questions will aid in choosing a professional to assist in the work:

- Do you propose to do the work on-site or remove and repair the elements off site?
- What products and methods do you propose to use in cleaning the metal?
- Will you hand clean or do you propose to use a rust converter?
- How will you perform repairs?
- If welding is required what method do you propose to use and how will you eliminate the chances of cracking the original metal?
- What type of coatings will you be using and how will they be applied? Hand application as opposed to spray application is recommended to allow for more thorough coverage.
- Does the professional have experience with historic resources?

Painting and Coating Systems

Rust is the main cause of deterioration of both cast and wrought iron. Although rust cannot be prevented its return can be delayed with proper surface preparation, caulking and paint. A good coat of paint is the best protection for historic ironwork. The following paragraphs summarize the appropriate preparation of surfaces and the proper application of a protective coat of paint. Experience has shown that in Michigan paint should be applied every three to six years. This recommendation is based on the incidence of rust encountered during routine maintenance.

Initially evaluate the problem by determining what is causing the corrosion. Especially vulnerable to water seepage are areas where elements of ironwork are joined. Where water is drawn into joints by capillary action, corrosion can become severe.

Galvanic corrosion becomes a problem where cast iron and wrought iron come into contact. This is noticeable where, for example, a cast iron rail is placed atop a wrought iron connector. The difference in composition of the two metals causes the cast iron to be pushed up and to split from the chemical interaction of the two metals.

> Simply sealing this joint doesn't eliminate the problem . . . it only seals in the moisture and corrosion continues unabated. It is necessary to stabilize (and often) remove the corrosion . . . only then can the joint be sealed (red lead putty was originally used, but today, a clear silicone sealant is usually more practical). (*Cemetery Ironwork*, Chicora Foundation web site)

Secondly, it is necessary to seal the metal with a rust inhibiting primer as soon as possible after the surface has been cleaned and repairs have been made. Two coats should be applied per the manufacture's specifications. One coat will not sufficiently seal the surface to prevent recurrent corrosion. When applying paint, multiple thin coats are preferable to one thick coating. Thicker paint coats are more likely to fail than thinner coats and the excessive paint will likely conceal intricate patterns in the ironwork.

For paint to properly adhere to the surface it should be applied within the following temperature and humidity parameters. At the time of application the temperature should not exceed 80 degrees Fahrenheit, nor should it be expected to fall below 50 degrees Fahrenheit for the next 24 hours and the humidity should be less than 80 percent. Additionally, rain or moisture should not be in contact with the surface for at least 24 hours. In Michigan, this will often require removal of the elements to an indoor location for proper recoating. Refer to manufacturer's specifications.

Historical accuracy is important in choosing both the color and the finish of paint to be used. Not only should paint be applied with a brush to ensure a solid bond with the metal, it is inconsistent with historical accuracy to apply a sprayed or rolled finish. Historically cast iron was painted a flat black. Semi-gloss or gloss finishes would be inappropriate.

While in the past lead based paint was the norm, today because of health and environmental concerns it is only available in commercial and industrial grade paint. Because they cause immediate oxidization when they come into contact with bare metal, latex-based products should not be considered. Alkyd based paints and primers are the present recommended choice.

Replacement

If damage is excessive or an extensive amount of elements (such as fencing sections) are missing, replacements should be considered. The mixing of old with new elements is often not advisable because the composition of new metals could lead to *galvanic corrosion*. If total

replacement is being considered every attempt to follow the Secretary of the Interior's Standards and Rehabilitation Guidelines are encouraged. Old photographs and other documented records should be used to find or create a historically correct replacement. The list of resources in Appendix B offers the names of some companies that can supply historically accurate, reproduction ironwork. Sometimes molds for casting new fencing can be made from old fence elements. If the property never had an ironwork fence, consider a material or design that does not impart a sense of inaccurate history.

Zinc

Because of the unique character of this metal, repairs should only be done by trained professionals. Zinc is a nonmagnetic, brittle, bluish-gray metal that is heavier than iron but not as heavy as lead. It is quite resistant to corrosion even when untreated, and was used for monuments and statues in historic cemeteries.

There are three main types of damage to zinc monuments: breakage, corrosion and a phenomenon called *creep*. Other than simple painting, treatments of all three types of damage require a professional conservator (such as Architectural Iron in Milford, Pennsylvania; Karkadoulias Bronze Art in Cincinnati, Ohio) and are extremely expensive.

Due to zinc's brittle characteristic, breakage and separation at the seams is the most notable type of damage. Such common occurrences as falling branches, careless mowing and vandalism can damage the metal. Successful methods of repairing breakage are soldering or other repair techniques such as the use of epoxy or polyester resins.

Zinc monuments were cast from almost pure metal and the joining material was also zinc. After the castings were removed from the molds, the panels were sealed by pouring super-heated zinc onto the seams. The molten metal would soften the edges of the cast piece, thus forming a tight seal.

Zinc monuments, because of their unique characteristics, have deteriorated very little over time.

Because of its innate characteristics, zinc, even when unpainted, is not as susceptible to corrosion as cast iron. Over time it develops a patina of zinc carbonate, which protects the surface and gives it its characteristic bluish-gray cast. Bare zinc holds up well and should be left untreated. Sometimes zinc was painted, bronzed, or coated with copper. Painting and re-bronzing for statues that originally had these coatings is the suggested protection. Pitting can occur where zinc was originally coated in copper and left exposed to the weather. Repair of any corrosion problems of coated zinc, if severe, is a task for professionals.

An unusual characteristic of zinc is a tendency to sag where the underlying support system is inadequate. It is subject to deformation as it slowly sags under its own weight. This is called *creep* and can be disastrous for the monument causing the panels to split and / or the metal to sag and spread at the base. Attempts have been made to repair statues by filling their hollow core with concrete. The results have been ruinous. The expansion of the fill material causes the monument to split at the seams causing irreparable damage. This method should never be employed. The suggested repair method requires shoring up the structure with stainless steel support mechanisms that should be installed by professional conservators. Two excellent sources for information on this metal are briefs by the Association for Gravestone Studies and the Smithsonian Center for Materials Research and Education.

IDENTIFYING MONUMENT AND HEADSTONE MATERIAL

Before any headstone is cleaned or repaired it is important to know what type of material it is. The most common material for monuments in Michigan cemeteries is stone: usually granite, sandstone, limestone, or marble. Monuments of iron, concrete, zinc, and even wood are found to a lesser extent in Michigan cemeteries. An unusual example is the wood markers found in Emmett County's Middle Village Cemetery.

Below is a brief discussion of some of the most common monument materials found in Michigan. The following information on granite, sandstone, limestone and marble is from *Landscapes of Memory: A Guide for Conserving Historic Cemeteries, Repairing Tombstones*, published by Management Board Secretariat Publications Ontario and the GSA Technical Procedures website.

Sandstone

Sandstone is a medium-grained sedimentary rock made up primarily of quartz grains and cemented by a variety of binding agents (silica, calcite, or iron oxide). It is porous, soft and easily worked; with the strength depending upon the binders. Sandstone was used for monuments, but not commonly.

Sandstone is typically buff, gray, brown, red, purple, or pink in color (the latter four colors are commonly called brownstone) (General Service Administration, #04470-01). Some nearby sources of sandstone were: Medina varieties in southern Ontario (red-brown, gray or mottled); Ohio sandstone from the Berea beds south of Cleveland (light gray or buff); Ohio Briar Hill sandstone (variegated rusty color); and Michigan Lake Superior sandstone (red).

Sandstone weathers best when its end-grain faces the weather (ie, naturally-bedded). "In many nineteenth century applications however, the grain was placed parallel to the weather-side (face-bedded) for aesthetic reasons." Spalling, which is the separation and breaking away of layers or small pieces of stone; is exacerbated by the freeze-thaw cycle, and is especially common where sulfur pollution is involved (General Service Administration, #04470-01).

Limestone

Limestone is also a sedimentary stone composed principally of calcium carbonate (calcite) or calcium and magnesium (dolomite). The majority of the limestone used in Michigan was formed in a shallow sea that covered the Midwest more than 300 million years ago. It is not uncommon to see calcite streaks, fossils, or shell formations in the stone.

Limestone varies greatly in texture and porosity. It is usually white, gray, or buff in color. Under normal conditions it weathers to a light silver gray or white depending on the stone variety, but is usually darker in color than the bright white of marble. Limestone, unlike marble, does not take a polish well and therefore has a matte appearance. (General Service Administration, Limestone: Characteristics, uses and problems 04460-01) As with sandstone and marble, pollution causes significant deterioration. Breaks and cracking often occur along the bedding planes.

The Woodmen of the World organization, an agency that sold life insurance, began in the late nineteenth century. It provided plans to local carvers for member's monuments. They were originally carved limestone in the shape of tree trunks. The book *Your Guide to Cemetery Research* states that carvers preferred limestone from Bedford, Indiana, for these markers, because it was easiest to re-create the look of tree trunks. The markers are not an uncommon sight in Michigan.

Marble

Marble is a hard metamorphic stone composed of calcium carbonate. It is formed as a result of the recrystallization of limestone under the intense pressure of geologic processes.

The limited porosity of marble makes it less vulnerable to the leaching effects of water. However, it is very susceptible to damage from acidic agents. Marble can be of two types: calcite or dolomite. Dolomitic marble is much more resistant to acid damage than calcite marble. The color of marble ranges from the brilliant white of calcite to black, blue-gray, red, yellow and green, depending on the mineral composition. (General Service Administration #04455-01)

Marble used in tablets and other monuments in cemeteries is typically the brilliant white calcite type. Common problems with marble are dissolution by acid rain, and sugaring. Sugaring is a gradual disintegration of the surface of the marble, causing a rough granular, crystalline or sometimes powdery appearance. (General Service Administration #04455-01) Marble, when exposed to pollution containing sulfuric acid can have its surface converted to gypsum. This gypsum when combined with other elements forms a black crust that ultimately blisters and crumbles away the surface of the stone.

Marble was predominantly used for headstones in the 1880s and 1890s. In order to properly restore or repair marble it is important to appreciate the differences among the many varieties. Much of the marble used in Michigan's cemeteries was quarried in Vermont, for example Vermont blue marble. According to the American Standards for Testing Materials (ASTM) "marble possesses an interlocking texture and a range of grain size from cryptocrystalline to 5mm. All marble as defined here must be capable of *taking a polish*." Using this definition, a limestone such as "Tennessee Marble" (which is actually limestone) may in some instances be considered a marble.

Granite

Granite is a coarse-grained igneous rock which is composed chiefly of quartz, feldspar, orthoclase or microcline, and mica. Depending upon the mineral content, granite may range in color from light pink and gray, to red, brown and black. There are three distinct types of granite: fine grained, medium, and coarse-grained. This very hard stone was introduced into cemeteries only after the 1870s, when improvements occurred in quarrying and carving technology. Granite takes a polishing well and is relatively acid resistant. Granite is one of the most durable stones for architectural and artistic purposes.

Concrete

Concrete is distinguished by its ability to be molded into an infinite variety of shapes, as well as the potential for a wide variety of surface textures, depending on the finishing techniques and the aggregate used. Markers were often finished to resemble limestone. Concrete is gray or white unless artificially colored. Its hardness and strength when cured

depends on the mix – the proportions of Portland cement, sand, and aggregate (gravel or stone) mixed with water. Concrete is much less expensive than natural stone.

A good example of the use of concrete is the intricately shaped "tree stump" markers. Concrete's ability to be molded simplified the process compared to the much more labor-intensive process of carving limestone. The molding could be very detailed, including the bark and some limbs. Once a master form had been created, the marker could be reproduced in concrete with a minimum of additional effort.

In the late nineteenth century molded concrete tree stump markers were fairly common. Concrete was also used for small markers in Potter Fields and for table and box tombs.

Zinc (white bronze)

Zinc (white bronze) is a bluish-gray nonmagnetic, metallic element that is generally brittle but can be worked when heated. The metal is heavier than iron, but much lighter than lead. Often zinc was used for tall, commemorative monuments, though smaller markers such as tablets and ground markers were also available. The monuments are hollow and retain much of their original definition. Although durable and inexpensive, these markers came to be perceived by many as "cheap and faddish." *(Massachusetts Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries,* p. 37*)*

Zinc markers were often tall monuments such as the obelisk on the left. Tablet markers as tall as 3 feet can be found as well as smaller 1-foot markers (next page) such as these found in Newburgh Cemetery.

One-foot zinc tablet headstone.

Ground markers made of zinc, though rare, can still be found.

Small iron medallions placed beside the grave often indicated the deceased's affiliation with particular groups.

Iron

Some historic Michigan cemeteries have iron monuments or crosses. Many cemeteries also contain small iron medallions placed beside the gravestone, which indicates the deceased's affiliation with fraternal or military associations.

CLEANING HEADSTONES AND MONUMENTS

In planning for a cemetery's conservation, the care and maintenance of headstones is extremely important. It must first be decided whether or not to clean the monument. Do not attempt to return the stone to its original brightness, which would involve removing all patina.

> Often people mistake the patina of age for *dirt*. They want marble stones, for example, to be as white as when originally purchased – and this is a tragic mistake. Not only does such aggressive cleaning cause irreparable damage, but it destroys the stone's patina – and history – making it look like the stone was placed in the cemetery only yesterday. (Chicora Foundation web site)

A monument that is located in constant shade may be prone to biological growth. Cleaning the monument may remove the growth, but it will soon return, thus starting a cycle of frequent cleaning. Each cleaning has the potential to harm the stone and therefore it may be better not to start the cleaning process. (Chicora web site)

Certain plants and biological growth have the potential to harm a headstone and thus should be removed. This section of the manual provides information on the type of damage inflicted on headstones. It will also provide information on the appropriate technique, equipment and agents for cleaning monuments.

Damage to headstones falls into three classifications:

1. Environmental:
   - carbon-based deposits from industrial and vehicle emissions
   - improper cleaning and / or repair methods
   - air pollution / acid rain

2. Natural sources:
   - aging and weathering of stone
   - settling of the stone
   - organic growths, including lichen, algae, and fungi
   - climbing plants and vines

3. Human-inflicted:
   - neglect
   - vandalism
   - improper use of maintenance equipment such as mowers and weed whackers

All three types of damage will most likely be encountered. The following guidelines will help in determining what can and should be done. Some of the tasks require an experienced conservator and should be handled accordingly. Before beginning any cleaning program, become familiar with the following important principles. These principles have been compiled from a variety of sources such as *Grave Concerns, A Preservation Manual for Historic Cemeteries in Arkansas; Landscapes of Memories: A Guide for Conserving Historic Cemeteries, Repairing Tombstones;* the Chicora Foundation, and the National Center for Preservation Training and Technology.

Before you begin:

- A condition survey should be completed on the stone prior to cleaning. Photograph the stone before starting, and again when the cleaning is complete and the stone is dry.
- Keep a record of the cleaning date, the methods and chemicals used, and any immediate change that was noted. Photography is also recommended to record the critical cleaning steps and results. These records should be stored with other cemetery documentation.

Cleaning parameters:

- Do not attempt to return the stone to its original brightness, which would involve removing all patina.
- Do not clean any stone if there is a possibility of freezing temperatures within the next seventy-two hours.
- When possible, clean stones on a cool, overcast day so that evaporation and drying will occur more slowly.
- Limit cleaning of stones to not more than once every four to six years. Cleaning may result in some wearing away of the surface of the stone.

Guidelines for Cleaning Monuments:

1. Evaluate the general condition of the monument. Only a sound stone should be cleaned. Carefully sound (gently tapping the surface with a knuckle) the stone to determine if there are any underlying hollow areas, as evidenced by a hollow tone. If hollow areas are detected, do not continue with cleaning or handling; an experienced conservator should be consulted.

2. Do not attempt to clean the monument if any cracks, flaking or scaling, or eroding granular surfaces are present. Again, any attempt to clean a stone that is less than fully stable should be left to an experienced conservator.

3. **Determine the type of soiling** in order to select the most effective manner of removal. Types of soiling include:
   - carbon or soot
   - ordinary dirt
   - organic (algae, fungi, lichens, mosses)
   - climbing plants
   - efflorescence (salts)

4. **Always start with the gentlest effective method for cleaning headstones.** Often a simple rinse with water and a natural bristle brush is all that is needed. If rinsing with water is not sufficient, carefully proceed with a recommended cleaning agent.

5. **Test the entire cleaning process in an inconspicuous area** on the monument before applying it to the total monument. Allow to dry for several days and check for adverse reaction.

6. **A good supply of water is <u>mandatory</u> when cleaning stones, and when using any type of cleaning agent.** Running water from a garden-type hose is preferred, but spray bottles will suffice for small jobs. Clean, *unused* garden sprayers that hold one gallon or more of water are convenient.

   **Note: Potable water is the ideal (but not absolutely necessary) because this implies that the water is free from objectionable amounts of chemical, minerals and impurities which could possibly harm the headstones. (John Spaulding, AGS Research Clearinghouse Coordinator)*

7. **Do not allow cleaning solutions to dry on a monument.** Keep the agent wet during the cleaning process. If allowed to dry, residue from chemical cleaning solutions can create a blotchy appearance, provide a medium for future bacterial action, resulting in more staining and accelerated deterioration.

8. **A cleaning procedure that is recommended for one specific application is not applicable for all situations.**

Equipment needed for cleaning monuments:

- A variety of sizes and shapes of high quality natural bristle brushes. Use only brushes without dyes in the bristle. A variety of sizes and bristle stiffness is recommended. Brushes with colored handles are **not** recommended because inadvertent contact with the monument may leave a colored streak on the stone.
- Protective eye glasses or goggles, and rubber gloves
- Toothbrushes for intricate carvings
- Wooden craft sticks or shims for scraping debris or growth off stones
- Clean sponges (closed cell, cosmetic-type sponge only; this avoids remnants of the sponge remaining on the stone)
- White rags
- Plastic pails (**avoid metal containers** which may damage stones by incidental contact)
- Q-tips for test spots, and toothpicks for small recessed areas
- Compressed air (60 psi maximum) will assist in clearing off loose debris and dirt. The compressor should have a pressure regulator to avoid damage due to excessive pressure. A small broom can also be used.

Tools and Equipment to Avoid:

- **Never use metal tools** while cleaning stones. Tools such as wire brushes, putty knives, and shovels etc. can severely damage old stones.
- **Do not use any type of adhesive tape**, which may leave a residue on the stone.

General Cleaning Process

1. **Pre-wet the monument** with **clean** water before applying any chemical solutions. Wetting the surface avoids excessive penetration of both cleaning solutions and soil into the stone, and helps to soften the soiling material.
2. Clean the monument **on all sides from bottom to top** to avoid stains and streaks. Rinse frequently during the process.
3. Do not use a dry brush on the stone. Dip frequently in water to reduce friction on the stone – or have a hose running with a constant flow of water over the stone as you brush.
4. To ensure that stones have been properly rinsed, check the pH using a test strip. A pH of about seven is desirable.
5. **To repeat: never allow a cleaning solution to dry on the stone.**

Often after simply training and with proper supervision, even young volunteers can be used to clean headstones. Here a young volunteer uses water and a natural bristle brush to do the initial cleaning.

Removal of Climbing Plants/ Vines

Climbing plants, such as vines and ivy, although rooted in the ground, will sometimes attach themselves to a headstone. Allowing plants to remain on headstones poses several preservation problems, including:

- Holding moisture against the surface of the stone
- Damage to the soft surfaces of the marker by root expansion in the interior of the stone and subsequent chipping of small areas on the surface
- Erosion of mortar joints by invasion of the roots
- Obscuring the inscription
- Impeding access to the stone for making repairs

The following recommendations are taken primarily from Chicora Foundation's training seminars. Before attempting to remove such growth, carefully examine the stone to see if the roots of the plant have compromised mortar joints, or have become imbedded in the surface of the stone. Caution: never pull vines off of a monument because it may damage the stone.

- Cut the plant off at the base of the growth using pruning shears.
- If the vine is large, cut it every six to twelve inches, leaving any growth adhering to the headstone.
- Peel back the bark one to two inches on either side of the cuts.

- Apply an herbicide, such as Chevron *Brush-B-Gon* or Monsanto *Round-Up*, with a small paintbrush to treat the exposed plant layers. Also apply the herbicide to cut areas on the stump.
- Be careful that no herbicide comes in contact with the headstone. Do not allow any herbicide to touch the ground or it may wick up into the stone.
- Allow the chemical to work its way into the plant and kill it. This may take a few days.
- After the plant is completely dead and brittle, remove the remains. Using a wooden scraper, such as a cedar shim, work the remains of the plant from the monument. Wetting the stone will facilitate removal.
- After all surface vegetation has been removed; gently remove any remaining plant matter by scrubbing the area with water and a natural bristle brush.

Removal of Organic Growths

In urban areas, headstones may be covered with a layer of sooty carbon residue from industrial and vehicle emissions, which can prove very difficult or impractical to remove. It is usually black in color and for this reason can be confused with certain other growths such as fungus and algae. The following test will determine whether the soiling on a headstone is dirt, carbon or soot (inorganic), or an organic growth:

- Dip a cotton swab in household bleach and touch the black deposit in an inconspicuous place (e.g., the lower rear corner of the marker).
- If the soiling remains black where the bleach swab touches the area, it is likely to be dirt, soot and other inorganic stains, which will not change color.
- If the test area turns light brown, green, or disappears, then the condition is organic growth. *(Chicora website; Landscapes of Memories: A Guide for Conserving Historic Cemeteries, Repairing Tombstones,* p. 18)

Lichen, mosses, algae, and fungus commonly grow on headstones. Some of these growths may appear to be black; resembling the sooty deposits left by carbon residue, but upon closer inspection may appear multicolored. These organic growths trap moisture on / under the surface of the stone, and their roots may invade the stone, causing damage to the binding agents that hold the stone together.

Some lichens secrete organic acids that can destroy calcium carbonate, which is the primary component of limestone. These lichens are considered *lithophagous* because they "eat" the surface of the stone. They are particularly harmful to limestone, marble and sandstone. *(Landscapes of Memories: A Guide for Conserving Historic Cemeteries, Repairing Tombstones,* p. 18)

Lichen and other organic growths can be treated with the architectural anti-microbial product, D-2, to prevent the damage that these growths cause. D-2 can be sprayed or brushed onto the growth to loosen a broad spectrum of biological deposits. D-2 has several attributes that make it very desirable:

1. It is non-toxic and biodegradable
2. It kills most bacteria within several minutes
3. There are no special precautions for handling and storage
4. It does not cause damage to headstones
5. It is harmless to landscape plants

When using D-2, thoroughly wet the surface of the stone, apply the liquid product, either full strength or diluted (1:1 to 1:4 with water), using roller, brush or sprayer. Then gently scrub the surface with a high quality, natural bristle brush and allow the D-2 to stay on the surface for one to ten minutes (taking care not to allow the stone to dry). It may be necessary to repeat the process. Finally rinse the surface thoroughly with water. (Chicora Foundation website and Cathedral Stone Inc.)

Pressure Washing and Sandblasting Not Acceptable

Use caution when working with monument and restoration specialty companies, because some still use high-power pressure washing for cleaning stone and metalwork. Experience has shown that older stones that have developed small fissures and subtle weaknesses are more likely to fail, even under the lower pressure of a typical 1000 psi consumer pressure washer. Sandblasting, whether sand, baking soda, or walnut shell as media, is too abrasive for older headstones

Instead of power washing or sandblasting, it is recommended that a garden hose, delivering a maximum of 60 psi, be used. Pressure higher than 60 psi has the potential to remove the outer surface of the stone, and can blast off raised lettering and deteriorated surfaces before the operator becomes aware of the damage.

Be sure to have an ample supply of water available so that any deposits or cleaning agents can be thoroughly rinsed off before drying. When cleaning products are not totally rinsed from the marker, accelerated soiling and damage can occur.

CLEANING AGENTS

When working with volunteers, it is recommended that cleaning agents be limited to water, D-2, and non-ionic detergents such as Vulpex, Photo-Flo, and Orvus. However, when conservation workers are more qualified, or when volunteers are working under the close supervision of a professional, the other options listed below may be used.

Cleaning Agents — According to Type of Agent

Tracy C. Walther, a member of the *Association for Gravestone Studies* and an architectural conservator, recommends the following:

A. Soaps and Detergents

Recommended:

1. Non-ionic detergents (e.g., Photo-Flo, Orvus and Vulpex) are recommended because they are electrically-neutral cleaning agents that neither contain nor contribute to the formation of soluble salts. Because they provide better wetting of the masonry surface, non-ionic detergents facilitate removal of general soiling.

Agent	Mix Rate (by volume)	Availability
Vulpex	1 part Vulpex per 6-7 parts cold water	Conservation, janitorial, and photographic suppliers
Orvus	1 oz per 5 gal water	Farm and feed store
Photo-Flo	1 oz per 5 gal water	Photo supply store

Not Recommended:

1. Soaps (e.g., Ivory) are *not recommended* because they are rendered insoluble by calcium ions present in masonry and hard water. Soaps may also produce free alkali and fatty acid salts that can damage stone.
2. Commercial household detergents (liquids and powders) are generally chemically complex synthetic compounds that frequently contain additives that may be detrimental to masonry. Detergents may cause the formation and deposition of soluble salts in masonry.

B. Acidic Cleaning Materials — Acidic agents are never recommended

Hydrochloric or muriatic acid, phosphoric acid (e.g. Lime Away, Naval Jelly), or oxalic acids can damage headstones. Hydrochloric or muriatic acid may result in ferrous chloride (rust) staining and the deposition of soluble salts.

C. Alkaline, Corrosive, and Biocidal Cleaning Materials — Recommended:

1. Calcium Hypochlorite (also known as Chlorine, HTH, Shock Treatment), a *granular* product, is **recommended for the removal of biological growth**. This product must not be confused with liquid chlorine or sodium hypochlorite (household bleach) — *which are not recommended*.

   Calcium hypochlorite is **recommended for use only by experienced conservators (Level 3)**. It is available from swimming pool suppliers. A suggested cleaning mixture is one ounce calcium hypochlorite per gallon of hot water. This product should be used only when a water hose with good water pressure (e.g., 50-60 psi) is available for rinsing the cleaning solution from stones.

2. Ammonium Hydroxide (e.g., household ammonia): Solutions of household ammonia are **recommended for cleaning of light colored stones. Ammonia is particularly effective for the removal of biological growth**. A suggested cleaning mixture is one cup of ammonia to one gallon of water. When using household ammonia be certain that it does not contain dyes or fragrances that may prove harmful to certain stone.

> *Caution: When using a cleaning mixture that includes household ammonia, damage to bronze or other metal components can result.*

3. Quaternary Ammoniums (e.g., algaecides or biocides for swimming pools) have a slightly different chemical structure than ammonium hydroxide. They are **especially effective for the removal of biological growth, particularly stubborn black algae**. Quaternary ammoniums, which are available from swimming pool suppliers, list ingredients such as alkylbenzyl trimethyl ammonium, benzyl alkyl dimenthyl ammonium chlorides, or benzyl aklyl dimethyl ammonium bromides.

Not Recommended:

1. Sodium Hydroxide (e.g., Borax), and Sodium Hypochlorite (e.g., Clorox, liquid chlorine) *are not recommended* for general cleaning of stone.

2. Trisodium Phosphate (e.g., TSP, Calgon) is *not recommended* for cleaning monuments. It can cause the formation and deposition of soluble salts. "Calgon" contains trisodium phosphate and a number of additives that may be detrimental to monuments.

3. Fantastic All Purpose Cleaner, Formula 409, Spic and Span, and abrasive cleansers are *not recommended* for cleaning monuments. Avoid products containing sodium chloride, sodium sulfate, sodium carbonate, sodium bicarbonate, and ammonium carbonate, due to the propensity to form and deposit soluble salts in monuments.
   (Walther, Tracy C. 1990, *Cleaning Masonry Burial Monuments*. The Association for Gravestone Studies, Greenfield, Massachusetts)

Cleaning Agents for Specific Stone Types

Another leading authority on cemetery preservation, Lynette Strangstad, in her book *A Graveyard Preservation Primer*, recommends cleaning solutions according to stone type. They are listed in reverse order of cleaning strength; i.e., weakest first (which is the preferred order of application):

Marble and Limestone:

1. Water only.
2. Non-ionic cleanser such as Photo-Flo, (available at photographic supply houses) Triton-X 100, Igepal (available from conservators' supply houses), and water.
   – *Use one ounce to five gallons of water*.
3. Vulpex (a soap) – available from conservators' supply houses).
   – *Use one part Vulpex to two to four parts water*.
4. Household ammonia. (diluted)
   – *Use one cup per four cups of water*.
5. Calcium hypochlorite. Use only to remove biological growth. Available as swimming pool disinfectants.
   – *Use one pound (dry weight) to four gallons of water. The water must be warm*.

Sandstone:

1. Water only
2. Non-ionic detergent and water (see Marble)

Subflorescence and Efflorescence

Subflorescence is caused by the deposition of crystalline salts below the surface of a stone.

Some of the causes of subflorescence are:

- wicking of moisture (contaminated with salts, fertilizers or herbicides) into the stone
- using incorrect cleaning compounds
- using the wrong kind of mortar for masonry repairs
- air and water pollution.

Subflorescent salts can be drawn out of a stone by applying a poultice. Application of a poultice may require hiring a professional conservator.

Efflorescence is caused by the deposition of the salts on the surface of a stone; resulting when subflorescence migrates to the surface of the stone and becomes visible.

> Efflorescence is an indicator of excessive salts. In order to prevent or reduce the damage from subflorescence, causes need to be identified and steps taken to eliminate the source(s). Delamination (breaking off of layers) of the stone surface can eventually result from subflorescence.

Poultices are water-based pastes made from *diatomaceous earth, fuller's earth* or *kaolinite* applied over stained areas on the monument. The following are the steps in applying a poultice:

- Mix the chosen product with water to the consistency of peanut butter.
- Apply the poultice to the soiled area – 1 / 4 – 1 / 2 inches thick.
- Wrap the area with plastic sheets to avoid premature drying.
- Remove the poultice when nearly dried – as indicated by cracks in the poultice material. In the process of drying, the poultice draws out the stain in most instances.
- After removing the poultice, the stone must be thoroughly cleaned with water to remove poultice residue.

> For specific stains, special products can be added to the poultice to enhance performance. Conservator supply companies, such as Granite City Tool, offer premixed poultices.

Sealants

Do not apply any type of sealant or consolidant to a headstone. The Chicora Foundation, NPS Preservation Briefs, and the Association for Gravestone Studies all agree with this advice. A stone in contact with the ground continues to wick-up moisture and must be allowed to "breathe" and expel the moisture, although some sealing products claim to seal the surface of stone while still allowing the stone to breathe. Because of the risk of preventing the migration of moisture, applying any type of sealer or consolidant should be left to trained conservation professionals, and used only in very specific applications.

REPAIRING HEADSTONES AND MONUMENTS

Overview – The following are important conservation principles for repairing or otherwise conserving grave markers / headstones. The Association for Gravestone Studies, the National Center for Preservation Technology and Training, and other cemetery conservation groups, offer seminars on the topic and are sources of additional information that may be helpful.

While the repairs in this manual are primarily applicable to stone monuments and markers, the general principles may apply to any preservation or conservation repair. The italicized comments are intended to clarify the repair criteria, some of which may seem to be contradictory:

- The repair is less strong that the original.
  Additional damage to the stone could result if the repair material is stronger than the original stone. If a new break occurs, the intent is to avoid any more damage to the original stone; i.e., the repair should fail, not the stone.
- The repair is reversible.
  A repair should be able to be disassembled without damage to the stone. This is desirable because improved repair procedures may become available in the future.
- The repair respects the original material of the marker.
  The repair methods and materials are compatible with those of the original marker, and minimize the possibility of further damage or discoloration to the stone.
- The repair is as historically accurate as is reasonable and possible.
- The repair does not inhibit the natural permeability and breathe-ability of the stone.
  Avoid adhesives, coatings, sealers or other repair materials that may retain moisture or affect breathe-ability, which can result in secondary damage.
- Before attempting to repair headstones in a historic cemetery, inspect stones carefully to assure that they have not developed previously unforeseen cracks, spalling or other weaknesses that would affect the repair.

General Caution. Repairing old stones requires training in specific skills and patience. Before starting complex projects such as multiple-break repairs or infill repairs, the practitioner should become totally familiar and comfortable with the repair methods.

Familiarity with the types of stone, with characteristics of mortars and epoxies, and with other equipment is required prior to working on an actual historic headstone.

> If possible, practice on discarded stone fragments or on landscape stones. Each type of repair material; e.g., two-part epoxies and mortars, have unique characteristics. A wide variety of mortar recipes and proprietary infills are available (e.g., Jahn restoration mortar products from Cathedral Stone Products, Inc.).

Documentation

Before starting a repair, photograph each side of the stone. Rinsing gently with water may reveal parts of the inscription not previously visible, as well as the name of the stone carver. Document all information regarding the condition of the stone and any existing repairs that are visible, including materials and methods, and any pins, braces or straps previously used. If a previous repair has failed, record that fact and the reason for failure, if known. The purpose of accurate documentation is to help future conservators if new methods in the future provide the opportunity to improve the condition or the permanence of the repaired stone.

Record the repair process with photographs and notes, and document the condition of the stone when the repair is complete. Document all information on a headstone survey sheet. Identify all actions taken from start to finish, including the type of adhesive material or mortar mix used. If holes are drilled for blind pinning, record their locations and size, and the type and size of dowels used. Specifications or formulas for metal or other materials used should be documented, as well as any other treatment such as cleaning or infill. No action should be overlooked or considered too insignificant. If a commercial mortar product was used, Material Safety Data Sheets [MSDS] should accompany the records. The MSDS, available from chemical and mortar manufacturers and suppliers, should be kept with all other repair information records.

Fragility and Soiling

Always handle stones as extremely fragile items. When wet, stones are much more susceptible to breaking. A stone that has been lying on the ground absorbing moisture can take as long as a month to dry, depending on conditions. When stones have dried,

efflorescence may appear on the surface. Any efflorescence or soiling should be removed prior to the repair. A poultice can be used to draw out the contaminating salts. See "Cleaning" section for specific poultice application practices.

Lifting and Moving the Stone

Headstones weigh 160 to 180 pounds per cubic foot. Use extreme care when lifting or moving stones to avoid personal injury or damage to the stone. When moving the stone, support the weight of the stone evenly, using nylon straps and boards to equalize the load. Larger stones can be moved by two persons using a lifting pole with nylon straps, or with lifting devices such as a portable crane, or a tripod with chain hoist. Stones should be protected from contacting chains or other metal lifting objects. Only experienced conservators should move heavy stones.

> Handling Cautions: Metal bars and shovels should not be used to pry or lift a monument or headstone. Do not try to lift heavy stones without the assistance of another person. Even when using lifting equipment, another person should be available to assist if needed.

COMMON REPAIRS

The following are the most common types of repairs on stones in historic cemeteries, all involving slab markers/tablet stones. Repairing large or complex stones should be reserved for conservation professionals with the necessary experience and equipment. The following repairs are listed from easiest to the most difficult:

- Correcting tilted stones that were set directly in the ground
- Resetting fallen stones that were set directly in the ground
- Stabilizing and resetting a stone or a concrete base
- Replacing a marker into a base
- Making concrete bases for partial slab or tablet markers
- Repairing a snapped marker
- Infill of missing stone fragments using mortar

Correcting Tilted Slab or Tablet Markers Set Directly in the Ground (Not In Bases)

Tilted markers are among the most common problems in older cemeteries. Slab or tablet markers, installed directly in the ground (with approximately one third of the stone below grade), may have been standing for a century or more. Stones, especially in sandy soil, may have tilted due to shifting or the effect of gravity; or may have sunk, partially concealing the inscription. A stone that is leaning may become warped. In the worst case, if not corrected, the stone could eventually fracture due to its own weight. Generally, if the marker

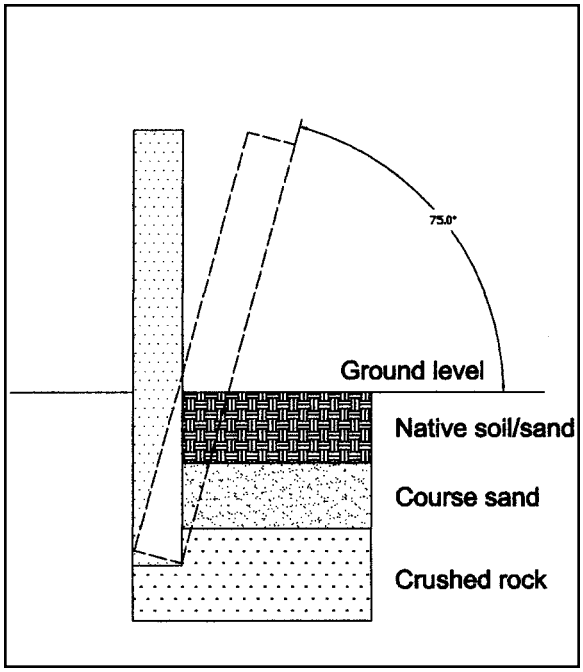
is leaning less than fifteen degrees from the vertical, intervention to set it upright is not suggested. A stone that has sunk only minimally will usually not need to be removed unless the inscription is obscured below grade.

Straightening a tilted marker is fairly straightforward project and involves minimal cost. Trained and supervised volunteers can usually do it. Check to be sure that there are no unseen conditions that would preclude straightening the stone without damage. Removing the stone completely from the ground will usually not be necessary.

Straightening Tilted Markers

2

- Hand-dig the ground around the stone. Remove the sod with a spade-shovel so that it can be easily replaced. Do not allow metal tools to contact the stone. Unless the stone has sunk so that the inscription is obscured or repairs to the stone are needed, it is usually not necessary to remove the stone from the hole.
- Excavate to the depth of the bottom of the stone. Assure that the sides of the hole are wide enough so that when the stone is straightened, the edges of the stone will not hang up on the sides of the hole, causing undue stress.
- Straighten the stone to vertical, checking for plumb. While supporting the stone, backfill the hole one-third full with heavy aggregate such as broken brick or 21-AA stone (from a cement yard) and tamp. Add coarse sand and gravel mix (aggregate) and tamp, leaving three to four inches for topsoil and sod. Place landscape fabric atop the aggregate, to maintain drainage by preventing dirt from filtering into the aggregate.
- Replace the topsoil and lightly tamp. Mound up soil to allow for settling. Replace the sod. After two or three weeks, check for settling around the base of the stone, adding more soil as required.



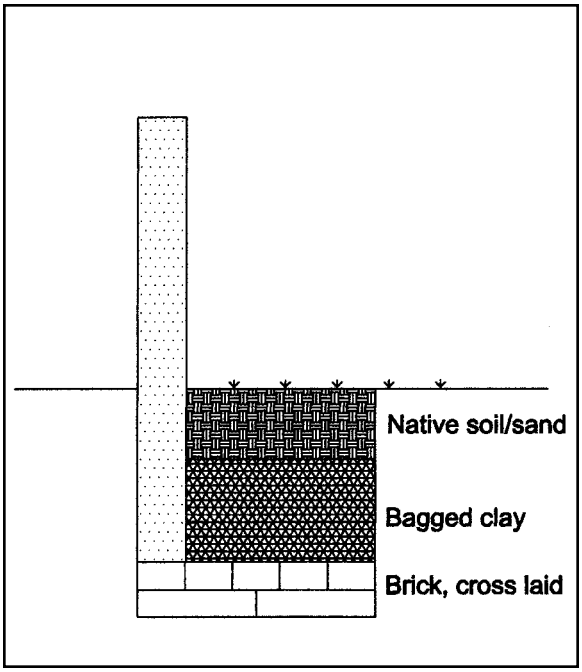
Straightening a marker is a common task done usually when the marker is out of plumb by 15 or more degrees. Always use caution when moving a stone. Trying to force a stone can cause it to snap.

Straightening Markers When The Stone is Removed

2 If the stone must be removed temporarily, additional preparation of the bottom of the hole is required to prepare for reinstallation. See the *Lifting* section for instructions on removing the stone from the hole.

- Excavate the existing hole to a rectangular shape, with vertical sides, and level bottom. The front wall of the hole remains at the original location of the front face of the stone. To achieve a solid base, tamp the bottom with a length of 4 x 4 lumber or other tamper.
- The depth of the hole is established by the desired height of the headstone above the ground. If possible, set the height so that the lowest inscription is visible – ideally a minimum of two inches above grade. The actual height at which the stone was previously set may be visible from staining on the stone (witness marks). The depth of the hole may vary depending on the following alternative "fill" method selected:
  - Alternative 1 – Stone and aggregate fill – Lay dry flat stones in the bottom of the hole. Lower the headstone into the hole with the front face of the stone against the front wall of the hole, centered side-to-side. Straighten to vertical, checking for plumb. While holding or bracing the stone, backfill with heavy aggregate (such as broken brick or 21-AA stone from a cement yard) to half-fill the hole, and tamp. Next add coarse sand and gravel mix to within a few inches of the top, and tamp. Place landscape fabric atop the aggregate, to maintain drainage by preventing dirt from filtering into the aggregate.
  - Alternative 2 – Clay bricks and bagged clay fill – As an alternative to aggregate fill products above, line the bottom of the hole with unfired clay bricks, and use bagged clay as backfill. A first course (layer) of unfired clay bricks is laid on the bottom, with a second course laid perpendicular to the first. Lower the headstone into the hole with the front face of the stone against the front wall of the hole, centered side-to-side. Straighten to vertical, checking for plumb. While holding or bracing the stone, backfill with bagged clay to half-fill the hole, and tamp. Add topsoil to within a few inches of the top and tamp until firm. Clay provides a concrete-like and extremely solid base and support for the stone, and is easier to transport and more volunteer-friendly than aggregate. Clay is used on baseball and softball fields; and may be available in municipalities' parks departments, as well as commercial nurseries. (One of the authors of this text developed this technique using clay material in collaboration with other professional conservators.)

- Add more topsoil and lightly tamp. Mound up soil to allow for settling. Seed or replace the sod. After two or three weeks, check for settling around the base of the stone, and add more soil as required.



The drawing shows the cross section of a repair when clay bricks are used as a base and bagged clay is used to strengthen the repair.

Resetting Fallen Markers Set Directly in the Ground – Not in a Base

2 Slab or tablet stones in historic cemeteries may have fallen to the ground, and often are obscured from view by leaves, dirt, and turf. The stone may be stained by the decaying of organic materials, and damaged by maintenance equipment or by people walking across the stone. Stones lying on the ground are also continually subject to absorption of moisture, which weakens the stone. Markers that have fallen can be reset using the following procedure:

- Preparation – Gently remove any debris or turf covering the fallen marker. Using wooden shims carefully excavate around the perimeter of the stone. Extreme care should be exercised because moisture-saturated stones are very brittle and susceptible to snapping or chipping. Photograph the stone to document its condition.

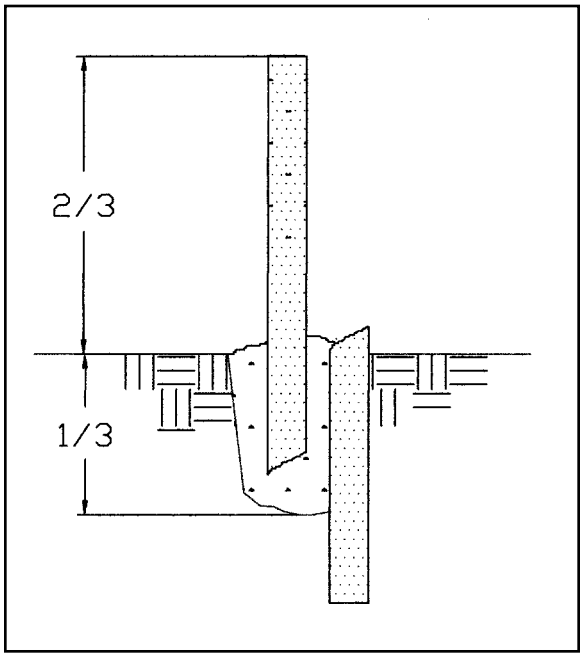
- Removing and Resetting the Stone – Carefully excavate under the stone to allow for insertion of nylon lifting straps. Hoist the marker from the ground

using nylon straps, supporting the weight evenly. Transfer the stone to a level base of two-by-fours to support the full length of the stone, and permit air circulation to allow the stone to dry. Allow space for replacing the nylon straps under the stone later for lifting. Depending on the weather, it can take a month or two for the stone to dry. Moving the stone into a heated building will accelerate the drying process. Remove any residual dirt by gently brushing. Total cleaning, including removal of efflorescence, should be accomplished after the stone has been fully dried and reset. Align and reset the stone using the method described in Straightening Tilted Markers (above).

Temporary Repairs of Snapped Headstones

2 When time and resources are limited it may be prudent to temporarily reset pieces of monuments until a better repair can be made. If stones have been snapped off and their "cousin piece" is still in the ground, this temporary fix can help to prevent additional damage. See sketch.

Remove the broken top half of the stone from the ground. Excavate a hole for the broken stone in front of the remnant, to a depth of one third the height of the fragment. Place the stone in the hole in an upright position. Fill the hole using clean sand or gravel as backfill (to avoid staining) and tamp firm. Although temporary, this repair can be an effective stopgap measure that can preserve the stone by keeping it upright until proper repairs can be made, as well as improve the appearance of the cemetery.



As a temporary fix simply resetting the broken piece in front of the parent stone is a reasonable action and one that can quickly improve the look of the cemetery.

Types of Monument Bases Supporting a Headstone and Marker

There are two styles of monument bases:

1. Slot-style monument bases, which may be made either of stone or concrete, have a narrow recess or slot in the top surface into which a tablet marker is inserted.

2. Flat-top bases made of stone that matches or complements the headstone, are usually set above grade and support a flat-bottomed marker. (See picture of stone base(s) with marker). The marker is adhered to the base either by a mortar bed, or occasionally with dabs of epoxy.

Tablet markers (photo A) are often inserted into a slot style base (photo B).

A ›

‹ B

Obelisks (photo C) as well as larger, thicker tablets can be set onto a base (photo D).

‹ C

D ›

Stone bases, whether slot-type or flat-top, usually protrude above grade from about two inches up to the full height of the base. Cast concrete bases are usually set slightly below grade (i.e., not visible).

A typical problem on the slot-type base is damage around the slot where the tablet is inserted into the base. If not repaired, installation of the marker is likely to fail. Broken pieces on stone bases can often be repaired with epoxy. Missing pieces can be recreated with infill mortar mix. Shifting of the base may have occurred, due to tree roots or heaving due to frost. Damage to a concrete base is usually corrected by re-casting it in concrete vs. repairing (See *Making a Concrete Base*).

The following sections will cover resetting bases, repairing the slot, replacing the marker, and making concrete bases.

Resetting Monument Bases

Tree roots or frost heaving can cause a monument base to shift or lift. The process for leveling and stabilizing a shifted base applies to both stone and concrete bases:

- Carefully excavate around the base of the marker. Rough unfinished surfaces on the periphery of a stone base can often provide an indication of the portion of the base originally set below grade. "Witness marks" or staining on the base may also indicate where the stone contacted the earth. After the sides of the base are exposed, check for damage.
  - If the stone base is damaged *around the tablet slot*, repair the slot prior to resetting the base and inserting the marker. This procedure is covered below.
  - Rejoin large broken sections of the stone base using epoxy. The resulting repair can usually be expected to withstand the forces encountered when the base is lifted.
  - Smaller repairs in other areas of the base, including infill replacement of missing sections, can be accomplished after the base is reset, before replacing the earth fill.
- If the base must be lifted, use the appropriate lifting techniques (previously described) to lift and place it on a lumber base for support. <u>If the marker is still attached to the base, the following instructions will avoid damage to the marker</u>:
  - Do not lift the base using the marker.
  - Always support the marker while lifting the base.
  - Do not lay the base and marker assembly on its side as the marker or the base could be damaged.

- The surface on which the base will be replaced must be firm and level. If the ground has heaved, reestablish a flat surface. Remove any roots that originally caused the problem, but do not disturb the soil any more than necessary. Level the surface and add *cement sand* or other fine aggregate on top of the soil. Firmly tamp each layer, as loose soil makes for a poor foundation.
  - If necessary, a concrete pad can be poured atop the aggregate to raise and/or stabilize the base. The pad, which is one or two inches wider and longer than the base and two to three inches thick, is hidden below ground. However, an aggregate base is usually adequate.
- Before lowering the base onto the amended and tamped aggregate, or onto the cured concrete pad, apply a one inch-thick layer of mortar to stabilize the base. Use the recommended mortar in this book.
- Lower the base onto the prepared mortar surface. Support the base at the corners and adjust the base to level. After the mortar has dried (usually two days), complete any necessary infill repairs on the stone base (see procedures below). Backfill the soil around the base, and seed or sod the area.

Replacing a Marker in Its Base

A common restoration project involves replacing a tablet marker (two to three inches thick) into the slot in a stone base. The slot is about one to two inches deep, and 3/4 inch wider than the thickness of the marker. Patching concrete or epoxy adhesive should not be used, because concrete is not compatible with stone, and an epoxy repair is not easily reversible. The following is the recommended procedure:

- Inspect the base for damage, especially the area around the slot. Inspect the stone to be placed in the base.
  - If the base is damaged in the area of the slot where the tablet is inserted, the slot must be repaired prior to the next step. Use epoxy to join those pieces that have a close fit, and use infill mortar mix (see Infill section – below) if needed to fill voids from missing pieces of stone.
  - Missing areas *on the periphery of the stone* can be repaired after the base is replaced – using *infill mortar techniques* – before replacing the earth fill around the base.
- After the repairs to the base have cured, reset the base in the ground and install the marker:
  - Remove all fragments of old mortar from the base and stone prior to applying new mortar. Dampen the slot and the bottom of the stone with water spray so that the stone does not absorb moisture from the mortar.

- Using the recommended mortar mixture (see below), or a proprietary mortar such as Jahn Products, apply a one-half inch layer of mortar to the slot in the base. Place two or three one-quarter-inch thick 'setting cushions' (plastic pads available at monument dealers) in the bottom of the slot to maintain the thickness of the mortar. *Note:* proprietary mortars may require certification from the supplier to purchase.
- Lower the stone into place into the slot and support with wooden braces. Work mortar into the gap between the base and the stone, using wooden shims. Continually check the stone for plumb. Fill the gap around the headstone and create a small one-eighth inch fillet of mortar at the base to help shed water (a larger fillet [smooth, concave bead] would be prone to failure).
- While the mortar is still wet, re-check for plumb, and check the braces for stability. After the mortar has dried, usually in a day or two, the braces can be removed.

After the repair has been made, securing the marker is imperative. The use of clamps, wooden braces and shims assures the marker is not touched by the metal clamps, and also prevents the marker from moving while the repair treatment cures.

Making a New Concrete Base for Broken Slab or Tablet Markers

Unconventional repair methods may be required in cemeteries that have been vandalized or left unattended. One method is setting a fallen stone fragment upright in a base of poured concrete. Resetting the stone in a base protects the stone and displays more of the surface than if the stone were to be set into the ground. A new concrete base can be poured in a workshop under controlled curing temperatures and protection from rain.

> *Note: Creating a base is the only application for concrete in historic cemeteries endorsed by organizations such as the National Park Service, the Association for Gravestone Studies, and other professional conservation groups. "Common" concrete is normally inappropriate for historic cemetery restoration work. When properly installed, the headstone is protected by the layer of mortar from the damage that would result from contacting the surface of the concrete.*

Construct the female form for the base using dimensional lumber – 2 x 10s or 2 x 12s:

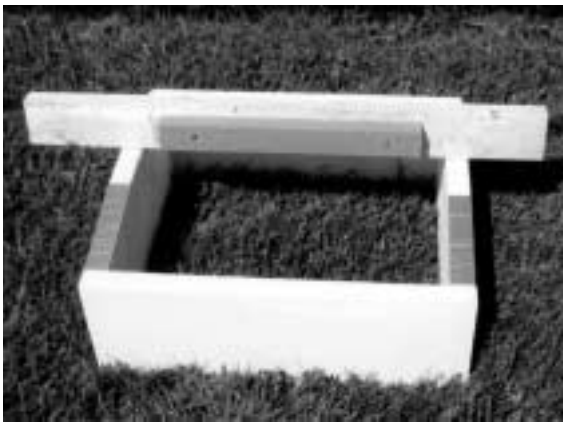
- Minimum depth – six inches plus one half inch for each 12 inches of stone height.
  e.g., the base of a three foot tall stone is about eight inches deep
- Minimum inside dimensions – top view: six to seven inches larger than the thickness and width of the stone, respectively.
  e.g., the base for a stone sixteen inches wide by two inches thick would have dimensions of twenty-three inches by nine inches
- The form for the base should create a slight (five to ten degree) downward pitch from the slot to the edge, allowing water to run away from the stone. Use screws or duplex nails (double-headed nails) to facilitate disassembly after the concrete is cured.
- To prevent the concrete from adhering to the form, cover the sides of the form with a thin plastic sheet (garbage bags or 0.5 mil drop cloth), or coat the form with linseed or motor oil.

Craft a male form or plug from wood to create the slot in the top of the concrete base:

- The male form is approximately one inch wider and one inch longer than the width and thickness of the stone, and at least two inches deep. The intent is to create a virtual half-inch gap all-around when the stone is inserted into the base. Cover the form with a thin plastic sheet to prevent the concrete from adhering.
- Screw the male form to the center of a 2 x 4 cut long enough to span the form for the base.

- Next pour the concrete into the form for the base, trowelling to shape.
- Depress the male form into the wet concrete, flush with the top of the female form. Attach the 2 x 4 to the ends of the form with screws. Trowel the concrete smooth, following the angle for water run-off.
- After the concrete has begun to harden (when the surface becomes dull-looking), remove the screws attaching the 2 x 4 to the female form, and carefully remove the male form exposing the slot. The intent is to remove the form before the concrete is completely cured (to permit easy removal). If the concrete around the slot *slumps*, replace the form immediately if possible, and continue curing. Allow the concrete base to harden for two days before removing the outer female form.

A wooden form constructed of 2x12 lumber makes an excellent material for making replacement bases. The shaded areas are angled away from the center so when the cement dries and the base is placed into service, water will run away from the marker.



A die is made from lumber so that when inserted into the uncured cement, a slot will be formed and the tablet stone can be inserted when the cement has cured.

In this picture the die is screwed to the form in the correct position so that a slot will be formed.

Set the base onto the prepared surface as described above. When resetting a partial stone, the top of the concrete base should be placed slightly above grade level (as opposed to hidden below-ground).

If the headstone that is being replaced into the base does not have a squared or flush bottom, reinstallation into the slot must be delayed until the headstone has been repaired so that it will sit squarely into the slot. Ideally the bottom area of the headstone that is missing could be recreated using infill mortar mix as described later. Another option is to craft the male form (see above) to replicate the shape of the bottom of the headstone into the base, so that the base accepts the out-of-square portion of the stone and holds it securely. Only as a last resort should any part of the headstone be removed to square up the bottom of the stone. Removal of stone should *never* be done when the artistic features or inscriptions will be compromised.

SNAPPED MARKERS – CONCEALED REPAIRS

Snapped tablets are common in older cemeteries. Repairing broken markers with epoxy or mortar requires extreme care. Improper repair methods can permanently alter the stone. However, the quality of the repair is not totally dependent on the conservator. Factors that may significantly contribute to the quality of the repair include the type of stone, the age and overall condition of the stone, the type of break, and condition of the surface. Three types of repairs are described in the following section, starting with the least complex method.

Two-part Epoxy Adhesives – Overview

Epoxy adhesives are a strong and an effective way to repair broken markers exposed to the elements. Epoxies are recommended not only by adhesive manufacturers but also by conservators. However, conservators should be aware of the following concerns with using epoxies on historic stone:

- Epoxy is not vapor-permeable. For this reason a preferred approach to covering the mating surface with epoxy may be to use only dabs of epoxy. This approach will permit the stone to breathe.
- Epoxy is very difficult to remove from the stone after curing.
- Epoxy tends to yellow and may break down with exposure to ultraviolet light.
- Working with epoxy requires the user to be neat, and to be very careful to avoid spills, oozing, and smearing. Any excess must be removed immediately with acetone to avoid additional damage to the stone.

Epoxies available at home improvement centers are typically not suitable for repair of historic stone and masonry. Those involved with epoxy repairs should be trained and comfortable with application practices before repairing any historic markers.

Types of Epoxy

Two types of epoxy that are recommended and used in historical cemeteries are *gel epoxy* and *low modulus/ low viscosity epoxy* (having the consistency of white household glue).

- **Gel Type –** This type is often referred to as gel or knife grade epoxy in that the consistency is much thicker (similar to peanut butter) than the low viscosity type. It is less messy to work with because it tends not to flow or leak out of cracks as easily as the low viscosity type. Some conservators recommend using knife grade epoxy for use in drilled holes when blind-pinning repair of stones.
- **Low-modulus/low viscosity –** A flexible (low-modulus) two-part epoxy that provides flexibility under stress from impact and thermal change is recommended for bonding close-fitting stone pieces, and for blind-pinning of broken stones. See appendix for recommended sources of epoxy products. Many conservators prefer low modulus, low viscosity epoxy, because it can be used for several tasks; e.g., pinning, crack stabilization, and bonding broken stone fragments.

Brands of Low Viscosity Epoxies that are recommended:

- Mastico – Available in a clear and a white version from Hilgartner Natural Stone Company. A good color match can often be achieved by adding stone dust to the clear product. www.hilgartner.com.
- Akepox 2010 – A very economical solution. Available from Architectural Stone in Troy, Michigan. The complete line of Akemi epoxy products is available through most monument dealers. Tinting agents are available.
- Barre Pak – A conveniently-packaged product that is pre-measured for consistent results. This product is very volunteer-friendly. Available in gray color in a seventy gram plastic pouch. Mixing is done in the pouch. Available at Miles Supply Company Inc., PO Box 237 Barre, VT. 05641-0237. (802) 476-3963.

Using Two-Part Epoxy

General directions for mixing epoxy (always consult manufacturers' recommendations):

- Prior to any repair, and especially before mixing or applying epoxy, the stone pieces should be dry-fitted to observe the fit of the mating pieces, and to assess the best method for repair.
- Carefully read and understand the manufacturer's specifications. Mix the two epoxy components per instructions provided.
- *Working Time* is the length of time during which the epoxy mixture is still workable and can be applied; i.e., before the epoxy begins to set. Working time at 70˚ F can vary from only a few minutes to an hour or more, depending on the type of epoxy and the amount of hardener used in the mixture. Cooler temperatures will increase the working time; at higher temperatures the epoxy begins to set up faster. *Consult manufacturer's specifications.*
- *Cure time* is the time after which epoxy achieves a high percentage of its maximum hardness and working strength; typically 24 hours at 70˚ F. Cooler temperatures increase the required cure time; at higher temperatures epoxy cures faster. *Consult manufacturer's specifications.*

Preparation of Fractured Surfaces for Repair with Epoxy

2 Inspect the mating surfaces for cracks or "sugaring" on the surfaces. If cracks are observed, consult a professional curator. If sugaring is found on the mating surfaces, abrade the surface with a wire brush to provide a sound surface for bonding.

- Dry-fit the stone pieces, and inspect for gaps and/or missing pieces. Missing pieces can be replaced later with infill mortar – see below.
- Clean the mating surfaces using water and a brush. Use denatured alcohol to clean any remaining residue. Apply acetone to dry the surfaces.

Types of Repairs

1 Type 1 Repair – Epoxy Only

The simplest method for joining sections of broken markers is using epoxy-only. This method works best for a clean break with close-fitting stone pieces. The primary advantage is that the epoxy tends to fill the cracks to the edge, with no grout or infill required. A strong disadvantage is that the epoxy, which covers the mating surfaces, minimizes the vapor permeability between the joined sections of the stone, and the repair is more permanent than the second alternative (using epoxy dabs and grout). However, because it requires no drilling or other modifications to the stone, and uses only one repair material, it may be a preferred method for non-professional conservators.

- Before applying any epoxy, the mating surfaces must be clean and dry. Mix per manufacturer's instructions and apply epoxy on both sides of the mating surfaces, leaving 3/8 to 1/2 inch uncovered margin around the edge.
- Carefully replace the upper half of the stone onto the bottom piece, and shift or rock slightly to insure full mating of the epoxy, for a good bond. If any epoxy oozes out of the crack, clean it immediately with acetone, or trim or gently peel off later when a skin has formed on the epoxy (well before it has fully cured). After assembly, use bar clamps or "C" clamps, with lengths of 1 x 2s to protect the stone from the clamps. Brace the assembly if required to prevent shifting. Remove the braces after the epoxy has cured. *See manufacturer's specifications.*
- No epoxy should be visible after the repair has been completed. The tendency for epoxy to yellow and weaken when exposed to UV rays makes this consideration important. Based on the condition of the break, it may be necessary to fill the remainder of the crack with infill mortar mix or grout.

2 Type 2 Repair – with Epoxy "Dabs" and Grout

The second method for repairing snapped markers uses dabs of low-modulus epoxy adhesive with cementitious (mineral-based) grout in the remaining cracks for additional adhesion. The grout is applied after the epoxy is cured. The following repair is for tablet stones with the top portion of the marker broken off, and the bottom portion still soundly mounted in the base or in the ground.

The three advantages of this repair: 1) It is less likely to damage to the stone, compared with blind pinning (see below), 2) the repair can be accomplished by trained volunteers, and 3) because the broken surface of the stone is not fully covered with epoxy, the stone therefore is allowed to breathe. However, applying grout, which is the most difficult part of the procedure, may require drilling injection ports (holes) in the area of the crack, and careful attention must be paid to avoid possible staining of the stone by the grout.

Applying the Epoxy – Before applying any epoxy, the mating surfaces must be clean and dry. Mix epoxy per manufacturer's instructions. Apply two or three quarter-sized dabs of epoxy (one inch [2.5 cm] in diameter) on both sides of the mating surfaces. Applying excess epoxy (i.e., over the entire mating surfaces) should be avoided, to make the repair more reversible, and to provide clean mating surfaces at the edges for the grout to bond to the stone.

Joining the Stone – Carefully replace the upper half of the stone onto the bottom piece, and shift or rock slightly to insure full mating of the epoxy for a good bond. If any epoxy oozes out of the crack, clean it immediately with acetone. After assembly, use bar clamps or "C" clamps, with lengths of 1 x 2s to protect the stone from the clamps. Brace the assembly if required to prevent shifting. Remove the braces after the epoxy has cured (see manufacturer's specifications).

Filling Gaps with Grout – Apply a mineral-based, vapor-permeable, low viscosity grout in the cracks as a supplement to the dabs of epoxy, which will improve the overall strength of the repair. If the corners of the mating surfaces are beveled or rounded, grout will fill the resulting gaps of 3/16 to 3/8 inch. Jahn M40 Crack Injection Grout (available from Cathedral Stone Products) or an equivalent product is recommended. Before working with grout, refer to the details available on the *Cathedral Stone* website. Grout injections should be attempted only after practice attempts on discarded stone fragments or on landscape stones, and only when the repair team has become comfortable with the repair process. The following is a brief summary of the manufacturer's recommendations for preparation and application:

- Wash the cracked surfaces using water to remove dirt and foreign material.
- Mix the grout per manufacturer's directions. Immediately before injecting the grout, wet the crack by flushing with water. Apply *non-staining, non-oil-based clay* (available from Cathedral Stone Products, Inc.) to the crack to act as a dam to retain the grout when injected. The intent is to prevent grout from escaping from the crack and soiling the face of the stone. *Detailed instructions for Mixing, Application, and Curing are contained on the Cathedral Stone website.*
- This method requires drilling ports or holes in the crack, using a carbide-tipped drill, to permit injection of grout. The diameter of the hole is approximately the size of the crack, and is intended to permit distribution, via injection of the grout throughout the crack. Follow the detailed manufacturer's instructions.
- Allow the grout to dry for approximately forty-eight hours. After the grout has cured remove the clay from the stone.

> *Caution:* If grout is left to dry on a stone, it will permanently damage the stone. Clean up any grout overflow immediately with water. Extreme care should be exercised.

Type 3 Repair

Blind Pinning (modified from the Oregon Historic Cemeteries Association website / CRM Bulletin)

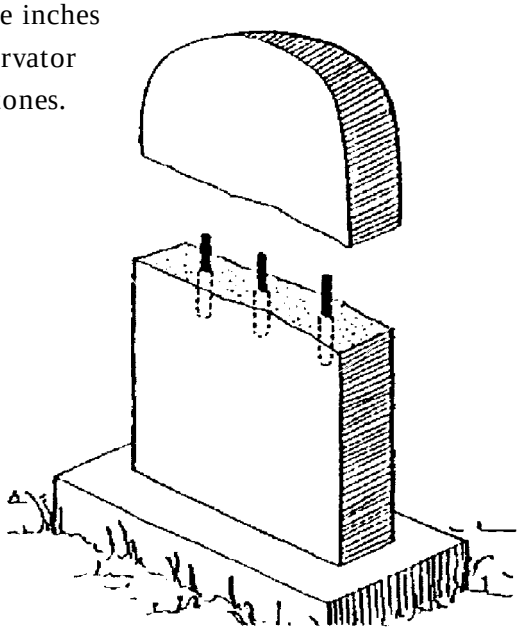
Overview – A clean break between sections of gravestones may be repaired by blind pinning, which involves drilling holes into both stone fragments and inserting nylon or stainless steel reinforcing pins or rods. Epoxy is used in the holes to adhere the pins.

Blind pinning is the most difficult of the three repair processes, as well as the most risky and most permanent repair, compared with repairs that do not use pins. Therefore, it is usually not the preferred method of repair, especially for non-professional conservators.

Another serious concern is that pinned stones in cemeteries that experience frequent vandalism may experience collateral damage if re-broken; i.e., the drilled holes can be blown out, requiring extensive and visible infill repairs. This option however is the repair method chosen when the break is located near to the ground, and additional support is required to prevent future snapping. Often, repairs close to the ground (within two or three inches) fail prematurely when epoxy alone is used.

Special Concerns:

Only professional conservators and skilled craftsmen should attempt this type of repair. However, this method has been learned and applied by trained and skilled individuals. Blind pinning should only be undertaken on a stone in sound condition. Pinning is usually done only on stones that are three inches thick or greater. Only an experienced conservator should attempt pinning on two inch thick stones.

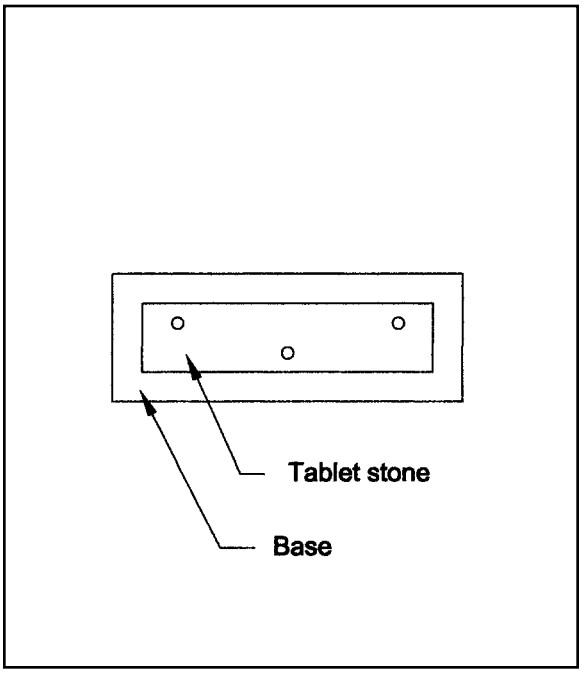


Repair of snapped marker using nylon or stainless steel dowels epoxied into their holes. Dabs of epoxy can be used to secure the two pieces together while grout can be injected after the epoxy has cured to reinforce the repair. Knife grade epoxy can be used for the dabs of adhesive and for securing the dowels to the holes.

2 3 Blind Pinning – Instructions

1. Clean surfaces to be joined and allow to dry. Dry-fit the mating pieces. If the stone is out of the ground or has fallen from its base, arrange the pieces on the workbench and determine the location for the holes to be drilled. If not, the difficult job of aligning and drilling the holes will have to be done on-site.

2. Drill two or three holes for pinning using carbide-tipped bits. If the third hole is used, offset its location from a straight line to minimize the chance of splitting along the grain of the stone (see sketch). Impact drills should not be used because of possible damage to the stone.



When using dowels in the repair it is best to offset the middle dowel to avoid the chance of weakening the marker along a bedding plane.

a) Accurate placement and alignment of holes is difficult and critical. Drill the holes parallel to the axis of the monument and accurately aligned with opposing holes.

b) Hole size – The diameter of the holes should be about 1/4 inch larger than the pins, which allows for some misalignment of the holes. Hole depth in *each* stone should be about two inches; with total depth of four inches– about one inch greater than the length of the pin.

c) Save the small amounts of stone dust for possible use in tinting mortar. Clean out the holes with compressed air.

3. Pin size – For a three inch-thick stone, use 3/8 or 1/2 inch diameter pins– three inches long. (For a two inch-thick stone, smaller 1/4 inch pins are used to minimize the chance of splitting). Use non-corrosive pins such as nylon with threads or grooves for good adhesion. Non-stainless steel rods are not desirable, because of rusting or staining, and higher thermal expansion vs. stone.

4. Dry fit with pins installed. Apply epoxy adhesive to the holes in the stone. Coat the nylon pins with epoxy and place in holes.

5. Apply two or three quarter-sized dabs of epoxy (about one inch diameter) on opposite sides of the mating surfaces per the Type 2 Repair (above). *Note:* Type 1 repair methodology (above) – with epoxy spread over the mating surfaces – may also be used when the mating surfaces have a close fit.

6. Set detached pieces (with pins) in place. Gently rock to assure full mating of the epoxy. Clamp the stone to align the two stone pieces, using bar clamps with wood spacers. Avoid contacting the stone with metal clamps or tools.

7. Excess epoxy can be removed with acetone, or trimmed by carefully scraping before fully cured. After the epoxy has cured, remove the clamps. Fill any voids left in the stone using grout or color-matched mortar (see above).

8. Cementitious mortar can be used to fill any remaining gaps.

2 III 3 Missing Stone Fragments

Missing fragments of damaged headstones or bases can be replaced using mortar infill to approximate the original shape of the monument. Proprietary (premixed) mortars are available, or mortars can be made on-site from a specific formula.

The color of the mortar can often be closely matched to the stone; when dry, infill-patch can achieve a similar texture to the stone. When attempting to match the color of infill mortar to the stone color, it is desirable to err with a color lighter than the stone. Infill can be darkened with judicious use of stain after curing, but a darker color cannot be lightened. Stone dust (crushed stone made from stone fragments available at monument makers) can be used to achieve the desired color. Stone dust is also available from conservator supply companies and masonry supply stores.

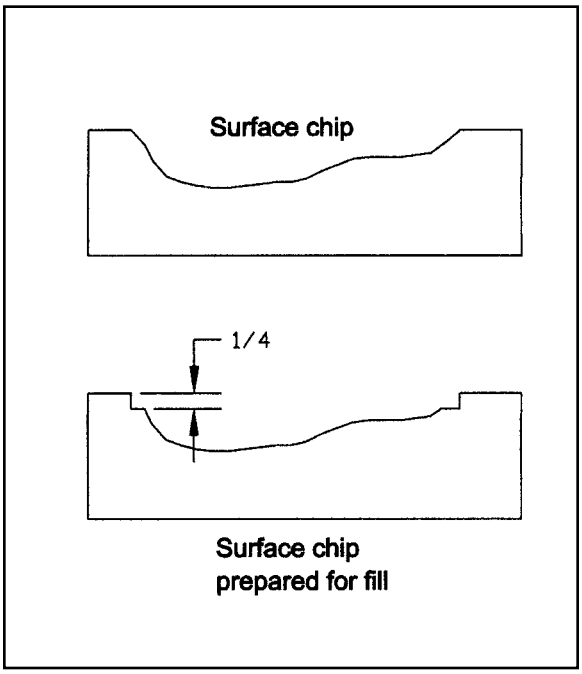
Extreme care should be exercised with infill repairs. Avoid spilling infill material on areas where not required, because discoloration or staining of the stone can occur. Use only proprietary mortars, or specific mortar formulas suitable for the application. Only experienced teams should carry out infill repairs. Before attempting infill on historic markers, conservators should practice on discarded stone fragments or on landscape stones. The following process is time consuming and requires meticulous workmanship.

Preparing the Stone for Infill

The following instructions were taken from the Cathedral Stone Products, Inc. web site.

2 3 Do not apply mortar on a section of stone that has an obtuse (blunt) angle on the fracture at the surface. The resulting feathered edge of mortar would be weak and vulnerable to chipping and premature failure.

To correct this problem, grind a square-cut 1/4 inch notch or recess into the beveled/fractured surface. (See sketch) This provides a more square (vs. sharp-edged) mortar section, which also increases the bonding surface area and decreases the possibility of future joint failure. Minimize any grinding on the *finished* surface of the monument, which would affect its appearance.



Chips and breaks need to be prepared as shown in this illustration. A feathered edge repair is prone to failure.

Similarly, when preparing to use infill to fill any voids in the stone, grind a square-cut notch to minimize the sharp thin edges of the mortar. This process is recommended by Cathedral Stone Products Inc., as well as other professional conservators.

Applying Mortar

- Prior to applying mortar, wet the stone with water to avoid absorption of moisture from the mortar by the stone and a resulting weak mortar joint. Avoid leaving puddles of water, which will weaken the cured mortar.
- Apply the mortar by building up thin layers to minimize voids. Work the mortar into any cracks or crevices along the break line. The surface of the mortar should be one-quarter to one-half inch higher than the desired final surface when the initial application of mortar is completed.
- When the surface of the mortar fill has begun to *partially* set, gradually tool (scrape) the mortar to the finished size and shape. Use a stainless steel "screed" or other flat tool that will not stain the mortar. Contouring the infill surface to the desired shape (prior to complete curing) is similar to the work of a sculptor or mason. As the mortar hardens, continue tooling until the remaining high (proud) surfaces are flush with the original surface, or to the desired contour. Practice on discarded stone fragments or on landscape stones.
- Carved designs, tooling marks or textures, and even partial word inscriptions can be added using sculpting tools when the infill mix is still workable. Photographs or other records can be helpful in determining any wording or other original features that may be missing. Texture or surface finish close to that of the original stone may be achieved by using a variety of brushes or tools. A smooth finish will usually dry to a lighter color than a slightly textured or stippled finish.

Keep Infill Moist During Curing – Infill repair areas should be kept moist and covered for at least twenty-four hours, especially if a large amount of fill has been used. Use damp towels to keep the area moist for one day, and / or keep the area covered with plastic sheets. Shrink wrap available at office supply stores can be used to wrap the repair after it has cured to the extent where the application of the wrap will not alter the desired form. Dampen the surface several times for several days using a spray bottle of water if shrink wrap is not used.

Note: Always check the manufacturer's directions for brand-specific detailed instructions for proprietary grout mixes; i.e., preparation, mixing, application, curing and other specific information. For example, Cathedral Stone Products, Inc.'s website contains comprehensive instructions for proprietary Jahn M70 mortar.

Clean-Up

Remove uncured mortar from the periphery of the repair area before it is dried. Use clean water and a closed cell sponge. Repeat several times to prevent a halo-effect (staining of adjacent masonry).

Repairing a Stone Monument Base Using Infill

Infill mortar mix is often used to repair the area of the base (slot) where the tablet is inserted. First reattach any stone fragments using epoxy. Where fragments are missing, the remaining voids will require application of infill. Because of the high stress in the slot where the stone is set, nylon or stainless steel pins (set in holes in the stone, protruding into the infill) may be needed for reinforcement (see Blind Pinning section for instructions on drilling holes).

A male form or plug is crafted to form the slot in the infill for the tablet (see concrete base fabrication section). Remove the plug after the mortar has been allowed to partially cure. Premature removal will result in the uncured infill sagging into the slot. Trowel the mortar for the final contour. (Tooling practice is described in Applying Mortar section.)

Selecting Mortars and Grout

Mortars are used in a variety of applications in the cemetery. Because of the many different applications, including the various stone materials, no one mortar will work for all re-pointing tasks. Because of the interaction between the stone and the mortar, the type of stone and application will dictate the selection of a mortar mix.

It is important to use mineral-based mortars (containing white Portland cement and lime) when repairing damaged historic markers. Premixed products containing latex or acrylic additives commonly found at home improvement centers are *not compatible* with stones in historic cemeteries. Because these "modern" products are so commonly used, it is often difficult to find a mason with experience using traditional lime-based mortars. The International Masonry Institute and Michigan Historic Trades Network are good resources for masons that have experience working with lime based mortars. (The addresses are in the source appendix.)

Material properties of stone and characteristics of mortar mixes are discussed on many internet sites, several of which are identified in the appendix.

Mixing mortar from scratch components, using a formula, is not difficult, and may be less expensive than proprietary mixes. It also offers the user the greatest latitude for custom-matching aggregate size, and to some extent, strength and color characteristics.

However, premixed (proprietary) mortars offer tested performance and uniform characteristics, with little variation from batch to batch. Although slightly higher in cost than mixing mortar from recipes, proprietary mortars offer volunteer workers an easy-to-use alternative with proven results.

Ingredients of Mortar

Mortar is made up of four basic components: water, sand, lime, and white (not gray) Portland cement. The strength of mortar can vary significantly depending on the proportions. Increasing the percentage of Portland cement yields higher strength mortar. More lime results in a softer, more plastic mix with improved workability.

Sand – A primary ingredient in mortar, sand gives the mortar its color and texture. Washed sand crystals that have worn, rounded surfaces (vs. sharp crystals) should be used for work on historic stone. Washed sand improves the workability of the mortar mix, and will result in a finished appearance similar to the historic mixes.

Binders – Portland cement and lime are the two commonly used binders. A high lime mortar is a soft mortar that can resist failure due to temperature changes, and is water-soluble and able to reseal hairline cracks. High concentrations of (white) Portland cement give higher hardness, but shrink more upon setting, resist migration of water, and have greater thermal expansion and contraction. These properties are undesirable on historic stone. It is important to use a suitable mixture for the type of stone and application.

As a point of reference, American Society of Testing Materials (ASTM) Type K mix is a low-strength (75 psi compressive strength) mortar, consisting of one part cement, three parts lime and ten parts sand.

Other Mortar Specifications – ASTM C 270, Specification for Mortar for Unit Masonry defines four types of mortar; with different compressive strength, air content, and water-retention abilities (cured products):

- Type S (avg. compressive strength of 2,500 psi.)
- Type M (avg. compression strength of 1,800 psi.)
- Type N (avg. compression strength of 750 psi.)
- Type O (avg. compression strength of 350 psi.)
- Type K (average compressive strength of 75 psi.) — Not included in ASTM C270 since 1984 but still used in historic applications.

Special Properties of Mortars

Mortars are selected on the basis of their ability to react to the environment similar to the substrate (stone). Avoid mortars with acrylic or latex binders because they inhibit the ability of the stone to breathe and allow salts to become trapped, causing damage to the stone.

Proprietary mortars such as the Jahn products, offered by Cathedral Stone Products, Inc. in Maryland, are single-component, cementitious, mineral-based mortars designed for specific stone types and applications. **Some proprietary mortars require special training and certification to purchase and install.** Firms that make mortars for historic repairs can be found in the appendix and on the internet.

> *Note: Mortar repairs are to be viewed as sacrificial; i.e., if the repaired stone breaks again, it is intended that the repaired joint will fail, not the material of the stone.*

Non-proprietary Mortar Mixes

The white Portland and lime mixes described below have both the plasticity necessary to insure a good bond, and lower hardness compatible with historic stones. Because these mortars closely approximate the strength, permeability and appearance of older mortars and stone, they are appropriate for their respective application (from *John Walters Recipes for Mortar Mixes* – www.rootsweb.com/-inpcrp/mortarmixes.html).

Slot Mix – A mixture used in the *slot* of a monument base when replacing a tablet stone. Mix the following dry components (by volume):

- One part white Portland cement
- Four parts hydrated lime
- Eight parts clean sand
- Water (Very little water is needed for this mix. It should be very stiff and dry looking.)

Stack Mix – A mixture used to set (stack) a marker onto a *flat stone* base. Mix the following dry components (by volume):

- One part White Portland cement
- Three parts hydrated lime
- Water (Very little water is needed for this mix. It should be very stiff and dry looking.)

Both the headstone and the stone base must be clean and sound. Remove all dried mortar from the base or stone. Masking the base stone to the size of the footprint of the headstone will avoid excessive clean up. Dampen the bottom of the headstone and the base with a spray bottle of water, to insure that the stone does not absorb water from the mortar.

- After pre-wetting the base and stone, apply a one-half-to one-inch-thick layer of mortar onto the top of the stone base, covering the outline of the stone. Set the headstone on the base. Use wooden braces for support if required.
- Completely fill the gap around the stone and the base. Create a one-eighth inch mortar fillet at the intersection of the stone and the base to help shed water. After the mortar has dried, usually in a day or two, the braces can be removed.

Infill Mortar Mix – Another basic mix, often used in historic cemeteries to replace missing fragments of stone. The intent is that the dried mortar closely matches the stone being repaired both in color and texture. The choice of aggregate (e.g., sand or stone dust), will dictate the color and texture to some extent. Stone dust, available at sand and gravel / landscape suppliers, or made by crushing stone fragments, can provide a variety of colors and textures. Experiment with different aggregates and check for color-match when dry. If a close match cannot be achieved, choose a lighter colored aggregate, and color the mix with grout dye to match. Mix the following dry components (by volume):

- Two parts White Portland cement
- Four parts Hydrated Lime
- Seven parts stone dust (aggregate) from the parent stone if available
- Water (Very little water is needed for this mix. It should be very stiff and dry looking.)

An infill repair is done not only to improve appearance but to reinforce a repair. Here the repair is done so that the finished edges are of the same worn appearance as the rest of the marker. From a few feet away the repair is indiscernible.

MASONRY REPAIRS AND REPOINTING

Structures in the cemetery such as brick walls, public vaults and other masonry features, while considered *permanent*, are subject to deterioration of the mortar joint. Properly mixed and installed mortars shed water from the masonry, and act as a cushion or buffer against thermal expansion and contraction. Damage caused by stress is intended to occur in the mortar joint, rather than in the stone or brick. Repointing deteriorated joints is an important factor in assessing the maintenance needs of historic masonry structures. A well-prepared and installed joint should last at least twenty to thirty years, although much longer life can be expected under optimum conditions.

Repointing

2 Repointing is the process of cleaning loose mortar from a deteriorated joint, and replacing it with fresh mortar. Using a hammer and chisels, or a grinder, clean out all old mortar from the joint to a depth two to three times the width of the joint. Using an incorrect mortar mix can result in premature failure of the joint and damage to the structure itself. Improper preparation and cleaning of the joint, or a joint with insufficient new mortar, can also lead to premature failure.

The philosophy that “stronger is better” is a common mistake in selecting mortar. Mortar used on historic stone must be flexible to allow for movement while maintaining the bond to the substrate.

A mason experienced with historic lime mortars may be a better choice for larger repointing projects. However, if the following factors are considered in selecting a mortar mix, experienced non-professionals can achieve satisfactory results.

- Compression strength of the mortar – the objective is to match the strength of the existing mortar.
- Type of stone with which the mortar will interface.
- Permeability – a more rather than less permeable mix is usually desirable.
- Type of mortar existing in the joints. (with which the replacement mortar will be interacting)

Pack the mortar in the joints carefully to avoid voids and gaps. Avoid getting mortar on the surface of the bricks. Every attempt should be made to finish the joint with the finished profile and texture the same as the original joint.

Using laboratory tested pre-mixed proprietary mortars may be cost-effective compared with failure of the mortar and masonry.

> *Caution: Pre-mixed mortars available at home centers are too hard and strong for use in historic applications. If possible, have the existing mortar tested to determine its properties.*

GSA Recommended Mortars

Listed below are four mixes recommended for the respective applications in the U.S. General Services Administration Historic Preservation Technical Procedure 04100-03.

Dry components are combined before water is added. *Very little water is needed for these mixes; they should be very stiff and dry looking.*

Historic Masonry Set in Lime Mortar

- One part White Portland Cement
- Three parts lime
- Eight to twelve parts of sand to match existing texture (exact mix will vary due to grain size and will also affect final compression strength)
- Water to give a dry but workable consistency

Historic Masonry Set in Standard Mortar (approximates the ASTM Type "O." See Appendix)

- One part White Portland Cement
- Two parts lime or lime Putty
- Six to nine parts sand or stone dust to match existing texture
- Water to give a dry but workable consistency

Mortar for Use on Limestone (approximates ASTM Type "N." See Appendix)

- One part White Portland Cement
- One part lime
- Four to six parts aggregate
- Water to give a dry but workable consistency

Mortar for Use on Granite (approximates ASTM Type "S". For granite that shows deterioration, or walls indicating movement, use ASTM Type "N" as indicated for limestone.)

- Two parts White Portland Cement
- One part lime
- Seven to nine parts aggregate
- Water to give a dry but workable consistency

EXISTING REPAIRS, SPECIAL BRACES, AND GIRDLING

Older cemeteries display ingenious ways of retaining and supporting markers and marker fragments. While many of these historic repair methods are contrary to traditional conservation standards, many of these repairs have been at least effective. With their unique characteristics, they have become a part of the historic fabric of the cemetery. How the repair is treated (and conserved) becomes an important consideration.

"Do No Harm" Criteria

In some situations, the condition of the stones, or the resources available, may warrant using similar unconventional methods. *The rules identified earlier of "do no harm" and "do that which is reversible" still apply*. It is generally accepted that a stone fragment is 'better off' standing up than lying in the ground; therefore some of the unconventional methods can make good temporary fixes. Braces to hold up the stone, or girdling / banding to hold the stone together, may be effective. While this type of unique repair is sometimes acceptable, it should not be implemented on a large scale; thus widespread use is not advisable. Repair materials selected should cause no damage to the stone, including rust stains from iron or steel used in a repair.

In rare circumstances, unorthodox repairs such as this application serve its purpose. The metal braces used are stainless steel and do not restrict movement of the stone while it still holds the marker upright.

OLD REPAIR METHODS

Iron & Steel

Some older stones have been reinforced or repaired with steel angle or channel, or fastened with bolts or threaded rods through the stone. Steel banding or other bracing devices may also have been installed. Careful evaluation of these old repairs is critical. If the stone does not appear to be in imminent danger of failing, it may be best to leave it alone. If it is necessary or desirable to rework old repairs, a professional conservator should be consulted for corrections. Using steel or iron to shore up a monument is not an acceptable practice.

Drilling through a marker to affix braces is never an acceptable alternative.

Girdling

Professional conservators have used stainless steel channel to girdle stones that have broken, or are judged susceptible to failure. Although not desirable, girdling may be appropriate to prevent theft, accidental breakage and damage, or accelerated deterioration.

- A channel section, slightly wider than the thickness of the stone, is fabricated from high-grade 304 stainless steel, and installed along both edges of a tablet stone. The width of the front flange (3/4") is usually shorter than the rear, to minimize obscuring the inscription on the face. The channels are set in concrete footers to support the stone. Use metal tools with caution around gravestones.
- To stabilize and isolate the stone from the channel, lead wedges, lead rope, or lead wool (available from plumbing suppliers) is packed into the gap between the stone and the channel. Using lead requires attention to safety measures, including all applicable OSHA regulations.
- Use materials that will not adversely react with the stones; e.g., 304-grade stainless steel (vs. mild steel). Do not use silicone sealant or caulks. Because repairs should be reversible, drilling holes through the tablet to secure the channel is not desirable.

Professional conservators have in unique situations, girdled a marker with stainless steel channel. Here the repair is not easily seen and has not compromised the stone.

Tablet Stones Laid In Concrete

2 **3** In older cemeteries, broken stones are sometimes laid flat (imbedded) into a bed of concrete, with the intent of protecting them. Although this reflects an earlier attempt to make a repair, we now understand that the integrity of a stone in this position is compromised because it is now more susceptible to damage from maintenance equipment or from pedestrians. It may also be stained from being covered with leaves and turf, and has little chance of ever completely drying out.

However, removal of the stone from the concrete bed would result in even greater risks to the stone, and should not be attempted. Modifications to prior repairs such as this should be attempted only if the prior repair poses a safety hazard to maintenance crews and the general public.

Instead, carefully clean debris from the stone and the concrete, and identify the edges of the cement pad. Divert vehicle and pedestrian traffic by installing black anodized aluminum landscape edging into the ground around the concrete pad, secured with spikes, and extending approximately two inches above grade. Holes can be drilled into the edging for drainage if required.

Setting broken markers in cement is not an acceptable practice, but removing stones that have been set in concrete is too risky.

Temporary Removal

It may be necessary to temporarily remove a marker of special/unique character from the cemetery for safekeeping until appropriate repair methods can be implemented. Before it is removed, record the location of the stone for future replacement. If the marker will be removed from the grave for some time, a temporary marker should be placed in the location of the original.

Burying a Stone Temporarily

When facilities for temporarily storing broken stones are not available, or when a cemetery is subject to vandalism, another option (and a last resort) is to bury a piece (or pieces) of stone for safekeeping. Bury the stone where it was located. The location must be identified, and the record placed with the cemetery survey to assist in future replacement.

- Dig a hole in front of the existing stone – about eight inches deeper than the thickness of the stone, and large enough so that the stone pieces can lay flat. Tamp the bottom surface and place pea-stone on the bottom to facilitate drainage.
- Place the stone in the hole on top of the pea-stone and cover the marker with geo-textile fabric (available at landscape supply houses). Cover the stone and fill the rest of the hole with clean fill sand. Gently tamp – avoid cracking the marker.

SPECIAL REPAIRS – TABLE AND BOX TOMBS

Because of their special conservation needs, trained and experienced professionals should service these monuments.

Table Tomb

Table tombs may be warped due to improperly installed or deteriorated supports. The conservator may be able to reverse warping by removing the tablet, placing it upside down, and supporting it in a pool of water; with the intent of allowing it to gradually return it to its original (flat) shape. Add additional structural elements to support the top of the tomb, or repair and reinforce existing supports. The details for this work are outside the scope of this book. A professional conservator should be contacted for an assessment.

Box Tomb

Box tomb repairs should also be left to trained conservators. Often the corners, which may be pinned with metal fittings, are damaged as the pins rust and expand. As a result, the top of the tomb may have collapsed, damaging both the top and the sides.

Special Repair Criteria for Box and Table Tombs:

- It is important to retain as much of the original structure of tombs as possible. Even when the inscriptions are illegible, these tombs constitute an important element of the historic fabric of the cemetery.
- Lime mortars should be used as described above. Concrete is used only where footings need replacement.
- When replacing metal components, use high quality 304 stainless steel.
- All surrounding vegetation should be removed (or relocated if the plant is an heirloom variety) to avoid damage due to future plant growth.

A table tomb in very good condition.

A box tomb in fairly good condition. Note the stone delaminating on the right corner of the monument.

Chapter 4

MANAGEMENT AND MAINTENANCE OF THE CEMETERY

After documentation of the cemetery is complete and conservation has begun, it is time to turn attention to management and maintenance requirements. Each cemetery plan will depend upon its community's unique requirements, resources, and manpower. The creation of a local cemetery ordinance is a useful tool in planning for the long term management of the cemetery.

DEVELOPING A CEMETERY ORDINANCE

An ordinance helps to regulate the maintenance, funding, preservation, ownership, access and other issues related to both historic and modern cemeteries. Writing and adopting a local ordinance is time consuming, but worth the effort.

Identify a commission, a township board member, or a city council member that will support the ordinance. It will probably be necessary to educate local officials and commissioners regarding the conditions of historic cemeteries and the need for more specific regulations designed to preserve the integrity of these cultural resources. Once local officials recognize the need for regulation of historic cemeteries, work with these officials and the

city, village or township attorney to draft an ordinance. Provide a sample ordinance containing a list of issues to be addressed. The following are suggestions:

- Protection of the cemetery from vandalism and theft
- Preservation and conservation of the historic cemetery and its artifacts and planting
- Protection of the cemetery from the unlawful removal of human remains
- Lawful relocation of human remains from an actively used or abandoned cemetery
- Protection of the cemetery from the removal of funerary objects
- Development of land that contains a cemetery
- Legal accessibility of cemeteries located on private property
- Specific locations and needs of military veterans' grave markers
- Guidelines related to removal, replacement, and repair of objects associated with a cemetery
- Illegal possession and sale of gravestones and funerary accessories
- Sale of a cemetery
- Use of the Secretary of the Interior's *Standards and Guidelines.*
- Authority to acquire or manage the cemetery
- Authority to raise / appropriate money for conservation and maintenance
- Supervisory body that will oversee management and finances (e.g. city council)
- Rules and regulations of the cemetery
- Process to appeal rules and regulations
- Sale of lots including prices of lots and services
- Lot records required
- Registration of interments
- Funerals and interments (rules)
- Preparation and filing of plats
- Perpetual care fund (investment of assets, use of assets, administration of assets and transferring the fund)
- Memorials (monuments and markers: definitions, use, restrictions)
- Neglected or abandoned cemeteries

The above list, compiled from the Chicora Foundation, "Grave Concerns, A Preservation Manual for Historic Cemeteries in Arkansas," and The Association for Gravestone Studies (AGS), should serve as a guide in the creation of an ordinance, a strongly recommended addition to a list of long-term goals. A sample ordinance prepared by Theodore Chase for The Association for Gravestone Studies is available on the association's website.

PLANNING FOR MAINTENANCE

A burial ground that is properly maintained is pleasant to visit and discourages vandalism. After the cemetery landscape is documented and the initial cleanup has been done, it is time to plan for ongoing maintenance. Maintenance choices may depend upon the budget of the cemetery organization or community. Every cemetery is different and has individual needs.

Short and Long Term Maintenance Goals

Both short and long term maintenance goals should be developed. Much like the prioritization of tasks concerning the repair of monuments, the priorities of landscape preservation and conservation begin with safety and emergency stabilization issues. For example, the removal of tree limbs that are broken or diseased and are potentially hazardous should be addressed immediately. It is important that trained, insured, professionals address safety issues as early as is reasonable.

A maintenance schedule should be part of a cemetery's master plan or preservation maintenance plan. Goals will depend upon the cemetery's needs. Some examples are:

Short term goals:

- Safety and emergency stabilization
- Weeding
- Pruning
- Mowing
- Collection of trash

Long-term goals:

- Strategies for lawn care
- Resolving erosion problems
- The preservation or replacement of trees and smaller plants

SOIL AND TURF MANAGEMENT

Testing and Amending the Soil

2 Before investing any time or resources on the reestablishment of plants or introducing new plants into the cemetery, test the soil. Nutrients cannot be transmitted to the plants effectively if the soil itself inhibits the plants from absorbing the nutrients added during the fertilization process. A soil that has a pH level between the 6.0 to 7.0 range is recommended.

Test kits are available at local nurseries and landscape companies. More extensive testing can be done through a local agriculture extension service. It may suggest what micronutrients are required to bring the soil pH up to a desirable level. This modification can usually be accomplished over a period of about two years, depending on how much adjustment is required. Soil testing should be done in the cemetery every three or four years. Keep a record of any amendments to the soil in order to chart progress.

Any soil amendments made in the cemetery will eventually be wicked up into the markers. With this as a consideration, it is important that those applying amendments have the chemical formulations of each product checked by a knowledgeable professional prior to application to prevent potential damage to headstones and other features. Formulas that are acidic should be avoided, as they will damage marble and limestone. Formulas that contain salts should be avoided as well. Ideally, use a slow release, nonacid, organic fertilizer. Be very careful when applying any chemical to the cemetery. Always blow off or sweep off excess chemicals that may have come into contact with the markers.

Lime

The application of lime will help adjust the acidity level in the soil. It will also change the structure of the soil so that it will decompose organic matter more quickly, hasten bacterial action in the soil and enhance the translocation process of micronutrients from the soil to the plants. The application of lime is done only when soil test results indicate a need to adjust a soil's acid level. Lime should not be applied to soils in conjunction with animal manures and nitrogenous fertilizers, as the combination causes a rapid release of ammonia, which can burn plants.

Fertilizer

If the decision is made to fertilize, it is important to supply the turf with no more than one pound of nitrogen per one thousand square feet. It is always best to supply fertilizer in light, frequent applications as opposed to infrequent heavy applications. Generally speaking applications can be done on or around the first week of June, September, and November. It is important to follow manufacturer instructions when applying fertilizer and irrigation should be adjusted to complement the introduction of fertilizer. A slow release formula with a 3:1:1 ratio is suggested for most applications.

Although a strong stand of turf usually requires fertilizer to maintain its vitality, over-application to enhance growth will require more maintenance to keep the look of the cemetery acceptable to modern standards. Furthermore, because fertilizers contain acids and salts, the routine application of fertilizers is discouraged. A balance must be struck between the health and vitality of the turf and the important considerations of stone conservation.

Herbicides and Insecticides

The routine use of herbicides is discouraged. Their use should be restricted to eradicate noxious plants such as poison oak and poison ivy. Insecticides should be used only in the case of serious infestations. Indiscriminate application of any chemical in a historic cemetery should be avoided. The probability of damage to the markers is much greater than the benefit gleaned from the chemical application.

Soil Compaction

Soil compaction is the single largest killer of turf. Failure to maintain the subsurface portion of the turf disrupts the balance of the turf and leads to a steady decline. Often the decline is blamed on insect infestation, disease, improper watering, or poor fertilization practices. Aeration helps eliminate thatch. The unmanaged build-up of thatch will make the lawn suffer. Ideally the cemetery should be aerated twice a year; though once a year is often adequate. This can be done with three-quarter inch hollow core tines that penetrate no more than three inches deep. It is best done during periods of active turf growth such as spring, early summer, or fall and when the soil is moist to insure full tine penetration. Another benefit of aerating is that it can be done in conjunction with the over seeding of the turf or other renovation projects. A negative aspect of aeration is that openings in the turf provide opportunity for the invasion of weeds. It is important, then, to time the aeration to avoid optimum germination periods.

Aeration should not be done in areas where snapped markers are still lying in the ground. A core aeration machine can cause severe damage to stones left covered by only a couple inches of dirt. Aerate only after a complete survey and probing has been done to assure that no stones are damaged.

Over-Seeding

The regular introduction of grass seed to the cemetery is an important part of the maintenance plan for a strong stand of turf. For best results, over-seeding can be accomplished immediately after core aeration has been completed. A mix of seed should be used for optimum coverage. The mix should reflect the conditions of the area, such as shade or sun, and the soil conditions as well.

The following are recommended as good basic mixes. Specific needs should be identified and mixes made to fit those needs. A reputable landscape supply company, such as Lesco, can offer a variety of premixed-bagged seed. For additional information, a local agriculture extension agent can be of assistance, as could the greens keeper at the local golf course. Generally the seed is applied at a rate of 120 pounds per acre. Here are suggestions from the grounds manager at Fort Custer National Cemetery, Battle Creek, Michigan:

Full sun mix:

- Twenty percent Gnome Kentucky Bluegrass
- Twenty percent Micro Tall Fescue
- Twenty-five percent Titan II Tall Fescue
- Twenty-five percent Waldina Hard Fescue
- Ten percent Affinity E Perennial Ryegrass

Shady mix:

- Forty percent Red Fescue
- Thirty percent Perennial Rye
- Twenty percent Chewings Fescue
- Ten percent Kentucky Bluegrass

In general the type of seed mix chosen should include drought resistant, slow growing, low maintenance cultivars.

Watering

Watering of the lawns should be done where reasonable to maintain the normal growth and color of the stand of turf. If no water is available, be certain that applications of chemicals or seeds are done so that forecasted rain will have the desired effect. Most historic cemeteries do not have irrigation systems available, so the frequency of watering may be limited to natural rainfall. The cost of installing an irrigation system is often prohibitive. In addition it could be very damaging to the graves and markers, and is not historically accurate. If feasible, a water supply could be installed near the fence line or immediately outside of the fence line to accommodate maintenance needs. Locate the water tap near a roadway and use quick couplers that can be installed below grade. **Level 3**: An irrigation specialist can assist in the installation of these types of hook-ups.

Mowing

2 The lawns of historic burial grounds were not maintained using the same techniques and standards as the lawns in today's residential communities. In fact, cows and sheep were often the means by which the grass was "mowed." The turf was often longer than we are accustomed to seeing today, and to some extent, a return to the nineteenth-century standard may well be one of the best ways to preserve a historic burial ground. In some communities, however, the look that was accepted years ago would not be tolerated today. Using the older method can actually make maintenance harder because the removal of the longer thicker grass blades near to the bases of the stones is more difficult than keeping a shorter blade manicured.

How often the grass is mowed will depend on those involved in the project, the type of cultivar present, its general health, the weather and the availability of resources. Often, municipally owned graveyards are maintained by private contractors that simply cut the grass on a specified schedule. Without the proper instruction, supervision, and follow through, lawn maintenance will continue to be the most damaging activity to stones in the graveyard. Instruct those working in the historic cemetery that they will be working in a fragile environment with special requirements and care must be taken near monuments and historic plantings.

Without proper instruction and follow through, lawn maintenance damage like this will continue.

Generally speaking, no more than one third of the grass blade should be removed at any one cutting. Frequency of cutting is, to a great extent, dependent upon weather and fertilization conditions. For the most part, the following mowing schedule can be used to keep the cemetery looking manicured:

- From the beginning of the season to mid June, every five days
- From mid June to mid or late August, every ten days
- From late August to the end of the cutting season, every five days

There are points that can be discussed with those responsible for the maintenance of the cemetery lawn that will lessen the chance of damage to gravestones and historic plant material from mowing. Specific topographical and other unique features will warrant additional discussion with the lawn maintenance crew. At the very least be clear regarding the following points:

- The maintenance crew must be trained in the specific needs of the cemetery prior to actually cutting, with **an understanding that a historic cemetery is handled differently than a residential or commercial property.**
- **No riding mowers should be used in an historic cemetery.** They are too large for the closely spaced markers and in some circumstances too heavy and can leave ruts in the soil. Only walk-behind mowers are to be used in the cemetery.
- Grass should be cut to a height of 3" unless other unique considerations are discussed and agreed upon prior to cutting.
- All clumps of grass left by the mowers should be raked up and discarded off premises.
- All mowers used in the cemetery should **have and use discharge guards** to protect the gravestones and workers from thrown debris. It should be made clear to workers that **mowing equipment should never make contact with headstones.**
- Where possible, alternate the direction of mowing every other cut.
- **All mowers should be equipped with rubber bumpers on the decks**, any axle assembly, or other feature on the mower that might come in contact with a stone while mowing. This can be fabricated out of old inner tubes or tires and can be riveted on. Loose cell foam can also be used as a bumper.
- While mowing around stones the discharge chute should project away from the marker.
- Grass should be cut by the mower up to, and no closer than, 12 inches from every marker. The rest of the turf will be trimmed with a line trimmer (weed whips) using a line that measures no more than .09" in diameter. There should be a clear understanding as to the delicacy of the markers in the cemetery.
- Any damage should be reported immediately to the cemetery administrator.
- There should be a process for delaying maintenance in the event of a funeral or burial.

Drainage

Determining drainage problems will require a professional engineer or landscape architect. Near many cemeteries the surrounding area has been developed causing a change in the original topography of the cemetery. As a result, the newly created run off from the developed areas can cause drainage issues that must be addressed. Not only will standing water cause damage to the stones and their surroundings, but the standing water poses a health issue as well. Often the installation of a French drain (a trench filled with gravel and topped with sand) or some drainage tile will rectify the problem. Install the drainage outside

the fence line of the cemetery so that the run-off is not allowed to enter the cemetery. Prior to any excavation be certain that graves are not going to be affected by these actions. In the event that soil has to be imported and used to level or build up an area, be certain that no markers are being covered and lost due to the addition of soil. In many instances a municipal planner or engineer will be available to suggest methods or improvements that will assist in the drainage issues. Advice from an archeologist experienced with cemetery work may be appropriate as well.

Depressions

Depressions in the soil are usually the result of earth in the burial shaft settling, or the result of removal of trees or bushes. For slight depressions it is generally recommended that they be left alone. If the depression poses a safety or drainage hazard and the decision is made to fill it, it is important to decide whether or not it is that of an unmarked grave. Any alteration of the landscape should be documented and recorded with the cemetery survey data.

Trees

2 Planting the proper tree in the right location and then correctly maintaining it will determine whether it will be an asset or a liability. It is recommended that trees be fertilized annually with a slow release fertilizer with a ratio of 3:1:1. An inspection of the trees should be made periodically to make sure the root systems are not interfering with gravestones and that broken limbs are not safety hazards. An effort should be made to replace a tree that has sustained damage or is no longer viable. The ideal plan is to replace a tree with the exact species. Replacement of a memorial tree, for example, could be done using its genetic stock. However, some old species are susceptible to insects and disease. Also, it may not be economically feasible to replace certain species or not advisable because it maybe harmful to gravestones.

3 In most cases it is recommended that an arborist (see Yellow Pages of the phone book) or tree service that is knowledgeable about historic landscapes be consulted when replacement is considered. If a tree needs to be removed due to disease, damage, or conflict with gravestones, it is best to cut it as close to the ground as possible, then leave the stump to decay without assistance of chemicals. After the stump has decayed topsoil can be added and the area reseeded.

"The Massachusetts Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries" is an excellent resource for landscape maintenance. It would be appropriate for use in Michigan because Massachusetts plant hardiness zones are the same as

in southern Michigan, zones 5 and 6. The following are some of Massachusetts's recommendations for tree maintenance:

> A specific planting plan should be developed prior to planting additional trees. The selection of tree species is an important consideration in terms of appropriateness, maintenance requirements and protection of historic artifacts. Botanic diversity is a particularly important consideration for sites that have roots in the rural cemetery movement. Monocultures are generally not recommended because of experience with devastating diseases like Dutch Elm Disease, White Pine Blister Rust and Chestnut Blight. Acid rain has been monitored for many years and it is suspected to be affecting Sugar Maples, causing Maple decline. Traditionally, Maples have been considered to be long lived trees where narrow tree pits, road salt and drought have not been a problem. ("Massachusetts Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries," p. 28-29)

Replacement trees should be limited to areas that do not interfere with grave markers, paths, drives, fences, walls, and buildings. Tree placement should take into consideration the specific characteristics in relation to the type of stone. For example, the roots of acidic trees, such as pine and oak, can be detrimental to marble, limestone, and sandstone, which contain calcium carbonate. Stones of the silica family, such as granite, are more resistant to acid. If a tree needs to be replaced in the cemetery, the Michigan Department of Natural Resources offers the following hardiness and size guidelines for tree selection:

RECOMMENDED MICHIGAN NATIVE TREES			
Common	**Genius Species**	**Hardiness Zone**	**Size Class**
Fir, Balsam	Abies Balsamea	3-5	large>40’
Maple, Red	Acer rubrum	3-9	large>40’
Maple, Sugar	Acer saccharum	3-7	large>40’
Birch, River	Betula nigra	4-9	large>40’
Birch, White	Betula papyrifera	2-4	large>40’
Hackberry	Celtis occidentalis	4-9	large>40’
Beech, American	Fagus grandifolia	4-9	large>40’
Cedar, Eastern Red	Juniperus virginiana	2-9	large>40’
Tuliptree	Liriodendron tulipfera	4-9	large>40’
Blackgum	Nyssa sylvatica	5-9	large>40’
Spruce, White	Picea glauca	2-6	large>40’
Pine, Red	Pinus resinosa	2-5	large>40’
Pine, White	Pinus strobes	3-8	large>40’
Cherry, Black	Prunus serotina	4-9	large>40’
Oak, Swamp White	Quercus biocolor	4-7	large>40’
Oak, Bur	Quercus macrocarpa	3-8	large>40’
Oak, Pin	Quercus paustris	5-8	large>40’
Oak, Red	Quercus rubra	5-8	large>40’
Oak, Shumard	Quercus shumardii	5-9	large>40’
Arborvitae	Thuja occidentalis	2-8	large>40
Basswood	Tilia Americana	4-7	large>40’
Ohio Buckeye	Aesculus glabra	4-6	medium 30-40’
Ironwood	Ostrya virginiana	3-9	medium 30-40’
Spruce, Black	Picea mariana	2-5	medium 30-40’
Maple, Striped	Acer pensylvanicum	3-7	small>30’
Serviceberry, Downy	Amelancier arborea	3-8	small>30’
Hornbeam, American	Carpinus caroliniana	4-8	small>30’
Redbud, Eastern	Cercis Canadensis	4-9	small>30’
Dogwood, Flowering	Cornus florida	5-6	small>30’
Dogwood, Grey	Cornus racemosa	4-8	small>30’
Hawthorn	Cratageus spp.	5-8	small>30’
Common Chokecherry	Prunus virginiana	3-8	small>30’
Nannyberry Viburnum	Viburnum lentago	2-8	small>30’

TREES NOT RECOMMENDED FOR PLANTING		
Common	**Genus Species**	**Comments**
Maple, Boxelder	Acer negundo	Weak wood, poor branch structure, prone to insect pests, invasive.
Maple, Norway	Acer plantanoides	Overplanted, invasive, susceptible to storm damage.
Maple, Norway Cultivars	Acer plantanoides cultivars	Overplanted, invasive, susceptible to storm damage.
Maple, Silver	Acer saccharinum	Weak wood, poor branch structure, very susceptible to storm damage, invasive roots.
Tree of Heaven	Ailanthus altissima	Weak wood, sucker growth
Birch, Paper	Betula papyifera	Prone to major insect pests, very susceptible to storm damage.
Birch, European White	Betula pendula	Prone to major insect pests, very susceptible to storm damage.
Chestnut, American	Castanea dentate	Prone to major disease and insect pests
Russian Olive	Elaeagnus angustifolia	Prone to major disease and insect pests, very invasive
Ash species	Fraxinus spp.	Prone to major disease and insect pests, especially Emerald Ash Borer
Ginkgo	Gingko biloba	Fruit from female trees have very unpleasant odor.
Honeylocust	Gleditsia tricanthos	Messy fruit, thorns may be harmful, thornless varieties are available.
Mulberry, White	Morus alba	Messy fruit, susceptible to storm damage, invasive roots.
Spruce, Colorado	Picea pungens	Out of range in Michigan, prone to disease
Spruce, Colorado Blue	Picea pungens var. glauca	Out of range in Michigan, prone to disease
Poplar, White	Populus, alba	Susceptible to storm damage, excessive sucker growth, invasive roots.
Poplar, Cottonwood	Populus deltoids	Susceptible to storm damage, excessive sucker growth, invasive roots.
Cherry, Black	Prunus serotina	Messy fruit, prone to disease and insect pests, very susceptible to storm damage.
Locust, Black	Robinia pseudoacacia	Prone to major disease and insect pests, sucker growth.
Willow, Weeping	Salix alba	Weak wood, poor branch structure, very susceptible to storm damage, invasive roots.

TREES NOT RECOMMENDED FOR PLANTING – CONTINUED		
Common	**Genus Species**	**Comments**
Willow Black	Salix, nigra	Weak wood, poor branch structure, very susceptible to storm damage, invasive roots.
Mountain ash, American	Sorbus americana	Major disease and insect pests
Mountain ash, European	Sorbus aucuparia	Major disease and insect pests
Elm, American	Ulmus americana	Prone to major disease and insect pests, especially Dutch Elm Disease, invasive roots.
Elm, Siberian	Ulmus pumila	Prone to major disease and insect pests, very susceptible to storm damage.
Elm, Slippery	Ulmus rubra	Prone to major disease and insect pests, especially Dutch Elm Disease.
Elm, Rock	Ulmus thomasii	Prone to major disease and insect pests.

Pruning

Trees and shrubs should be pruned on a regular basis to protect people and cemetery artifacts from falling branches. Too much shade may retain moisture in the ground, which affects grave markers, particularly marble and slate. Look for canopies that are too broad and susceptible to wind damage or trees that are shallow rooted and easily toppled. Consider thinning the crown of a tree as opposed to removing the tree. A five-year cycle of pruning is advised for normal maintenance. After inclement or windy weather the burial ground should be inspected for tree damage that would necessitate pruning or staking.

Plants

A supply of plants taken from the cemetery can be maintained by taking cuttings or propagating plants from seed. A small flower/plant bed might be started outside the cemetery for this purpose, assuring that a supply of the cemetery's historic species will be on hand. This could be done by volunteers, such as a local garden club or master gardener.

Some plants self-seed or put up new shoots through runners and create new plants known as volunteer growth. All volunteer growth should be removed at least once a year and a thorough inspection of trees and shrubs throughout the cemetery should be done on a yearly basis, to avoid damage caused by unchecked growth.

BUILDINGS, OTHER STRUCTURES, AND FEATURES

Many historic cemeteries contain structures such as mausoleums, chapels, and crypts. While it is beyond the scope of this work to address conservation of these buildings, they are an important part of the historic context of a cemetery and a plan for their conservation should be developed. Likewise, stone walls and concrete curbing fall into the same category. Professionals experienced with conservation of historical and architectural features should be consulted before any work is begun. Without reasonable, appropriate conservation measures these buildings and structures are endangered and begin to pose security and safety concerns. Failure to maintain historic structures not only detracts from the appearance of the cemetery but compromises the cemetery's historic fabric.

Pathways and Roads

2 The circulation pattern of roads and pathways in the cemetery should remain as originally laid out. Maintenance will depend upon how heavily the site is used. Repairing paved areas, cleaning paths and drives, removing hazards that might cause tripping, monitoring and repairing erosion problems, and snow removal are on-going activities. Brick and gravel paths and roadways require regular maintenance.

Vehicle entrances should be at least twelve to fourteen feet wide. Pedestrian entrances should be at least forty-eight inches wide. Paths should be a minimum of sixty inches wide and wheelchair access should be offered. (Strangstad, p. 20) The Americans with Disabilities Act is intended to eliminate, as much as reasonable, unnecessary barriers encountered by those with disabilities. There are exceptions to parts of this act, specific to historic settings. "Complying with barrier-free access requirements, in such a way that character-defining features, materials and finishes are preserved, for example, widening existing stone walks by adding new stone adjacent to it to achieve the desired width." (The Secretary of the Interior's *Rehabilitation Guidelines for the Treatment of Cultural Landscapes*, p. 86).

Signage

Another ancillary element that the cemetery plan needs to address is signage. In addition to historic signage there is often a need for contemporary signs. If they are well designed and appropriately placed they will enhance the visitor's experience by providing information, interpreting history, assisting in way finding, and indicating regulations that pertain to the site. Signage, though necessary, can be an unobtrusive component of the cemetery.

For a small cemetery, it is recommended that signs be limited to the cemetery entrance. Signs that provide pertinent information should be posted prominently, but should not

detract from the historic feeling of the cemetery. If it is necessary to include way finding or interpretive signage within the cemetery the number of signs should be limited and their color and design should blend with the surroundings. Avoid creating the impression of false history by using materials or styles that appear to be historic when they are not. Likewise, materials such as polished granite or marble should not be used as they can be confused with monuments.

Metal is the most durable and appropriate material for signage. Cast alloys of aluminum or brass will provide a visually pleasing sign that will be quite durable and require little maintenance. Although they are durable, avoid both sheet metal and plastic for aesthetic reasons. Though historically correct, wood tends not to weather well and may have to be replaced frequently. The mounting standards or posts can be as important as the sign, and care should be taken when choosing them. While it is appropriate to post signs on fencing it is not recommended that they be attached to trees. Before placing any signs, consider how they will affect the view shed and historic resources of the cemetery.

Signs that identify or name the cemetery are the ones most likely to be historic in nature. Often a historic cemetery will have an ornate cast iron sign as part of the entry gate. Where this type of sign exists it should receive the same care and maintenance as other decorative metalwork. Historic signs often provide little additional information beyond the cemetery's name, creating a need for other informational signage. Further information might include the cemetery's founding date and any other names for the cemetery, both historic and current, thus clearing up any confusion for those doing research pertaining to the site.

Informational Signs

To retain clarity of either instructions or information several different signs may be necessary. Informative signs should be posted near the entrance of the cemetery where the visitor can readily find them and should provide pertinent information such as the name and contact information of the agency maintaining the cemetery and its hours of operation.

Informational signs may also include:

- historical information
- founder's name
- the names of important persons interred
- state, national, or local register designation, if applicable
- information to contact cemetery authority for further rules and restrictions on funerals, headstones, plantings, etc.

If a restoration is in progress signage can keep the public informed. Such a sign might include the name of the group or agency in charge of the restoration project as well as information about where interested persons can contribute both financial and volunteer help. It should also identify a contact person with phone number, e-mail address, or a web site created for the project. A sign of this type can also serve to recognize those that have contributed to the restoration.

A cemetery may have a state historical marker that gives a brief summary of the history of the cemetery. Michigan law now requires that work on sites with state markers must meet the Secretary of the Interior's *Standards for Rehabilitation*, or the marker can be removed.

Signs that provide information on important burials, local settlement histories, or ethnic groups buried in the cemetery or that indicate unusual plantings or monuments can be erected by the local government, historical society or cemetery associations. If a group plans on this type of sign the history should be well researched and accurate. Where many markers are missing or stones are deteriorated, plaques may be used to list all known burials.

Signs such as these inform the public of the important historical information relative to the cemetery. They also demonstrate a community's commitment to the historic cemetery.

Regulatory Signs

Sometimes a cemetery association or a local government will post a regulatory sign near the entrance to inform the public of any special regulations pertaining to the cemetery. The public needs to be aware of restrictions on pets, jogging, or alcohol, or limitations on grave decorations or plantings. Where restrictions need to be posted, they should be done in as unobtrusive a manner as possible. It is off-putting to be met by a large list of "don'ts" upon entering the cemetery gates. Be advised that no rule can be created that is contrary to local, state, or federal regulation, so research the regulations as they relate to the site. Regulatory signs also advise the public of any restrictions, prohibitions, or permits required by the cemetery authority.

Regulatory signs may include:

- hours of operation
- rules / prohibitions, e.g., no dogs or alcoholic beverages
- caution regarding fragility of older stones
- caution not to move or tread on fallen stones
- policy regarding cleaning or "rubbing" of headstones, including any permits or permission required

Before any signs are ordered or installed, check with local authorities to see if any ordinances apply to the site, or if permits are required. While signage is essential for information and way finding, the over-use of signs detracts from a cemetery's appearance and raises the question of historical accuracy.

Lighting

Small cemeteries founded in the nineteenth century did not historically have lighting as an original feature. Modern security issues, however, sometimes dictate a need for some lighting. Maintaining historic context and balancing today's needs become an issue that should be addressed with thought and care.

Most experts recommend keeping lighting to a minimum and preferably confining it to outside the cemetery boundaries. It is suggested, however, that the lighting outside of the cemetery (possibly pre-existing) be enhanced if security needs exist. Improved street lighting or the addition of lighting on buildings surrounding the perimeter of the cemetery may offer the most reasonable approach.

Installing new lighting within the parameters of an historic cemetery is a challenge. The electrical lines needed for installation most likely do not exist within the boundaries of the cemetery. Overhead lines will most often be aesthetically unpleasing and burying lines is almost impossible given the nature of these sites. The heavy equipment necessary to install underground lines, the chances of disturbing a burial site, and the potential for damage to cemetery elements makes it a daunting and very expensive task.

While historic cemeteries do not often have lighting as a feature, any fixtures or poles that appear to be historic should remain. They require the same research and documentation as other features of the cemetery. All documentation should be included with cemetery survey data. Cemetery plans and goals should include proper conservation and maintenance of these historic features.

Other Features

Often, in order to optimize the use of a historic cemetery, a need arises for certain elements that never existed historically. Trash receptacles and, to a lesser extent, seating are modern additions that are of some necessity in the cemetery. Choice of materials and respectful placement is the key in incorporating these elements. Be aware that creating a false sense of history is unacceptable according to the Secretary of Interior's *Standards and Guidelines for Historic Preservation and Rehabilitation*. Using materials or designs that lead visitors to believe that these new elements were historically present is destructive to the historic integrity of a property. Trash receptacles should be placed discretely and unobtrusively in areas where they are required. Seating should be simple in design and, if needed, preferably placed outside the entrance to the cemetery. Avoid additional plantings that can be historically inaccurate and increase the cost of maintenance. Repair and conservation of pre-existing ancillary features is always suggested as they contribute to the historic character of the cemetery.

Chapter 5

THE CEMETERY AS
A CULTURAL ARTIFACT

MULTI-PURPOSE USE OF CEMETERIES

While a great number of historic cemeteries remain active with new sections platted and burials continuing, not all of the state's cemeteries are still in use. Though inactive, they are still important to a community as a cultural resource. A group formed to act as curator of a historic cemetery should be aware that in order for conservation efforts to continue, it is important to devise ways to attract, and interest, a diverse group of people. Finding new uses for historic cemeteries helps assure that they will be well maintained and cared for. In addition, multi-purpose use of a cemetery prevents the appearance of abandonment that can invite trouble. With good planning historic cemeteries can serve the living while commemorating the dead. A multi-dimensional approach to planning will help generate the interest and funds necessary to insure that goals set for the future conservation of the cemetery are achieved.

As an educational tool the cemetery offers the community many opportunities that, if utilized to their full potential, can benefit a cemetery preservation project in many ways. Charging a small fee for historic tours can be a means of providing much needed revenue for a project. History tours for both adults and children will build respect for and interest in local history as well as foster community pride and respect for the site. For school children

a field trip to the cemetery can spark an interest in preservation, art, folklore, or other studies. Genealogists often find information not easily accessible elsewhere. The cemetery can also serve as a laboratory and workshop for preservation projects. Imagination and planning will enable a community to fully utilize this important resource.

Tours are one way of utilizing the cemetery for educational purposes. Tecumseh, a small community in Lenawee County, Michigan, counts over three hundred Civil War soldiers buried in their Brookside Cemetery. Every spring, as part of Tecumseh's "Promenade the Past" annual festival, Robert Elliot, local historian and guide, conducts an extremely popular Civil War tour. He has done extensive historical research utilizing public records at the Archives of Michigan, personal letters, and other memorabilia to construct the lives of several soldiers. Local actors dressed in period costume stand alongside selected tombstones and recount the soldiers' histories in first-person narrative. Mr. Elliot who has been conducting these tours for ten years, says the emotional impact of the tour is impressive. Since he began the tours for school children, scouts, and others there have been no incidents of graffiti or vandalism in the cemetery. It is an excellent way to not only recount local history but to also tie that history to the broader story of our nation's past. The respect generated for the individuals involved in making the area's history leads to respect for the cemetery.

Brownie Troop 2487 visited Lodi Township Cemetery to learn about the cemetery and its history and to pick up trash and branches.

Involving local adult education, schools, scout troops, 4-H, and other organizations will insure a wide use of the cemetery. Two ideas include: a group meeting to read and record epitaphs, (even young children can participate in such an activity), or a group discussion on cultural attitudes towards death based on epitaphs and inscriptions.

Teachers may find the cemetery a useful learning tool. It can become an outdoor laboratory for the study of geology, chemistry, biology, and botany. Writing, literature, and history instructors can find ample opportunities for their students to use the cemetery to generate stories and research histories. For art instructors there is a wealth of sculpture and headstone carvings available for drawing, photographing, and studying. Geared either toward elementary or secondary education the following list of questions could be used in association with a visit to the cemetery. When combined with a prior history, culture, or art lesson, they will help focus the visit, generate an interest in, and provide a follow-up activity to the visit.

- Are any markers inscribed in foreign languages? What does this relate about the area's history?
- Are there indications of wars, epidemics or other catastrophic incidents recounted in the epitaphs or inscriptions? (Examples: Mentions of battles or military campaigns, a large number of people who died during the 1918-19 flu epidemic, or several family members that died on the same day.)
- What is the oldest grave marked?
- What is the newest grave marked?
- Are there any famous people buried in the cemetery? (local, state, or nationally important)
- What decorative carvings and epitaphs are noticed? Are there similar carvings on other monuments? Do similar motifs have similar dates? What does this indicate?
- What is the condition of the monument? The grounds? The fences etc.?
- What is the most common material used for monuments? (stone type)
- Was there anything surprising about the cemetery or the visit?
- Pick one monument and write a paragraph, or essay about the epitaph, carving/artwork, or the condition of the monument.

Workshops modeled on the Association for Gravestone Studies and the National Preservation Institute sponsored workshops can be planned. At times monument dealers, cemetery conservation groups, or preservation organizations like the Michigan Historic Preservation Network, conduct training sessions on proper gravestone cleaning and repair techniques.

The Michigan Historic Preservation Network, as well as other groups have given workshops on cemetery conservation. Here a representative from Cathedral Stone talks at a workshop given by the Michigan Historic Preservation Network in Rochester Hills, Michigan.

Grave Concerns, a Preservation Manual for Historic Cemeteries in Arkansas, offers a list of "Over 100 Things to do in a Cemetery." We reproduce it here in part, with a few original ideas, providing a list of activities that seem most suited to the Michigan climate, and the relatively small size of the cemeteries we have been discussing:

- Conduct walking tours highlighting selected burials in the cemetery such as Civil War soldiers or local founding fathers.
- Have students complete a living history of the cemetery. Write short biographies of those buried in the cemetery and have them available for walking tours and other activities.
- Conduct tours with interpreters dressed in period costumes recounting personal histories.
- Conduct a scavenger hunt where groups look for information that can be gleaned from inscriptions or artwork on monuments.
- Publish genealogical information.
- Plan demonstrations or conduct workshops on proper cleaning and/or maintenance techniques.
- Conduct a photographic workshop.
- Hold Memorial and Veterans Day services.

- Sponsor a "Make a Difference Day" clean up.
- Establish an adopt-a-plot or adopt-a-stone program to help with maintenance.
- Seek out students and others who must complete community service projects and use them for routine maintenance.
- List the cemetery on local and national historic registers.
- Create a slide show or power point program for use in presentations.
- Establish a web site about the cemetery.
- Design a pamphlet or self guided walking tour of the cemetery.
- Conduct a monument inscription workshop with instructions on reading the stones and understanding their meaning.
- Offer seminars on antique plant care and propagation.
- Establish a "Friends of the Cemetery" group or cemetery foundation.
- Other ideas can be found at www.angelfire.com.

As a landscape, the cemetery is a type of botanical garden where a variety of trees and other plant species may be found. In the spring wildflowers can be seen and in the fall a visitor may enjoy the rich palette of colored leaves. Some horticulture-related activities for individuals or organizations are:

- Have a shrub and tree tour.
- Lead a tour of garden enthusiasts to view and discuss historic plantings.
- If trees are mapped or easily identifiable, compare which species are native to Michigan and which are not.
- Have a spring flower tour. What flowers are symbolic?
- Identify Michigan wild flowers.
- Create a calendar or coloring book using historic cemetery plants.
- Hold a botanical watercolor or drawing class.
- Hold a workshop on care of the cemetery landscape.
- Offer limited sales of clippings and seeds from historic plants.
- Have an amateur or professional juried photograph contest and sale featuring photos taken in the cemetery. A percentage of the sales could go to the cemetery organization.
- Offer a workshop on propagating and growing antique plants.

These lists are only a beginning. Finding a way to integrate a historic cemetery into community life is limited only by the creativity of the planners.

GRAVESTONE RUBBING – DON'T

Cemeteries, with their irreplaceable headstones, are an important part of the cultural heritage of every area. Cemeteries contribute to our local and regional heritage, and should be respected and treated as carefully as any other historic artifact.

Gravestone rubbing is the process of reproducing the inscriptions on headstones onto paper by rubbing a wax stick, chalk or other art-markers over paper on the surface of the stone. While this may seem to be a harmless activity, many stones in historic cemeteries are permanently damaged by this practice. Persons unfamiliar with the requirements of historic cemeteries may assume that the various headstone materials are impervious to harm, however, stone can be easily damaged and must be treated with care. The following information regarding the damage to gravestones has been adapted from the Association for Gravestone Studies leaflet, "*Gravestone Rubbings for Beginners*" by Jessie Lie Farber.

Damage Caused by Rubbing

Gravestone rubbings are not recommended and are no longer considered an acceptable practice because of the harm and damage that can occur. Listed below are common concerns and damage caused by rubbing.

- Paper used to make the rubbing can tear, causing the rubbing material (often wax) to be transferred to the monument. Removing wax from the stone is extremely difficult without significant degradation of the stone.
- Rubbing over the edges of the letters and carving on a stone causes minute damage to those edges. Over time, this damage opens pores in the stone, allowing additional moisture into the stone, which can accelerate deterioration from the inside out.
- The harsh elements of nature to which stones are exposed not only deteriorate inscriptions and decorations, but also render the total facade susceptible to damage. Previous repairs, or existing deterioration due to spalling or sugaring of the surface, also make applying friction and pressure to the face of the stone an unsound practice.
- Some rubbing papers can leave a waxy residue on the stone, which hinders the stone's natural ability to breathe, and may discolor the stone and ruin the natural patina. The waxy residue can also interact with acid rain, accelerating deterioration of the crust of the stone. Using newspaper as a rubbing media, which is often advocated, can also adversely affect the stone because it contains acids and the ink may stain the stone.
- Adhesive tapes of any kind should not be used. They may leave a residue on a headstone that will adversely affect the stone.

- **The use of shaving cream to highlight inscriptions is not an acceptable practice and should not be allowed.** Shaving cream contains steric acid, a waxy solid, which causes the surface of stones to deteriorate more quickly. The damage to the surface of the stone is similar to that of acid rain, but is more severe. Marble and limestone are particularly vulnerable. Because it soaks into the stone quickly, it is very difficult to completely rinse off the surface. Residues include organic compounds, which attract harmful microscopic organisms such as moss and algae, further deteriorating the stone.

Photography as an Alternative to Rubbing

With the currently available photographic capabilities, rubbings are an unnecessary risk for fragile historic headstones. High-resolution photography of stones is a safe and effective alternative to rubbing. Photography can document and reproduce the same information. A digital camera can achieve remarkable results without chemicals or stress to the stones.

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Appendix A

FORMS

MICHIGAN GENERAL CEMETERY SURVEY FORM

Use continuation sheets where needed

Survey Date _____

Current Cemetery Name _____

Historic Cemetery Name _____

Address _____

Village/City _____ Township _____

County _____

Owner _____

Owner's address _____

Owner's phone number _____

Type of ownership

☐ private-profit ☐ private-nonprofit ☐ private-unspecified ☐ city ☐ township ☐ county
☐ state ☐ federal ☐ Native American ☐ other _____

Accessibility to public

☐ unrestricted ☐ restricted (private property) ☐ by car ☐ by foot

Description

Type of cemetery (check all that apply)
☐ community ☐ family ☐ military ☐ municipal ☐ national ☐ religious
☐ other, explain _____

Design/style/layout

☐ early burying ground/small historic cemetery ☐ Rural Cemetery
☐ Lawn Park ☐ Memorial Park

Condition

☐ currently in use ☐ abandoned ☐ maintained, but not in use

Overall evaluation of condition of grounds

☐ excellent ☐ good ☐ fair ☐ poor

Specific problems

☐ overgrown vines ☐ overgrown grass ☐ overgrown shrubs ☐ unpruned trees
☐ fences, walls in poor repair

Context

☐ urban ☐ rural ☐ residential ☐ commercial ☐ industrial

Approximate size of burial ground: _____x_____ft., _____acres

Boundaries

☐ fence (material) _____
☐ wall (material) _____
☐ gate (inscription) _____
☐ hedge (type) _____
☐ other _____
☐ none _____
Condition of boundaries _____

Topography
☐ flat ☐ rolling

Natural features: _____

Ethnic group(s) interred
☐ Caucasian ☐ Asian ☐ Native American ☐ African American ☐ Hispanic
☐ other, explain _____

Further information _____

Grave groupings (check all that apply)
☐ family ☐ fraternal order ☐ military ☐ religious ☐ ethnic heritage
☐ other, explain _____

Plot enclosures (check all that apply; indicate number of each if appropriate)
☐ curbing, material: _____
☐ hedge, type: _____
☐ wall, material: _____
☐ other (explain) _____

Gravestones
Approximate number of markers (fifty years or over in age) _____
Approximate number of markers (less than fifty years old) _____
Approximate number of burials _____
Evidence of unmarked burials _____

Number of markers with burial dates from ☐ 19th century ☐ 20th century

Age: earliest date_____ most recent date_____

Materials (check all that apply and place a **P** on the most prevalent material):
☐ fieldstone ☐ sandstone ☐ limestone ☐ marble ☐ granite ☐ wood
☐ concrete/cement ☐ iron (cast/wrought) ☐ white bronze/zinc
☐ other, explain _____

Note if other methods of marking graves exist, such as footstones, mounding, broken pottery, flowers, other types of decoration beyond markers:_____

_____

Orientation of markers (N-none/very few, S-some, M-most, A- all)

East/West_____ North/South_____

other (explain) _____

_____

Decorative carvings on the markers. Provide a list of common images:_____

_____

_____

Are there unusual markers? Describe_____

_____

_____

Names of stone carvers (specify name, town, company if available) _____

_____

Condition of markers (give approximate number)

☐ inscriptions illegible ☐ inscriptions legible ☐ no inscription ☐ sunken/tilted stones
☐ fragments/pieces on the ground ☐ broken but standing
☐ damaged surfaces/chipped/cracked

If other conditions or damage observed, please specify problem _____

_____

List any restoration efforts (examples: metal supports, enclosed in concrete etc.)

_____

_____

_____

List any hazards imperiling the cemetery's existence _____

_____

_____

List other structures (mausoleums, chapels, columbaria, etc.) and describe condition _____

_____

_____

_____

List artifacts (statues, urns, etc.) and describe condition _____

_____

_____

_____

Circulation system of paths and roadways_____

_____

_____

General overview of vegetation (List specific plants on **Plant Documentation Form**)_____

_____

_____

_____

Historical background

Year established (use circa if actual date not documented) _____

Ownership history _____

Has the cemetery been listed in an existing published/unpublished cemetery survey?

☐ No ☐ Yes: date, and where stored? _____

_____

List important individuals of local, state, or national importance buried here: _____

_____

_____

List any historical incidents: _____

_____

_____

List distinctive monuments, architectural features or sculptures and explain their historical significance: _____

_____

_____

_____

_____

Is this cemetery the successor to another located elsewhere? If so, explain_____

_____

Are the markers in their original locations or rearranged? _____

_____

_____

Additional information:_____

_____

_____

_____

Significance of this site to local, state, or national history:_____

_____

_____

_____

_____

Surveyor name _____

Surveyor address _____

_____

MICHIGAN INDIVIDUAL MONUMENT RECORD FORM

Cemetery or Graveyard Name _____

Municipal unit/county _____

Address or location _____

1. Monument number (from grid) _____
2. Monument type/shape
   ☐ head ☐ foot ☐ tomb ☐ family ☐ obelisk ☐ pedestal with urn ☐ block
   ☐ beveled ☐ flush ☐ marker/small tablet ☐ ledger stones ☐ box ☐ table
   ☐ rustic ☐ sculptural memorial ☐ columnar ☐ cross

   Tablet: ☐ rectangular ☐ semicircular ☐ with shoulders ☐ in base

   ☐ other (describe) _____

   _____
3. Material
   ☐ marble ☐ granite ☐ sandstone ☐ limestone ☐ fieldstone ☐ concrete
   ☐ white bronze (zinc) ☐ bronze ☐ iron ☐ other _____
4. Carver or manufacturer _____
5. Number of carved surfaces _____
6. Carving technique used: ☐ incised ☐ relief ☐ three dimensional
7. Decorative carving motif(s)
   ☐ urn and willow ☐ urn ☐ willow ☐ heart ☐ hands clasped ☐ hand pointing upward
   ☐ hand reaching down ☐ angel ☐ botanical ☐ lamb ☐ open book

   ☐ other (describe) _____
8. Number of people commemorated _____
9. Condition of marker
   ☐ sound ☐ chipped ☐ cracked ☐ crumbled ☐ eroded ☐ broken ☐ tilted ☐ sunken
   ☐ repaired ☐ in situ ☐ displaced ☐ encased in concrete ☐ overgrown (vines, weeds, brush)
10. Previous repairs
   ☐ cracks ☐ pins ☐ mortar ☐ adhesive ☐ girdling
11. Condition of inscription
   ☐ excellent ☐ clear but worn ☐ mostly decipherable ☐ mostly undecipherable
12. Dimensions

   main body: height _____ width _____ thickness _____

   base: height _____ width _____ thickness _____
13. Marker orientation
   ☐ N ☐ S ☐ E ☐ W ☐ NE ☐ SE ☐ NW ☐ SW
14. Master record number _____
15. Date of record _____
16. Name of recorder or group _____

17. Inscriptions

face _____

_____

_____

right _____

_____

_____

_____

rear _____

_____

_____

_____

left _____

_____

_____

_____

18. Photographs (one or more per side)

Additional information _____

_____

_____

_____

_____

Recent cleaning/repairs (date) _____

_____

_____

_____

_____

PLANT DOCUMENTATION FORM

Cemetery name _____ Reference number _____

Municipal unit/county _____

_____

_____

Date_____

Genus _____

Species_____

Common name _____

_____

Size _____

Color _____

PHOTO

Condition_____

_____

Location: master map grid number_____

Historical significance/context of plant _____

_____

_____

Does plant appear to be part of a planned landscape?

_____

Evaluation of integrity and significance_____

_____

_____

Recorder's name _____

SAMPLE PERMISSION FORM TO GAIN PERMISSION TO VISIT, CLEAN AND/OR RESTORE A CEMETERY
(adapted from www.savinggraves.org)

The undersigned land owner hereby grants permission to the volunteer named below and other persons acting in a volunteer supervision of said volunteer to attempt to restore _____ Cemetery in the county of_____, in the state of _____.

There is an understanding that such efforts may include (but are not limited to) removing all noxious and detrimental vegetation (including trimming trees, lawn mowing and weeding), removing accumulated debris from buried gravestones and markers, the excavation and repair of markers, and the straightening and resetting of gravestones.

Name and title (please print) _____

Signature of cemetery owner (or designee of municipality) _____

Date signed_____

Township of_____

Location of cemetery_____

Address of owner _____

Phone of cemetery owner_____

Special instructions to volunteer_____

_____

The volunteer named below agrees to perform the tasks set out herein to the best of his/her ability, promising to act in good faith to clean the above-named cemetery, to be responsible for the acts of any persons working under the volunteer's supervision, to be responsible for any damage sustained at the site and to exercise due and diligent care to prevent injury to the site or any persons.

The volunteer named below certifies that neither he/she nor any person operating under the volunteer's supervision shall remove from the above location any stone, monument, marker, artifact, ornamentation, enclosure, or other object without the express permission of the cemetery owner.

The volunteer named below further agrees that his/her efforts shall comply with the generally accepted cemetery conservation and preservation techniques as promulgated by organizations such as Saving Graves, The Association of Gravestone Studies, the National Park Service, and the National Trust for Historic Places.

Date signed_____

Signature of Volunteer _____

Printed name of Volunteer _____

Address of Volunteer_____

Telephone number of Volunteer_____

E-mail address of Volunteer_____

Appendix B

RESOURCES

ORGANIZATIONS

The following list includes local, state, and national resources related to cemetery preservation/ conservation.

American Institute for Conservation of Historic and Artistic Works
1717 K Street, Suite 200, Washington, D.C. 20006. (202)452-9545

Association for Preservation Technology
P.O. Box 8178, Fredericksburg, VA 22404. (800)338-1926

Center of Historical Cemeteries Preservation
P.O. Box 6296, Tallahassee, FL 32314. (850)877-9014
Promotes the study, documentation and preservation of historical burial sites in the southeastern United States and the Caribbean.

Chicora Foundation, Inc.
P.O. Box 8664. Columbia, SC 29202. (803)787-6910. www.chicora.org

Getty Conservation Institute
1200 Getty Center Drive, Suite 700, Los Angles, CA 90049. (310)440-7325

Michigan State Historic Preservation Office
Michigan Historical Center, 702 West Kalamazoo Street, Lansing, Michigan 48909-8240. (517)373-1630. www.michigan.gov/shpo.

National Endowment for the Humanities
1100 Pennsylvania Avenue NW, Washington, D.C. 20506. (202)682-5400.www.arts.endow.gov/
It offers assistance to nonprofit organizations seeking information on federal services.

National Institute for Conservation Heritage Preservation
1624 K Street NW, Suite 700, Washington, D.C. 20006. (888)388-6789.
www.heritagepreservation.org

National Park Service
1202 Eye St., NW, 2255 Washington, D.C. 20005. (202)513-7270. www.cr.nps.gov

National Register of Historic Places
National Park Service, U.S. Department of the Interior, P.O. Box 37127, Washington D.C. 20006. (202)343-9559.

National Trust for Historic Preservation
1785 Massachusetts Ave., N.W., Washington D.C. 20036. (202)673-4296

National Trust for Historic Preservation. Midwest office.
53 West Jackson Blvd., Suite 350, Chicago, IL 60604. (312)939-5547

National Preservation Institute
P.O. Box 1702, Alexandria, VA 22313-1702. (703)765-0100

Research Grant Guides
P.O. Box 1214, Loxahatchee, FL 33470. (561)795-6129. www.researchgrant.com

Save Outdoor Sculpture
1730 K Street NW Suite 566, Washington, D.C., 20006. (800)422-4612

The Association for Gravestone Studies
278 Main Street, Suite 207, Greenfield, MA 01301. (413)772-0836. www.gravestonestudies.org

The Council on Foundations
1828 L Street, NW, Washington, D.C. 20036. (202)466-6512. www.cof.org/home.htm

The Foundation Center
79 Fifth Avenue, New York, NY 10003. (212)691-1828. www.fdncenter.org/

GENERAL PUBLICATIONS

Wilson, Rex. *Archaeology and Preservation.* Information Sheet no. 28. Washington D.C.: National Trust for Historic Preservation, 1980.

Association for Gravestone Studies. 278 Main Street, Suite 207, Greenfield, MA 01301. www.gravestonestudies.org Several excellent leaflets on cemetery preservation are available for a small charge.

Curl, James S. *A Celebration of Death: An Introduction to Some of the Buildings, Monuments, and Settings of Funerary Architecture in the Western European Tradition.* New York: Charles Scribners' Sons,1980.

Gillon, Edmund V. Jr. *Victorian Cemetery Art.* New York: Dover Publications, Inc., 1972.

Hacker, Debi. *Iconography of Death, Common Symbolism of the Late 18th Through Early 20th Century Tombstones in the Southeastern United States.* Columbia, SC: The Chicora Foundation, Inc., 2001. (This publication and others are available from the Chicora Foundation web site.)

The Genealogical Institute, Publications Division. *How to Search a Cemetery.* Salt Lake City, Utah, 1974.

Jackson, Kenneth T., and Camilo Jos, Vergara. *Silent Cities: The Evolution of the American Cemetery.* New York: Princeton Architectural Press, 1989.

Meyer, Richard E., ed. *Cemeteries and Gravemarkers: Voices of American Culture.* Ann Arbor, Michigan: UMI Research Press, 1989.

Nichols, Elaine, ed. *The Last Miles of the Way: African-American Homegoing Traditions 1890-Present.* Columbia, South Carolina: South Carolina State Museum, 1989.

Ridlen, Susanne S. *Tree-Stump Tombstones: A Field Guide to Rustic Funerary Art in Indiana.* Kokomo, IN: Old Richardsonville Publications, Kokomo-Howard County Public Library, 1999.

Roberts, Warren E. *Investigating the Treestump Tombstone in Indiana, American Culture and Folklife: A Prologue and a Dialogue.* Simon J. Bronner, ed. Ann Arbor, Michigan: UMI Research Press,1985.

Strangstad, Lynette. *A Graveyard Preservation Primer.* California: Altamira Press, 1995.

Strangstad, Lynette. *Preservation of Historic Burial Grounds.* (2003) Washington, D.C. National Trust for Historic Preservation.

Zelinsky, Wilbur. *Unearthly Delights: Cemetery Names and the Map of the Changing American Afterworld, Geographies of the Mind.* David Lowenthal and Martyn J. Bowden, eds. New York: Oxford University Press, 1976.

HISTORIC PLANT IDENTIFICATION

Breck, Joseph. *The Flower Garden or Breck's Book of Flowers.* Boston: John P. Jewett and Co.1851. Reprint, Guilford, Connecticut: Opus Publications, 1988.
Great plant lists for mid-nineteenth century.

Crockett, James Underwood. *Trees.* New York: Time-Life Books, 1972.
Colored illustrations and narrative for identification and care.

Faveretti, Rudy and Faveretti, Joy. *For Every House a Garden.* Hanover, New Hampshire: University Press of New England, 1990.
Period plant lists.

Gardner, Joann. *The Heirloom Garden.* Vermont: Story Communications, Inc., 1992.
Black and white drawings, plant descriptions, and dates.

Leighton, Ann. *American Gardens of the Nineteenth Century.* Amherst, Massachusetts: The University of Massachusetts Press, 1987.
Contains a listing of nineteenth century plants in the appendix.

Proctor, Rob. *Annuals: Yearly Classics for the Contemporary Garden.* New York: Harper Collins Publishers, 1991.
Color photographs. Helpful in identifying antique plants that reseed themselves.

Proctor, Rob. *Country Flowers.* New York: Harper Collins Publishers, 1991.
Describes both cultivated and wild antique species. Color photographs.

Bailey, Liberty Hyde. *Hortus Third: A Concise Dictionary of Plants Cultivated in the United States and Canada.* New York: MacMillan Company, 1976. Plant descriptions.

Whiteside, Katherine. *Antique Flowers.* New York: Running Heads Incorporated, 1998.
Color illustrations, plant descriptions, and excellent bibliography.

SOURCES FOR ANTIQUE PLANTS

Antique Heirloom Plants
333 Redemption Rock Trail, West Sterling, MA 01564. (978)422-8371
www.antiqueheirloomplants.com

Antique Rose Emporium
9300 Lueckmeyer Road, Brenham, TX 77833. (800)441-0002

Baker Creek Heirloom Seeds
2278 Baker Creek Road, Mansfield MO 65704. (417)924-8917
www.rareseeds.com

Heirloom Roses
24062 NE Riverside Drive, St. Paul, OR 97137, (503)538-1576
www.heirloomroses.com

Old House Gardens
536 Third Avenue, Ann Arbor, MI 48103
www.oldhousegardens.com
Antique bulbs and reproduction seed catalogs for sale.

Michigan State University Extension Service
Agricultural Hall, Room 108, Michigan State University, East Lansing, MI 48824-1039, (517)355-2300.

Perennial Pleasures Nursery
P.O. Box 147, East Hardwick, VT 05836. (802)472-5104
www.antiqueplants.com

Roses of Yesterday and Today
803 Brown's Valley Road, Watsonville, CA 95076. (831)728-1901

Schliefert Iris Gardens
9515 Hwy 50, Murdock, NE 68407. (402)234-4172

Seed Savers Exchange
3076 N. Winn Road, Decorah, IA. (319)382-5990

Seeds of Change
1 Sunset Way, Henderson, NV 89014. (888)762-7333

Select Seeds
180 Stickney Hill Road, Union, CT 06076. (800)684-0395

Thomas Jefferson Center for Historic Plants
Monticello, P.O. Box 316, Charlottesville, VA 22902. (800)243-1743
www.monticello.org

SUPPLIERS

Jerith Aluminum Fences

Ace Fence Company
11022 Ingeram, Livonia, Michigan 48150. 734-427-6166

Monuments

Arnet's Beckers Burrells Monuments
4495 Jackson Road, Ann Arbor, MI 48103. 734-665-3658

Epoxy

Akemi Plastics, Inc.
Eaton Rapids, MI

Akepox 22010 Epoxy

Architectural Stone
2033 Austin Road, Troy, MI 48083

D-2, Anti-microbials, Jahn Mortars and Grouts

Cathedral Stone Products
7266 Park Circle Drive, Hanover, MD 21076. 800-684-0901. www.jahnmortars.com

Vulpex Soap

Conservation Resources International
8000-H Forbes Place, Springfield, VA 22151. 800-634-6932. www.conservationresources

Rust Converter

Corrosion Control Industries
P.O. Box 4717, Johnson City, TN 37602. 877-661-7878

Tools and Supplies for Stone Working and Restoration

Granite City Tool
247 28th Ave. South, St. Cloud, MN 56387. www.granitecitytool.com

Akepox 2010 Epoxy

Granite House
2984 28th Street Southwest, Grandville, MI 49418. 616-531-0606

Lime and Portland Cement

Graymont Dolime Inc.
21880 West State Route 163, Genoa, OH 43430. 800-537-4489. http://graymont-oh.com

Mastico Epoxy

Hilgartner Natural Stone Company
101 West Cross Street, Baltimore, MD 21230. 410-752-4832. www.hilgartner.com

Historically Accurate Fence and Ironwork

King Architectural Metals
3131 Washington Blvd., Baltimore, MD 21230. 800-542-2379

SUPPLIERS

Turf Care Products

Lesco, 1077 James L. Hart Pkwy., Ypsilanti, MI 48197. 734-487-5559. www.lesco.com

Portland Cement, Lime, and Rust Converter

Liner Rolpanit Inc. North America
30 Glen Cameron Road, Suite 101, Ontario, Canada L3T 1N7. 905-707-7087.
www.linrol.com

Elite Fence Products, Inc.

Michigan Fence and Supply Company
44865 Utica Road, Utica, Michigan 48317. 810-739-5351

Epoxy and Stone Working Tools for the Cemetery

Miles Supply Company
143 Boynton Street, P.O. Box 237, Barre, VT 05641-0237. 802-476-3963

Master Halco Ornamental Iron Fencing

Monumental Iron Works
P.O. Box 365, Lahabra, California 90633. 888-643-3623. www.mafence.com

Stone Consolidants, Paint Strippers and other Chemical Agents used in Restoration Projects

Pro-So-Co, Inc.
755 Minnesota Avenue, P.O. Box 1578, Kansas City, KS 66117. 800-255-4255

Industrial Rust Cover

Rustoleum
11 Hawthorne Pkwy., Vernon Hills, IL 60061. 800-553-8444. www.rustoleum.com

Epoxy

Sika Corporation, 201 Polito Avenue, Lyndhurst, N.J. 07071. 201-933-8800

Historic Iron Work and Fences

Stewart Iron Works Company
P.O. Box 2612, 20 West 18th Street, Covington, KY 41012. 859-431-1985
http://stewartironworks.com

Akepox 2010 Epoxy

Terrazzo and Marble Supply
1290 Evergreen Road, Detroit, MI 48223. 313-273-1556

Tools for Stone Work

Trow and Holden
45 South Main Street, Barre, VT 05641. 800-451-4394. www.trowandholden.com

Source for Vulpex Soap

University Products
517 Main Street, P.O. box 101, Holyoke, MA 01041. 800-628-1912
www.universityproducts.com

WEB SITES	
Name of Organization	**Web Address**
AHGP Michigan Cemetery Transcription and Photo Project	www.usgennet.org/mi/state1
Alliance for Landscape Preservation	www.ahlp.org
American Fence- locates AFA contractors in a specific area	www.americanfenceassociation.com
American Forest Historic Tree Nursery	www.historictrees.org
American Institute for Conservation of Historic and Artistic Works	www.//aic.stanford.edu
Ancestry- genealogy	www.ancestry.com
Antique heirloom plants	www.antiqueheirloomplants.com
Arkansas Historic Preservation Program- cemetery preservation	www.arkansaspreservation.org
Association for Gravestone Studies	www.gravestonestudies.org
Association for Preservation Technology	www.apti.org
Baker Creek Heirloom Seeds	www.rareseeds.com
Ben Meadows- environmental supplies such as probes	www.benmeadows.com
Cemetery Junction Directory Cemetery records	www.daddezio.com www.geneasearch.com
Chicora Foundation- cemetery conservation/preservation	www.chicora.org
Cyndi's list- genealogy	www.cyndislist.com/mi.htm
Chamblee roses- includes heirlooms	www.chambleeroses.com
Feroze Exports- sandstone	www.ferozeexports.com/sandstonedefination.htm
Genealogy Links	www.genealogylinks.net
Genealogy today	www.genealogytoday.com
Heirloom Gardens- seeds and plants	www.heirloomnursery.com
Heirloom Plants & Seeds - links to numerous sources	www.av.qnet.com
Heirloom Roses	www.heirloomroses.com
Indiana Pioneer Cemeteries	www.rootsweb.com (link)
International Society of Arboriculture	www.treesaregood.com
Internet Resources for Nonprofits	www.ai.mit.edu/people/ellens/non/online.html
I Love Plants- links to garden and plant-related web sites	www.iloveplants.com
Legal help	www.usgennet.org www.legalanthropology.com
Michigan Legislature website Legal: chap.456-cemetery assns. And chap. 128 cemetery day in May	www.michiganlegislature.org

WEB SITES	
Mapping software	www.legacymark.com www.cemoffice.com
Michigan Historic Preservation Network	www.mhpn.org
Michigan State Historic Preservation (SHPO)	www.michigan.gov/shpo
Michigan State University Extension Service	www.msue.msu.edu
Monticello-Thomas Jefferson Center for Historic Plants	www.monticello.org
National Center for Preservation Training and Technology	www.ncppt.nps.gov
National Institute for Conservation Heritage Preservation	www.heritagepreservation.org
National Plant Database	www.plants.usda.gov
National Register for Historic Places	www.cr.nps.gov/nr
National Park Service, Heritage Preservation Services	www2.cr.nps.gov
Old House Gardens bulb catalog.	www.oldhousegardens.com
Oregon Historic Cemeteries Association	www.oregoncemeteries.org
Perennial Pleasures Nursery-heirloom plants and seeds	www.antiqueplants.com
Roses	www.avagara.com
Roses of Yesterday	www.rosesofyesterday.com
Research Grant Guides	www.researchgrant.com
Sad news-genealogy search, books, and library	www.sadnews.net
Saving Graves	www.savinggraves.com
Sculpture site-cemetery link	www.sculptor.org
Heritage Preservation-click on Save Outdoor Sculpture	www.heritagepreservation.org
Select Seeds	www.selectseeds.com
Stewart Iron Works-fabricators of fences, gates, and furnishings	www.stewartironworks.com
The Foundation Center-guide to grant seeking on the web/links	http://fdncenter.org
The Right Tree Handbook	www.mnpower.com/treebook/
U.S. Forest Service, Hazards Tree Page	www.na.fed.us/spfo/hazard/pubs.htm
U.S. General Services Administration-technical briefs	www.w3.gsa.gov
Washtenaw County cemeteries	www.rootsweb.com/~miwashte/
Wayne County cemeteries	www.rootsweb.com/~miwayne/wacemetery.htm
Wayne County cemetery records	www.interment.net/usmi/wayne.htm
Wayside Gardens-old roses	www.waysidegardens.com

Appendix C

GLOSSARY

The following glossary terms have been taken from the National Register bulletin *Guidelines for Evaluating and Registering Cemeteries and Burial Places; A Graveyard Preservation Primer;* The Secretary of the Interior's *Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Historic Landscapes; Grave Concerns: A Preservation Manual for Historic Cemeteries in Arkansas;* and *Landscapes of Memories: A Guide for Conserving Historic Cemeteries, Repairing Tombstones.*

Altar tomb
a solid, rectangular, raised tomb or grave marker resembling ceremonial altars of classical antiquity and Judeo-Christian ritual.

Artificial stone
a term used to describe various materials also known as *art marble, artificial marble, cast stone,* and *composite stone.* Some mixture of stone chips or fragments is generally embedded in a matrix of cement or plaster, and the surface may be ground, polished, molded, or otherwise treated to simulate stone.

Bedding
the manner or direction in which bedding planes (layers, stratification or direction in which a stone is formed) are laid when a stone is in use. Bedding is a condition that is typically seen in sedimentary stones such as sandstone and limestone. Stone monuments have bedding planes that are either horizontal (naturally bedded), vertical and parallel (face bedded), or perpendicular (edge-bedded) to the exposed surfaces. Most historic slab grave markers have a bedding that is vertical and parallel to the face; it is easiest to split a stone along the natural bedding planes and turn it upright to create a grave marker.

Bevel marker
a rectangular grave marker, set low to the ground, having straight sides and uppermost, inscribed surface raked at a low angle.

Blistering
Swelling and rupturing of a thin, uniform layer of stone are usually found on sandstone, but also on granite. It is generally caused by salts and/or moisture and can occur either across or parallel to bedding planes.

Block markers
made of granite and the type of marker most used today. Most are made of granite, and age can be determined by the amount of engraving found on the stones. The early twentieth century block markers began with few images, but as time proceeded lasers were used to create individual and elaborate designs of portraits of the deceased and activities that they held dear such as hunting, traveling and other worldly pursuits.

Bluestone
a trade term applied to hard, fine-grained, commonly feldspathic and micaceous sandstone or siltstone of dark greenish to bluish gray color that splits readily alone bedding planes to form thin slabs. Commonly used to pave surfaces for pedestrian traffic, this material may occasionally be seen in gravestones.

Boxtomb
a grave monument resembling a box, usually about three feet by six feet and two feet by three feet high, making an individual grave, or occasionally a family or other multiple burial. Such structures may be known locally as crypts; burial, however, is generally below ground with construction taking place following burial.

Brownstone
a trade term applied to ferruginous dark brown and reddish brown sandstone quarried and extensively used for building in the eastern United States during the middle and late nineteenth century. Most later use has been for renovation, repair, or additions to structures in which the stone was originally used. In gravestones, most commonly used as bases, although common in some areas, such as the Connecticut River Valley, for table stones as well.

Burial cache
a place of concealment for burial remains and objects.

Burial mound
a mass of earth, and sometimes stone or timber, erected to protect burial chambers for the dead.

Burial site
a place for disposal of burial remains, including various forms of encasement and platform burials that are not excavated in the ground or enclosed by mounded earth.

Burial vaults
unseen underground brick boxes the size of the deceased. The top, seen as a hump the length of the body, is sometimes covered by plaster or cement. The ends may encase a marker for the deceased. These are much like the modern day concrete burial vaults. The barrel vault was generally made for the wealthy. It is believed to be an English contribution.

Calcite
a mineral form of calcium carbonate. It is the principal constituent of most limestone.

Carin
a mound of stones marking a burial place.

Cemetery
an area set aside for burial of the dead; in Latin American culture known as *campo santo*, or holy field.

Cenotaph
a monument, usually of imposing scale, erected to commemorate one whose burial remains are at the separate location; literally *empty tomb*.

Character-defining feature
a prominent or distinctive aspect, quality, or characteristic of a cultural landscape that contributes significantly to its physical character. Land use patterns, vegetation, furnishings, decorative details and materials may be such features.

Chest marker
a solid, rectangular, raised grave marker resembling a chest or box-like sarcophagus. (1.)

Cinerary urn
a receptacle for cremation remains, or ashes, in the shape of a vase.

Columbarium
a vault or structure for storage of cinerary urns.

Columns
pedestal monuments, once a sign of victory by the Romans (Column of Trajan), are used in cemeteries as a symbol of mortality. Columns were seen as more versatile than an urn or an individual likeness. The base could be used to house the body of the deceased. Most columns found in American cemeteries were erected between 1870 and 1900.

Component landscape
a discrete portion of the landscape, which can be further, subdivided into individual features. The landscape unit may contribute to the significance of a National Register property, such as a farmstead in a rural historic district. In some cases, the landscape unit may be individually eligible for the National Register of Historic Places, such as a rose garden in a large urban park.

Crematorium
a furnace for incineration of the dead; also crematory.

Crumbing
the effects of weather or trapped moisture in a stone. Can appear to be grains of sand eroding from the stone.

Crypt
an enclosure for a casket in a mausoleum or underground chamber, as beneath a church.

Cultural landscape
a geographic area (including both cultural and natural resources and the wildlife or domestic animals therein), associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values. There are four general types of cultural landscapes, not mutually exclusive: historic sites, historic designed landscapes, historic vernacular landscapes, and ethnographic landscapes.

Delamination
separation of layers of stone along bedding planes.

Displaced
original placement is important if the cemetery chooses to seek listing in the National Register of Historic Places. If the stones have been moved, it is no longer a marker. The displaced stone becomes a memorial since it no longer serves the original purpose. There are different reasons that stones may be rearranged. If the row alignment seems a bit too perfect or if the stones are arranged in an odd pattern, such as a circle, most likely all of the stones in a site have been moved.

Dolomite
rock consisting mainly of magnesium carbonate and calcium carbonate; limestone or marble with much magnesium carbonate in it.

Dolomite limestone
limestone that contains more than ten percent but less than eighty percent of the mineral dolomite.

Efflorescence
film or encrustation on masonry of soluble salts, generally white and most commonly consisting of calcium sulfate that may deposit on the surface of stone, brick, or mortar if moisture moves through the masonry. Often caused by free alkalis leached from mortar or adjacent concrete.

Epitaph
an inscription on a grave marker identifying and/or commemorating the dead.

Erosion/sugar decay
a fine white, gritty substance that is produced on marble markers. The erosion is usually due to weathering or pollution.

Exedra
a permanent open air masonry bench with a high back, usually semicircular in plan, patterned after the porches or alcoves of classical antiquity where philosophical discussions were held; in cemeteries, used as an element of landscape design and at a type of tomb monument.

Exfoliation
the peeling or scaling of stone surfaces caused by chemical or physical weathering.

Face
the visible surface of stone masonry after setting. In gravestones, commonly the carved surface of table stones and slabs.

Family cemetery
a small private burial place for members of the immediate or extended family; typically found in rural areas, and often, but not always, near a residence; different from a family plot, which is an area reserved for family members within a larger cemetery.

Feature
the smallest element(s) of a landscape that contributes to the significance and that can be the subject of a treatment intervention. Examples include a woodlot, hedge, lawn, specimen plant, alee, house, meadow or open field, fence, wall, earthwork, pond or pool, bollard, orchard, or agricultural terrace.

Fillett
a concave filling-in (e.g., with mortar) of a reentrant angle where two surfaces meet.

Flaking
a term commonly used regarding gravestones to indicate minor delamination of surfaces or otherwise unsound stone, which easily peels off in small sheets or layers.

Flat markers
often made of metal and placed flush with or embedded in the ground. This style of marker is generally found in twentieth century cemeteries. This style became popular with perpetual care sites, for they allow mowing with ease.

Flush marker
a flat, rectangular grave marker set flush with the lawn or surface of the ground.

Footstone
a marker used in the seventeenth and eighteenth century when both a stone at the head and a stone at the foot marked the grave. Footstones are smaller and more simply inscribed than their headstones. If they bear any carving, it is usually only the name or initials of the deceased, perhaps the death date, and sometimes a simple decorative design.

French Drain
a trench filled with gravel, and topped with sand used for eliminating excess water from low points and other areas with water-saturated soil.

Gneiss
coarse-grained metamorphic rock with discontinuous foliation. When used for building stone, generally classed as trade granite. Most gneiss is dark and composed mainly of quartz, feldspar, mica, and ferromagnesian minerals (iron-magnesium silicates).

Granite
defined geologically as igneous rock with crystals or grains of visible size and consisting mainly of quartz and the sodium or potassium feldspars. In building stone and gravestones, crystalline silicate rock with visible grains. The commercial term includes gneiss and igneous rocks that are not granite in the strictest sense.

Grave
a place or receptacle for burial.

Grave marker
a sign or marker of a burial place, variously inscribed and decorated in commemoration of the dead.

Grave shelter
a rectangular, roofed structure usually of wood, covering a gravesite, enclosed by boards or slats or supported by poles; in tribal custom used to contain burial offerings and shelter the spirit of the dead; also grave house.

Graveyard
an area set aside for burial of the dead; a common burying ground of a church or community.

Headstone
an upright stone marker placed at the head of the deceased; usually inscribed with demographic information, epitaphs, or both; sometimes decorated with a carved motif.

Igneous rocks
those formed by change of the molten material called magma to the solid state. The igneous rocks are one of three generic classes of rocks (igneous, sedimentary, and metamorphic). Various igneous rocks, generally termed granite if coarse grained, are used for building stone and gravestones.

Incised carving
engraving that is ornamentation made by cutting into the stone.

In place (in situ)
the original location of a gravestone.

Integrity
the authenticity of a property's historic identity, evinced by the survival of physical characteristics that existed during the property's historic or prehistoric period. The seven qualities of integrity as defined by the National Register Program are location, setting, feeling, association, design, workmanship, and materials.

Interment
a burial; the act of committing the dead to a grave.

Laminated stone
stone consisting of thin sheets; stone built up in layers, such as slate.

Ledger
a large rectangular grave marker usually of stone, set parallel with the ground to cover the grave opening or grave surface.

Limestone
rock of sedimentary origin composed principally of calcite or dolomite or both. Limestone varies greatly in texture and porosity. It is usually white, gray or buff in color. Under normal conditions it weathers to a light silver gray or white depending on the stone variety, but is usually darker in color than the bright white of marble. It is commonly used in gravestones and tomb structures.

Lych gate
traditionally, a roofed gateway to a church graveyard under which a funeral casket was placed before burial; also lich gate; commonly, an ornamental cemetery gateway.

Macadam
named after John L. Macadam (1756-1836), Scottish engineer who invented the process of using broken stones for roads.

Marble
geologically a metamorphic rock made up largely of calcite or dolomite. It is formed as a result of the recrystallization of limestone under the intense pressure of geologic processes. As used commercially, the term includes many dense limestone and some rock dolomites. Numerous minerals may be present in minor to significant amounts in marble, and their presence and distribution account for much of the distinctive appearance that many marbles possess. The color of marble ranges from the brilliant white of calcite to black, blue-gray, red, yellow and green, depending on the mineral composition. It is the predominant stone for gravestones in the nineteenth century.

Mausoleum
a monumental building or structure for burial of the dead above ground; a "community" mausoleum is one that accommodates a great number of burials.

Memorial
an object whose purpose it is to commemorate a person or an event.

Metal corrosion
deterioration of a metal through a chemical or electrochemical reaction between the metal and oxygen (oxidation) or other substances (acids, salts, water, different metals in contact, and so on). Corrosion is indicated by formation of the corrosion products (such as, rust on ferrous metals) or by loss of metal (pitting and so on).

Metamorphic rock
rock altered in appearance, density, and crystalline structure, and in some cases mineral composition, by high temperature or high pressure or both. Slate is derived from shale, quartzite from quartz, sandstone and true marble from limestone.

Mica
a group of silicate minerals characterized by nearly perfect basal cleavage (cleavage is the quality of a crystallized substance or rock of splitting along definite planes) causing them to split readily into extremely thin plates. They reflect light, causing a shiny or sparkly appearance. The micas are prominent constituents of metamorphic and igneous rocks. In gravestones, they are often apparent in brownstones.

Military cemetery
a burial ground established for war casualties, veterans, and eligible dependents. Those established by the federal government include national cemeteries, post cemeteries, soldiers' lots, Confederate and Union plots, and American cemeteries in foreign countries. Many states also have established cemeteries for them.

Monolith
a large, vertical stone grave marker having no base or cap.

Monument
a structure or substantial grave marker erected as a memorial at a place of burial.

Mortuary
a place for preparation of the dead prior to burial or cremation.

National cemetery
one of 130 burial grounds established by the Congress of the United States since 1862 for interment of armed forces servicemen and women whose last service ended honorably. Presently, the Department of Veterans Affairs maintains 114, the National Park Service (Department of the Interior) administers 14, and the Department of the Army has responsibility for two. The national cemetery in Michigan is Fort Custer National Cemetery in Augusta.

Obelisk
a four-sided, tapering shaft having a pyramidal point; a grave marker type popularized by romantic taste for classical imagery in the nineteenth century.

Peristyle
a colonnade surrounding the exterior of a building, such as a mausoleum, or a range of columns supporting an entablature (a beam) that stands free to define an outdoor alcove or open space.

Potter's field
a place for the burial of indigent or anonymous persons. The term comes from a Biblical reference: Matthew 27:7.

Receiving tomb
a vault where the dead may be held until a final burial place is prepared; also receiving vault.

Relief carving
ornamentation projecting forward from a surface usually shallow or, occasionally in gravestones, deep carving.

Rising damp
moisture carried upward through porous stone by capillary action. Soluble salts in the ground beneath a gravestone may be introduced into a stone through this process. If the salts crystallize within the pores of the stone, the action may cause the surface to break off, known as spalling; if the salts are carried to the surface of the stone and then crystallize on it, efflorescence is formed.

Rostrum
a permanent open-air masonry stage used for memorial services in cemeteries of the modern period, patterned after the platform for public orators used in ancient Rome.

"Rural cemetery"
a burial place characterized by spacious landscaped grounds and romantic commemorative monuments established in a gardenlike setting in the first half of the nineteenth century. Mount Auburn Cemetery (1831) near Boston was the first cemetery developed in this tradition.

Sandstone
sedimentary rock composed of sand-sized grains naturally cemented by mineral material. In most sandstone used for building and gravestones, quartz grains predominate. Sandstone is typically buff, gray, brown, red, purple or pink in color; the latter four colors are commonly called brownstone. Some sources of sandstone in the Midwest and Canada were: Medina varieties in southern Ontario (red-brown, gray or mottled); Ohio sandstone from the Berea beds south of Cleveland (light gray or buff); Ohio Briar Hill sandstone (variegated rusty color); and Michigan Lake Superior sandstone (red).

Sarcophagus
a stone coffin or monumental chamber for a casket.

Scaling
advanced loss of stone, which may vary in depth.

Schist
a metamorphic rock with continuous foliation. It splits along foliation and is occasionally used for gravestones.

Screen memorial
a vertically set grave marker consisting of a tablet with wing elements resting on a continuous base.

Sedimentary rock
formed from materials deposited as sediments, in the sea, in fresh water, or on the land. The materials are transported to their site of deposition by such forces as running water, wind, or moving ice. They may deposit as fragments or by precipitation from solution. Limestone and sandstone are the sedimentary rocks most used for building and gravestones.

Sepulcher
a burial vault or crypt.

Shale
rock of clay origin, easily split into layers. It is occasionally used for gravestones.

Shelter house
a pavilion or roofed structure, frequently open at the sides, containing seats or benches for the convenience of those seeking a place to rest; erected in rustic and classical styles to beautify a cemetery landscape.

Slant marker
a rectangular grave marker having straight sides and inscribed surface raked at an acute angle.

Slate
a hard, brittle metamorphic rock consisting of clay minerals and characterized by good cleavage (cleavage is the quality of a crystallized substance or rock of splitting along definite planes) that is unrelated to the bedding in the earlier shale or clay from which it formed. It was a popular gravestone material of the eighteenth century, particularly in coastal areas. Many of the best-preserved examples of gravestone art are found in slate, an extremely stable stone.

Soapstone
massive soft rock that contains a high proportion of talc. It is occasionally used in gravestones.

Soiled/stained/discolored
A natural or man made condition that alters the original color or finish of the surface of the stones.

Soundness
the quality of a stone exhibits no sign of damage.

Spall
occurs when part of the stone flakes or splits away through frost action or pressure. As a noun, a chip or flake of stone.

Stele
an upright stone or commemorative slab commonly inscribed or embellished on one of the broader vertical surfaces; a grave marker type revived from classical antiquity.

Surface crusts
hard crusts that develop through movement of moisture towards the surface and outer edges of stone and deposition of dissolved material in those areas. Dark- colored crusts on sandstone result from a chemical reaction of the stone to airborne pollutants and often indicates disintegration of the stone behind the crust.

Table marker or stone
a rectangular grave covering consisting of a horizontal stone slab raised on legs, which sometimes are highly elaborate; also “table stone.”

Tablet stone
a stone grave marker consisting of a single piece of stone usually not more than three inches thick and set vertically in the ground; to be distinguished from a table stone or vault.

Tomb
a burial place for the dead.

Tomb recess
a niche or hollow in a wall that shelters a tomb.

Tympanum
a semicircular (or occasionally triangular) decorated face at the top of a tablet stone.

Vault
a burial chamber, commonly underground.

Appendix D

INFORMATION FOUND ON
MONUMENTS AND MARKERS

ORGANIZATION ABBREVIATIONS USED ON MONUMENTS AND MARKERS

Gravestone abbreviations are often a source of frustration to those surveying cemeteries. The following list compiled by Michael Joseph Mitchell, member of the Association for Gravestone Studies is one of the more complete lists available. The abbreviations on stones encountered in the cemetery should be viewed in their local, regional, and state context and their historical context, as there may be other interpretations of abbreviations.

AAONMS	Ancient Arabic Order of Nobles of the Mystic Shrine (Masonic)
AASR	Ancient and Accepted Scottish Rite (Masonic)
ABA	American Benefit Association
AF&AM	Ancient Free and Accepted Masons
ALOH	American Legion of Honor
AMD	Allied Masonic Degree
AMORC	Ancient and Mystical Order Rosae Crucis (Rosicrucians)
AMOS	Ancient Mystic Order of Samaratins (see IOOF)
AOF	Ancient Order of Foresters
AOH	Ancient Order of Hibernians
AOKMC	Ancient Order of Knights of Mystic Chain
AOUW	Ancient Order of United Workmen
APA	American Protective Association
AOM	Ancient Order of Mysteries (Masonic)
AUSA	Association of the United States Army
AUV	Association of Union Veterans
B of RTM	Brotherhood of Rail Road Track Men
BARE	Benefit Association of Railway Employees
BAY	Brotherhood of American Yeomen
BK of M	Black Knights of Molders
BKA	Benevolent Knights Association
BLE	Brotherhood of Locomotive Engineers
BLF&E	Brotherhood of Locomotive Firemen and Engineers
BPOE	Benevolent and Protective Order of Elks
BPOEW	Benevolent and Protective Order of Elks of the World
BRT	Brotherhood of Railway Trainmen
BSA	Boy Scouts of America
C of C	Children of the Confederacy
CAR	Children of the American Revolution
CBKA	Commandery Benevolent Knights Association
CBL	Catholic Benevolent Legion
CCTAS	Crusaders Catholic Total Abstinence Society
CDof A	Catholic Daughters of America

Abbreviation	Interpretation
CKof A	Catholic Knights of America
CMBA	Catholic Mutual Benefit Association
COOF	Catholic Order of Foresters
CSA	Confederate States Army
CSN	Confederate States Navy
CTAS	Catholic Total Abstinence Society
DAR	Daughters of the American Revolution
D.O.A./DA	Daughters of America
DAC	Daughters of the American Colonists
DAV	Disabled American Veterans
DOKK	Dramatic Order Knights of Khorassan (Knights of Pythias)
DoL	Daughters of Liberty
DOLLUS	Dames of the Loyal Legion of the United States
DON	Daughters of the Nile (Masonic)
DUV / DUVCW	Daughters of Union Veterans of the Civil War
EAA	Experimental Aircraft Association
EAU	Equitable Aid Union
EBA	Emerald Beneficial Association
FAA	Free and Accepted Americans
FCL	Fraternity, Charity, Loyalty, seen on some Union and Masonic stones
FMF	Fleet Marine Force
FOAST	Fraternal Order of Alaska State Troopers
FOE	Fraternal Order of Eagles
FOF	Fraternal Order of Firefighters
FOP	Fraternal Order of Police
GAR	Grand Army of the Republic
GSA	Girl Scouts of America
GALSTPTR	German American Legion of St. Peter
GLAUM	Grand Lodge Ancient Order of Mysteries-Masonic Order
GLDS	Grand Lodge Daughters of Scotia
GUOOF	Grand United Order of Odd Fellows
IBBH	International Brotherhood of Blacksmiths and Helpers
ICBU	Irish Catholic Benevolent Union
IOA	International Order of Alhambra
IODE	Independent Order, Daughters of the Empire
IOF	Independent Order of Foresters
IOGT	International Order of Good Templars
IOH	Improved Order of Heptasophs
IOI	Independent Order of Immaculates

Abbreviation	Interpretation
IOJD	Independent Order of Job's Daughters
IOKP	Independent Order of Knights of Pythias
IOOF	Independent Order of Odd Fellows
IOOF-PM	Independent Order of Odd Fellows Past Master
IOR	Independent Order of Rechabites
IORG	International Order of Rainbow Girls (Masonic)
IORM	Improved Order of Redmen
IOStL	Independent Order of St. Luke
IOV	International Order of Vikings
ISDA	Italian Sons and Daughters of America
ISH	Independent Sons of Honor
IUOM	Independent United Order of Mechanics
IWW	Industrial Workers of the World
JAOUW	Junior Order-Ancient Order of United Workmen
J.O.A.M.	Junior Order of American Mechanics
J.O.U.A.M.	Junior Order of United American Mechanics
K.of C.	Knights of Columbus
K.of P.	Knights of Pythias
K of FM / KFM	Knights of Father Matthew
K of H	Knights of Honor
K of L	Knights of Loyola
K of SJ	Knights of St. John
K of STP	Knights of St. Patrick
K of STW	Knights of St. Wenceslas
K of T / KT	Knights of Tabor
K of TM	Knights of the Macabees
KG	Knights of St. George
K.M. / KM	Knights of Malta (Masonic)
KM	Knights Militant (KKK)
K.T. / KT	Knights Templar (Masonic)
KGC	Knights of the Golden Chain
KGC	Knights of the Golden Circle
KGE	Knights of the Golden Eagle
KGL	Knight Grand Legion
KHC	Knights of the Holy Cross
KKK	Knights of the Ku-Klux-Klan
KLH	Knights and Ladies of Honor
KMC	Knights of the Mystic Chain
KOL	Knights of Labor

Abbreviation	Interpretation
KPC	Knights of Peter Claver
KSF	Knights of Sherwood Forest
KSL	Knights of St. Lawrence
KOTM	Knights of the Macabees
KSTG	Knights of St. George
KSTI	Knights of St. Ignatius
KSTJ	Knights of St. Joseph
KSTM	Knights of St. Martin
KSTP	Knights of St. Peter
KSTP	Knights of St. Paul
KSTT	Knights of St. Thomas
LAOH	Ladies Ancient Order of Hibernians
LGAR	Ladies of the Grand Army of the Republic
LKof A	Loyal Knights of America
LOL	Loyal Order Orange Lodge (The Orange Order) (Orange Men)
L.O.M.	Loyal Order of Moose
LOOM	Loyal Order of the MOOSE
LOVUS	Legion of Valor of the United States
MAW	Marine Air Wing
MBS	Mutual Benefit Society
MCL	Marine Corps League
M.W.A.	Modern Woodmen of America
MOPH	Military Order of the Purple Heart
MOS&B	Military Order of the Stars and Bars
MOVPER	Mystic Order of Veiled Prophets of the Mystic Realm (Grotto)
MOLLUS	Military Order of the Loyal Legion of the United States
NL	Navy League
NU	National Union
N.O.W.	Neighbors of Woodcraft
NCOA	Non-Commissioned Officers Association (Military Society)
NEOP	New England Order of Protection
NOK	New Order Knights (KKK)
NSDAR	National Society Daughters of the American Revolution
NSSUP	National Society Sons of Utah Pioneers
O of A	Order of Amaranth (Masonic)
O of UF	Order of United Friends
OCF	Order of Chosen Friends
OCR	Order of Confederate Rose
OES	Order of the Eastern Star

Abbreviation	Interpretation
OGC	Order of the Golden Crodd
OSC	Order of Scottish Clans (St. Andrews Societies)
ODHS	Des Schwestern Verbandes (Sisters of the Federation)
OUAM	Order of United American Mechanics
PFof A	Patriotic Friends of America
PH	The Order of Patrons of Husbandry (The Grange)
PM	Patriarchs Militant (Independent Order of Odd Fellows)
PBA	Police Benevolent Association
POW	Prisoner of War
RA	Royal Academy
RA	Royal Arcanum
RK	Roman Knights
R.A.M.	Royal Arch Masons
R.N.A.	Royal Neighbors of America
ROJ	Royal Order of Jesters (Masonic)
RMOKHSJ	Religious and Military Order of Knights of the Holy Sepulcher of Jerusalem
RO-AUM	Rosicrucian Order (Masonic)
RSGF	Royal Society of Good Fellows
RSM	Royal and Select Masons
RSTV	Rite of St.Vita
RSTV	Rite of St.Vaciara
RTT	Royal Templars of Temperance
S of E	Sons of England
S of St.G	Sons of St. George
SR	Scottish Rite (Masonic)
ST	Sons of Temperance
SV	Sons of Veterans of the United States of America
S.A.L.	Sons of the American Legion
SAR	Sisters of the American Revolution
SAR	Sons of the American Revolution
SBL	Society B. Lafayette
SCV	Sons of Confederate Veterans
SUV/SUVCW	Sons of Union Veterans of the Civil War
S.A.W.V.	Spanish American War Veteran
SBCL	Saint Bonifazius Catholic Union
SMAA	Scandinavian Mutual Aid Association
SNA-AUM	Shrine of North America (Masonic)
S.S.M.A.	Soldiers and Sailors Memorial Association
TCL	Tall Cedars of Lebanon (Masonic)

Abbreviation	Interpretation
TH	Temple of Honor and Temperance-Independent Order of Odd Fellows
TPLF	Temple of Honor and Temperance
TROA	The Retired Officers Association
UR	The Uniform Ranks designation
UCV	United Confederate Veterans
UDC	United Daughters of the Confederacy
UFL	Union Fraternal League
U.S.A.	United States Army
U.S.N.	United States Navy
U.S.A.F.	United States Air Force
U.S.C.G.	United States Coast Guard
U.S.M.C.	United States Marine Corps
UAOD	United Ancient Order of Druids
UOPF	United Order of Pilgrim Fathers
VFW	Veterans of Foreign Wars
W.C.	Woodmen Circle
W.O.W.	Woodmen of the World
W.O.W.	Women of Woodcraft
WKSC	White Knights of the Southern Cross (KKK)
YMCA	Young Men's Christian Association
YWCA	Young Women's Christian Association
MILITARY MARKERS	
BTN	Battalion
DIV	Division
ART	Artillery
INF	Infantry
CAV	Cavalry
CO	Company
PVT	Private
CPL	Corporal
SGT	Sergeant
WO	Warrant Officer
LT JG	Lieutenant Junior Grade
LT	Lieutenant
COM	Commander
CAPT	Captain
COL	Colonel
MAJ	Major
ADM	Admiral
GEN	General

COMMON LATIN PHRASES USED ON MARKERS

Yet another confusing part of reading tombstone inscriptions is the phrases that were often carved into the stone as an addition to the epitaph or simply as the epitaph. These phrases were carved in Latin and it was not uncommon for phrases such as those listed below to be inscribed on Catholic stones and Protestant stones in the twentieth century. The list, taken from the book *Iconography of Death* by Debi Hacker, will assist you in understanding the meaning of the inscription on the stones.

AB INITIO, AB FINEM	"From beginning to end"
AMOR DEI	"The love of God"
AVE MARIA, GRATIA PLENA	"Hail Mary, Full of Grace"
DEO VINDICE	"Latin for "God will Vindicate"
ECCE AGNUS DEI	"Behold, the Lamb of God"
FECIT	"Maker," meaning the stonecutter
FUGIT HORA	"Time Flies"
HIC DORMIT	"Here Rests..."
HIC IACET SEPULTUS	"Here lies buried..." also seen as initial H.I.S.
HIC PAUSAT	"Here Rests..."
HIC REQUIESCIT	"Here Rests..."
HIC SEPULTUS	"Here (lies) buried..." also seen as initials H.S.
HIC SITUS EST	"Here lies..."
IN MEMORIUM	"In memory of..."
LIBER VITAE	"The Book of Life." The Book of Life was believed to be a record of the elect, to be opened at the end of the world.
MANUS DEI	"Hand of God"
MEMENTO MORI	"Remember that you must die"
PAX	"Peace"
REQUIESCIT IN ISTO TUMOLO	"In this grave rests..."
REQUIESCIT IN PACE	"He/She rests in peace." Also seen as initials R.I.P.
SIC ITUR AD ASTRA	"Thus is accomplished the journey to the stars"
SIC TRANSIT GLORIA MUNDI	"So passes the glory of the world"
SPIRITUS SANCTUS	"The Holy Spirit"
SPUS SCUS	an abbreviation for the Latin phrase "Spiritus Sanctus"
VERUM DEI MANET IN AFTERNUM	"The word of God Endureth forever." Often inscribed on the open pages of the Bible on a tombstone. Also seen as initials V.D.M.A.
VOX CLAMANTIS IN DESERTO	"The voice (of one) crying in the wilderness"

SYMBOLS AND THEIR MEANINGS

Debi Hacker's book, *The Iconography of Death*, is the source of the following list of commonly used symbols.

Carving	Suggested Meaning
Acorn	Symbol of fertility and life, power of spiritual growth
Anchor	Hope; may represent sailing, seafaring or service in the Navy
Angels	Rebirth, protection, divine love, angels lead souls to heaven, praying angel looking up represents intercession
Apple	The fruit of salvation, does not represent the fruit eaten in the Garden of Eden
Arches	Roman symbol of the heavens; passage from this world into the next; triumph in death; journey to heaven
Arrow	When held by a cherub represents a spiritual weapon, dedicated to the service of God; represents death; could represent hunting or military if used with other weapons
Banner	Victory; God's love; triumph, rejoicing
Beehive	Symbol of a pious and unified community
Bed	A visual denial of death, as in "She is not dead, but sleepeth"
Bird	The soul; bird in flight represents the soul's flight to heaven
Book	Wisdom, knowledge, education; the Book of Life or record of the elect, which will be open at the end of the world
Bouquet	Life cut short, grief
Burning Flame	The soul; eternal life in the hereafter
Butterfly	Resurrection
Calla Lily	Marriage, fidelity
Cannon	Military service or profession
Celtic Cross	Union of heaven and earth
Chain	Links of the chain represents earthly existence; if one link is broken it represents the end of earthly existence; chain with three links represents the International Order of Odd Fellows
Chalice	Symbol of Christian faith
Cherub	Represents a heaven bound soul; spiritual resurrection; usually on children's stones
Clouds	Symbol of heaven, heavenly reward, or unseen God
Column	Broken column represents life cut short; column with facades represents heaven
Crown	Christian fortitude; victory over sin and death; promise of eternal life
Cypress	Devotion to God; immortality; eternal life; mourning
Dog	As man's best friend it represents watchfulness and fidelity
Door	Entry to Heaven
Dove	Purity of the soul; peace; in flight, represents the soul going to heaven, the Holy Ghost

Carving	Suggested Meaning
Eagle	The Christian soul strengthened by grace; may also represent nationalism, military profession, or Civil War veteran; Masonic symbol
Eye	All-knowing and ever-present God; Masonic symbol; Holy Trinity
Female Figure	Grief, sorrow
Fern	Humility, solitude and sincerity
Finger Pointing Downward	Deceased has been chosen by God
Finger pointing upward	Indicates that the soul has gone to heaven
Fleur-de-Lis	Trinity; the Virgin Mary; the three segments indicate faith, wisdom, and valor
Flowers	Goodness of life, abundant life; lushness of heavenly paradise
Garland	Victory in death
Gate	Death; heaven; reward of the faithful
Grapes	The grape is the symbol of the blood of Christ; spiritual resurrection
Hand	The hand of God
Hands Clasped	Farewell; hope of a meeting in heaven; union of marriage
Harp	Joy; worship; music of heaven; Irish descent; musical ability of deceased
Heart	Love; devotion; soul triumphant; courage
Hourglass	Symbol of mortality and the swift passing of earthly time
Ivy	Symbol of faithfulness and eternal life; death; friendship
Lamb	Symbol of Christ; innocence (found most often on a child's grave); on adult grave it represents a devout Christian; guidance from God
Lamp	Eternity; devotion to God; guidance and enlightenment from God; wisdom; piety; divine inspiration
Lily of the Valley	Devotion to God; purity, devotion; humility
Log	Divine harvest; end of life; Woodsman of the World symbol; part of the "rustic movement"
Masonic Compass	Freemasons
Moon	Eternity; sign of the second coming
Morning Glory	Shortness of a young life
Oak	Strength of faith and virtue; endurance of the Christian against adversity; Christ; Christian faith; valor
Obelisk	Eternal life; regeneration; when draped, represents mourning
Olive	Peace; marriage; fertility; family; crown or wreath of olives represents a spiritual victory
Open gates	The spirit entering heaven
Palm	Symbol of victory; reward of the righteous; a righteous man,
Peacock	Immortality through resurrection
Pine Cone	Ancient symbol for regeneration and fertility; immortality
Poppies	Rest; peace; mortality
Rainbow	God's throne; heaven; symbol of pardon and of the reconciliation given to the human race by God

Carving	Suggested Meaning
Rope	Binding together, as in a fraternal organization
Rose	Devotion to God; red rose represents martyrdom; white rose represents purity; paradise; the Virgin Mary; motherhood; rosebud represents a life cut short; love; grief
Scallop Shell	Birth; new life; baptism
Scythe	Death; end of life, divine harvest; man's mortality
Severed Branch	Death; end of life cycle
Sheaf of Wheat	Divine harvest; bounty of life; fruitful life; end of a fruitful life
Star	Divine guidance, Christ; heaven
Sun Shining	Christ; heavenly light; heaven
Swords	Military profession
Sword, broken	Life cut short
Swords, crossed	Represents ranking military person
Swords, points down	Death during military service
Sword held by angel	Justice and mercy; judgment
Thistle	Scottish descent; Scotland; earthly sorrow and sin
Tree	Tree of Knowledge; symbol of life or death, depending on whether the tree is healthy or cut down
Tree stump	Part of the "rustic" movement; symbol of Woodsman of the World; death is inevitable, end of life
Triangle	Holy Trinity
Trumpet	Praise of God; Judgment Day
Urn	Mortality; grief; draped urn represents mourning
Violet	Humility, a flower of spring represents youth; short life
Weeping Willow	Mourning; sorrow; Christian faith, spreading of the Gospel;
Wings	Symbol of divine mission; angels, archangels, seraphim and cherubim have wings
Winged Face/Head	The soul in flight, joyful resurrection
Winged Hourglass	Mortality, mans fleeting earthly existence
Wreath	Victory in death

Appendix E

PRESERVATION GUIDELINES

STANDARDS FOR PRESERVATION & REHABILITATION

The following standards for the preservation and rehabilitation of historic landscapes have been taken from the Secretary of the Interior's *Standards for the Treatment of Historic Properties and the Guidelines for the Treatment of Cultural Properties*. We include these standards in order to give some guidance in what is acceptable preservation practice. For an unabridged version of the secretary of the interior's guidelines, see the National Park Service web site or address in the resources section of the appendix.

Preservation Standards

1. A property will be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken.

2. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration necessitates repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color, and texture.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

REHABILITATION STANDARDS

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.
3. Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
4. Changes to a property that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterizes the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will be undertaken in such s manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

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In 1997 Gregg King joined the Canton Township Parks Division and within two years he found himself in charge of maintenance and preservation efforts at the township's three historic cemeteries. Looking for local contractors to aid in his work, Mr. King soon realized that there were almost as many opinions and methods as there were contractors. Realizing a need for a local, comprehensive and historically accurate source of historic cemetery conservation methods, he began the task of exhaustively researching, and synthesizing available information. This manual is the result of Gregg's years of investigation and research obtaining information from organizations such as the Association for Gravestone Studies and the National Preservation Institute. It is written in collaboration with Kosky Glynn & Saborio LLC, Historic Preservation Consultants, and with the enthusiastic support and financial aid of Canton Township and the Michigan State Historic Preservation Office. For local governments, cemetery and civic organizations, and laypersons involved in cemetery care and conservation it is an easy to follow and user-friendly guide and source book which guides the reader through the process, from documentation to cleaning and repair as well as landscape considerations. For Michigan it is an aid in preserving its small historic cemeteries using in part the Secretary of the Interior's *Guidelines for Historic Preservation*. For Gregg King it is an offering to those who find themselves considering a cemetery conservation project in hopes that it will assist them in their journey.

Food Jan. 23, 2015 11:44AM EST

15 Health Problems Linked to Monsanto's Roundup

EWContributor

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Monsanto invented the herbicide glyphosate and brought it to market under the trade name Roundup in 1974, after DDT was banned. But it wasn't until the late 1990s that the use of Roundup surged, thanks to Monsanto's ingenious marketing strategy. The strategy? Genetically engineer seeds to grow food crops that could tolerate high doses of Roundup. With the introduction of these new GE seeds, farmers could now easily control weeds on their corn, soy, cotton, canola, sugar beets and alfalfa crops—crops that thrived while the weeds around them were wiped out by Roundup.

In the nearly 20 years of intensifying exposure, scientists have been documenting the health consequences of Roundup and glyphosate in our food, in the water we drink, in the air we breathe and where our children play.

Eager to sell more of its flagship herbicide, Monsanto also encouraged farmers to use Roundup as a dessicant, to dry out all of their crops so they could harvest them faster. So Roundup is nowroutine y sprayed directly on a host of non-GMO crops, including wheat, barley, oats, canola, flax, peas, lentils, soybeans, dry beans and sugar cane.

Between 1996 - 2011, the widespread use of Roundup Ready GMO crops increased herbicide use in the U.S. by 527 million pounds—even though Monsanto claimed its GMO crops would reduce pesticide and herbicide use.

Monsanto has falsified data on Roundup's safety, and marketed it to parks departments and consumers as "environmentally friendly" and "biodegradable, to encourage its use it on roadsides, playgrounds, golf courses, schoolyards, lawns and home gardens. A French court ruled those marketing claims amounted to false advertising.

In the nearly 20 years of intensifying exposure, scientists have been documenting the health consequences of Roundup and glyphosate in our food, in the water we drink, in the air we breatheand where our children play.

They've found that people who are sick have higher levels of glyphosate in their bodies than healthy people.

They've also found the following health problems which they attribute to exposure to Roundup and/or glyphosate:

ADHD: In farming communities, there's a strong correlation between Roundup exposure and attention deficit disorder (ADHD), likely due to glyphosate's capacity to disrupt thyroid hormone functions.

Alzheimer's disease: In the lab, Roundup causes the same type of oxidative stress and neural cell death observed in Alzheimer's disease. And it affects CaMKII, an enzyme whose dysregulation has also been linked to the disease.

Anencephaly (birth defect): An investigation into neural tube defects among babies born to women living within 1,000 meters of pesticide applications showed an association for glyphosate with anencephaly, the absence of a major portion of the brain, skull and scalp that forms during embryonic development.

Autism: Glyphosate has a number of known biological effects that align with the known pathologies associated with autism. One of these parallels is the gut dysbiosis observed in autistic children and the toxicity of glyphosate to beneficial bacteria that suppress pathogenic bacteria, along with pathogenic bacteria's high resistance to glyphosate. In addition, glyphosate's capacity to promote aluminum accumulation in the brain may make it the principal cause of autism in the U.S.

Birth defects: Roundup and glyphosate can disrupt the Vitamin A (retinoic acid) signaling pathway, which is crucial for normal fetal development. The babies of women living within one kilometer of fields sprayed with glyphosate were more than twice as likely to have birth defects according to a study from Paraguay. Congenital defects quadrupled in the decade after Roundup Ready crops arrived in Chaco, a province in Argentina where glyphosate is used roughly eight to ten times more per acre than in the U.S. A study of one farming family in the U.S. documented elevated levels of glyphosate and birth defects in the children, including an imperforate anus, growth hormone deficiency, hypospadias (an abnormally placed urinary hole), a heart defect and a micro penis.

Brain cancer: In a study of children with brain cancer compared with healthy children, researchers found that if either parent had been exposed to Roundup during the two years before the child's birth, the chances of the child developing brain cancer doubled.

Breast cancer: Glyphosate induces human breast cancer cells growth via estrogen receptors. The only long-term animal study of glyphosate exposure produced rats with mammary tumors and shortened life-spans.

Cancer: House-to-house surveys of 65,000 people in farming communities in Argentina where Roundup is used, known there as the fumigated towns, found cancer rates two to four times higher than the national average, with increases in breast, prostate and lung cancers. In acomparison of two villages, in the one where Roundup was sprayed, 31 percent of residents had a family member with cancer, while only 3 percent of residents in a ranching village without spraying had one. The high cancer rates among people exposed to Roundup likely stem from glyphosate's known capacity to induce DNA damage, which has been demonstrated in numerous lab tests.

Celiac disease and gluten intolerance: Fish exposed to glyphosate deve op digestive problems that are reminiscent of celiac disease. There are parallels between the characteristics of celiac disease and the

known effects of glyphosate. These include imbalances in gut bacteria, impairment in enzymes involved with detoxifying environmental toxins, mineral deficiencies and amino acid depletion.

Chronic kidney disease: Increases in the use of glyphosate may explain the recent surge in kidney failure among agricultural workers in Central America, Sri Lanka and India. Scientists have concluded, "Although glyphosate alone does not cause an epidemic of chronic kidney disease, it seems to have acquired the ability to destroy the renal tissues of thousands of farmers when it forms complexes with [hard water] and nephrotoxic metals."

Colitis: The toxicity of glyphosate to beneficial bacteria that suppress clostridia, along with clostridia's high resistance to glyphosate, could be a significant predisposing factor in the overgrowth of clostridia. Overgrowth of clostridia, specifically C. difficile, is a well-established causal factor in colitis.

Depression: Glyphosate disrupts chemical processes that impact the production of serotonin, an important neurotransmitter that regulates mood, appetite and sleep. Serotonin impairment has been linked to depression.

Diabetes: Low levels of testosterone are a risk factor for Type 2 diabetes. Rats fed environmentally relevant doses of Roundup over a period of 30 days spanning the onset of puberty had reducedtestosterone production sufficient to alter testicular cell morphology and to delay the onset of puberty.

Heart disease: Glyphosate can disrupt the body's enzymes, causing lysosomal dysfunction, a major factor in cardiovascular disease and heart failure.

Hypothyroidism: House-to-house surveys of 65,000 people in farming communities in Argentina where Roundup is used, known there as the fumigated towns, found higher rates of hypothyroidism.

Inflammatory Bowl Disease ("Leaky Gut Syndrome"): Glyphosate can induce severe tryptophan deficiency, which can lead to an extreme inflammatory bowel disease that severely impairs the ability to absorb nutrients through the gut, due to inflammation, bleeding and diarrhea.

Liver disease: Very low doses of Roundup can disrupt human liver cell function, according to a2009 study published in Toxicology.

Lou Gehrig's Disease (ALS): Sulfate deficiency in the brain has been associated with Amyotrophic Lateral Sclerosis (ALS). Glyphosatedisrupts sulfate transport from the gut to the liver, and may lead over time to severe sulfate deficiency throughout all the tissues, including the brain.

Multiple Sclerosis (MS): An increased incidence of inflammatory bowel disease (IBS) has been found in association with MS. Glyphosatemay be a causal factor. The hypothesis is that glyphosate-induced IBS causes gut bacteria to leak into the vasculature, triggering an immune reaction and consequently an autoimmune disorder resulting in destruction of the myelin sheath.

Non-Hodgkin lymphoma: A systematic review and a series of meta-analyses of nearly three decades worth of epidemiologic research on the relationship between non-Hodgkin lymphoma (NHL) and occupational exposure to agricultural pesticides found that B cell lymphoma was positively associated with glyphosate.

Parkinson's disease: The brain-damaging effects of herbicides have been recognized as the main environmental factor associated with neurodegenerative disorders, including Parkinson's disease. The onset of Parkinson's following exposure to glyphosate has been welldocumented and lab studies show that glyphosate induces the cell death characteristic of the disease.

Pregnancy problems (infertility, miscarriages, stillbirths): Glyphosate is toxic to human placental cells, which, scientists say, explains the pregnancy problems of agricultural workers exposed to the herbicide.

Obesity: An experiment involving the transfer of a strain of endotoxin-producing bacteria from the gut of an obese human to the guts of mice caused the mice to become obese. Since glyphosate induces a shift in gut bacteria towards endotoxin-producers, glyphosate exposure maycontribute to obesity in this way.

Reproductive problems: Studies of laboratory animals have found that male rats exposed to high levels of glyphosate, either during prenatal or pubertal development, suffer from reproductive problems, including delayed puberty, decreased sperm production, and decreased testosterone production.

Respiratory illnesses: House-to-house surveys of 65,000 people in farming communities in Argentina where Roundup is used, known there as the fumigated towns, found higher rates of chronic respiratory illnesses.

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Concerns over use of glyphosate-based herbicides and risks associated with exposures: a consensus statement

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Abstract

The broad-spectrum herbicide glyphosate (common trade name "Roundup") was first sold to farmers in 1974. Since the late 1970s, the volume of glyphosate-based herbicides (GBHs) applied has increased approximately 100-fold. Further increases in the volume applied are likely due to more and higher rates of application in response to the widespread emergence of glyphosate-resistant weeds and new, pre-harvest, dessicant use patterns. GBHs were developed to replace or reduce reliance on herbicides causing well-documented problems associated with drift and crop damage, slipping efficacy, and human health risks. Initial industry toxicity testing suggested that GBHs posed relatively low risks to non-target species, including mammals, leading regulatory authorities worldwide to set high acceptable exposure limits. To accommodate changes in GBH use patterns associated with genetically engineered, herbicide-tolerant crops, regulators have dramatically increased tolerance levels in maize, oilseed (soybeans and canola), and alfalfa crops and related livestock feeds. Animal and epidemiology studies published in the last decade, however, point to the need for a fresh look at glyphosate toxicity. Furthermore, the World Health Organization's International Agency for Research on Cancer recently concluded that glyphosate is "probably carcinogenic to humans." In response to changing GBH use patterns and advances in scientific understanding of their potential hazards, we have produced a Statement of Concern drawing on emerging science relevant to the safety of GBHs. Our Statement of Concern considers current published literature describing GBH uses, mechanisms of action, toxicity in laboratory animals, and epidemiological studies. It also examines the derivation of current human safety standards. We conclude that: (1) GBHs are the most heavily applied herbicide in the world and usage continues to rise; (2) Worldwide, GBHs often contaminate drinking water sources, precipitation, and air, especially in agricultural regions; (3) The half-life of glyphosate in water and soil is longer than previously recognized; (4) Glyphosate and its metabolites are widely present in the global soybean supply; (5) Human exposures to GBHs are rising; (6) Glyphosate is now authoritatively classified as a probable human carcinogen; (7) Regulatory estimates of tolerable daily intakes for glyphosate in the United States and European Union are based on outdated science. We offer a series of recommendations related to the need for new investments in epidemiological studies, biomonitoring, and toxicology studies that draw on the principles of endocrinology to determine whether the effects of GBHs are due to endocrine disrupting activities. We suggest that common commercial formulations of GBHs should be prioritized for inclusion in government-led toxicology testing programs such as the U.S. National

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Toxicology Program, as well as for biomonitoring as conducted by the U.S. Centers for Disease Control and Prevention.

Keywords: Glyphosate, Acceptable daily intake (ADI), AMPA, Consensus statement, Endocrine disruptor, Reference dose (RfD), Risk assessment, Roundup Ready, Toxicology

Background

This Statement of Concern is directed to scientists, physicians, and regulatory officials around the world. We highlight changes in the scope and magnitude of risks to humans and the environment stemming from applications of glyphosate-based herbicides (GBHs). The objectives of this statement are to: 1) demonstrate the need for better monitoring of GBH residues in water, food, and humans; (2) identify limitations or weaknesses in the way the EPA, the German Federal Institute for Risk Assessment, and others have previously assessed the potential risks to humans from exposure to GBHs; and (3) provide recommendations on data needs and ways to structure future studies addressing potential health risks arising from GBH exposures.

Our focus is on the unanticipated effects arising from the worldwide increase in use of GBHs, coupled with recent discoveries about the toxicity and human health risks stemming from use of GBHs. Our concern deepened when the World Health Organization's International Agency for Research on Cancer (IARC) re-classified glyphosate as "probably carcinogenic to humans" (i.e., Group 2A) [1].

We highlight a number of issues that influence our concern about GBHs including: 1) increased use of GBHs over the past decade, including new uses for these herbicides just prior to harvest that can lead to high dietary exposures; 2) detection of glyphosate and its metabolites in foods; 3) recent studies that reveal possible endocrine system-mediated and developmental impacts of GBH exposures; and 4) additional complications for farmers, most acutely the emergence and spread of weeds resistant to glyphosate and the concomitant use of multiple herbicides in mixtures, both of which increase the risk of human and environmental harm. We discuss evidence pointing to the need to adjust downward the acceptable daily intake for glyphosate. Our major concerns are embodied in a series of consensus points that explicitly address the strength of the supporting evidence, and our recommendations focus on research essential in narrowing uncertainty in future GBH risk assessments.

When regulatory agencies conducted their initial assessments of glyphosate toxicity (in the 1970s) and approved a wide array of agricultural and non-agricultural uses, only limited and fragmentary data on GBH toxicity and risks were available. Testing done by contract laboratories were commissioned by the registrant and submitted to regulatory agencies. Results indicated minimal mammalian toxicity. A large review published in 2000, written by consultants associated with the registrant and drawing on unpublished industry reports, agreed with and reinforced that conclusion [2]. However, their review did not address some statistical differences reported between test and control groups that could be interpreted more cautiously, and surely warrant further assessment [3, 4].

In killing weeds and indeed almost all growing plants, the primary mode of glyphosate herbicidal activity is the inhibition of a key plant enzyme, namely 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). This enzyme is part of the shikimic acid pathway and is essential for the synthesis of aromatic amino acids that govern multiple, essential metabolic processes in plants, fungi, and some bacteria. Since this EPSPS-driven pathway does not exist in vertebrate cells, some scientists and most regulators assumed that glyphosate would pose minimal risks to mammals. However, several studies, some described below, now show that GBHs can adversely affect mammalian biology via multiple mechanisms.

Glyphosate use is increasing significantly

The United States has the world's most complete, publicly accessible dataset on GBH use trends over the past 40 years. Usage trends have been analyzed by EPA in a series of pesticide sales and use reports spanning 1982–2007 [5, 6], U.S. Geological Survey scientists [7, 8], the USDA's National Agricultural Statistics Service (NASS) [9], and academic and industry analysts [10–12].

Briefly, glyphosate was registered in 1974 in the U.S. Initially, this broad-spectrum, contact herbicide was sprayed by farmers and ranchers primarily to kill weeds before the planting of fields, and for weed control in pastures and non-crop areas. In 1987 between 6 and 8 million pounds (~2.72–3.62 million kilograms) were applied by U.S. farmers and ranchers [5]. In 1996, the first year genetically engineered (GE), glyphosate-tolerant crops were planted commercially in the U.S., glyphosate accounted for just 3.8% of the total volume of herbicide active ingredients applied in agriculture [7].

By 2007, the EPA reports agricultural use of glyphosate in the range of 180–185 million pounds (~81.6–83.9

million kilograms) [6]. The USGS team projects that glyphosate accounted for 53.5% of total agricultural herbicide use in 2009 [7]. In the 20-year timespan covered by EPA sales and usage reports (1987–2007), glyphosate use rose faster and more substantially than any other pesticide. Usage in the range of 81.6–83.9 million kilograms, which occurred in 2007, was more than double the next most heavily sprayed pesticide (atrazine, 73–78 million pounds; ~33.1–35.4 million kilograms). For over a decade, GBHs have been, by far, the most heavily applied pesticides in the U.S.

By 2014, annual farm-sector glyphosate usage increased to approximately 240 million pounds (~108.8 million kilograms), based on average annual crop use reported by the NASS [9, 12]. Available use data published by the USDA, USGS, and EPA show that a surprisingly large share (approximately two-thirds) of the total volume of GBH applied since 1974 has been sprayed in just the last decade.

Glyphosate residues are found in foods

GBHs are widely used on a range of crops including maize, soy grain, canola, wheat, barley, and edible beans, among others [9]. GBH application to these crops can result in residues of glyphosate and its primary metabolite AMPA in crops at harvest [13], as well as in processed foods. For example, the UK-Food Standard Agency residue testing conducted in October 2012 found glyphosate residues at or above 0.2 mg/kg in 27 out of 109 samples of bread [14]. Testing by the US Department of Agriculture in 2011 revealed residues of glyphosate in 90.3% of 300 soybean samples, and AMPA in 95.7% of samples at concentrations of 1.9 ppm and 2.3 ppm respectively [13]. Other laboratories have reported much higher levels in soybeans in recent years (e.g., [15, 16]).

Late season, harvest aid use of GBHs is an important new contributor to the increase in residue frequency and levels in some grain-based food products. This is particularly true in humid, temperate-climate countries such as the UK. Such applications are made within one to two weeks of harvest to accelerate crop drying, thus permitting harvest operations to begin sooner (a so-called "green burndown" use [17]). Such late season applications typically result in much higher residue levels in the final harvested product compared to crops subjected to typical application rates at earlier stages in the crop growth cycle. Pre-plant applications of GBHs, as well as post-harvest or fallow period applications, rarely result in detectable residues in grain, oilseeds, or forage crops.

Data from humans and laboratory animals indicate hazards associated with exposure

Classical toxicity studies assess high doses and examine 'validated' endpoints – those that have been shown to be replicated easily in many laboratories [18]. Although these endpoints are known to represent adverse outcomes, they typically do not correlate with human diseases, and are not considered comprehensive for all toxicological endpoints [19, 20]. Regulatory long-term (2 year) toxicity studies in rodents revealed adverse effects of glyphosate on the liver and kidney (reviewed in [3, 4]). These studies, however, typically do not address a wide range of potential adverse effects triggered by disruption in endocrine-system mediated developmental or metabolic processes [3, 21–24]. Studies examining low doses of GBHs, in the range of what are now generally considered 'safe' for humans, show that these compounds can induce hepatorenal damage [25–28].

Concerns about the carcinogenic properties of GBHs have increased after the World Health Organization's International Agency for Research on Cancer (IARC) re-classified glyphosate as "probably carcinogenic to humans" [1]. This decision was based on a small number of epidemiological studies following occupational exposures, rodent studies showing associations between glyphosate and renal tubule carcinoma, haemangiosarcoma, pancreatic islet cell adenoma, and/or skin tumors, and strong, diverse mechanistic data.

Human epidemiological [23, 29–31] and domesticated animal studies [32, 33] suggest associations between exposures to GBHs and adverse health outcomes. For example, congenital malformations have been reported in young pigs fed GBH residues-contaminated soybeans [32]. This suggests that GBHs may be at least a contributing factor to similar birth defects observed in human populations living in and near farming regions with substantial land area planted to GBH-tolerant GE crop cultivars [23, 34].

Collectively, studies from laboratory animals, human populations, and domesticated animals suggest that current levels of exposure to GBHs can induce adverse health outcomes. Many of these effects would likely not be detected in experiments adhering to traditional toxicology test guidelines promulgated by pesticide-regulatory authorities.

Further complications: resistance and mixtures

Genetically engineered crops with tolerance to glyphosate are widely grown, and their use has led to increased application of GBHs [10, 35]. This increased use has contributed to widespread growth of glyphosate-resistant weeds [36, 37]. To combat the proliferation of glyphosate-resistant weeds, GE plant varieties have been approved for commercial use that are resistant to multiple herbicides, including several older compounds that are possibly more toxic and environmentally disruptive than GBHs (for example, 2,4-D and dicamba).

While farmers have struggled for 30 years with the steady increase in the number of weeds resistant to one or more herbicides, the geographic scope and severity of the weed control challenges posed, worldwide, by the

emergence and spread of glyphosate-resistant weeds is unprecedented [37]. Moreover, the consequences triggered by the spread of glyphosate-resistant weeds, in contrast to the emergence in the past of other herbicide-resistant weeds, are unparalleled, and include the need for major changes in tillage and cropping patterns, and large increases in farmer costs and the diversity and volume of herbicides applied [10, 36, 38, 39].

In addition to resistance, concerns have been raised about the toxicity of herbicide mixtures, because current data suggest that chemicals in combination can have effects that are not predicted from tests of single compounds [40, 41]. GBHs themselves are chemical mixtures; in addition to the inclusion of glyphosate (the active ingredient), these herbicides include adjuvants such as surfactants, which can make GBH-product formulations more toxic than glyphosate alone [42–44]. In light of the increased numbers, levels and extent of herbicide use elicited by weed resistance, it is reasonable to predict that there will be a marked increase in the diversity of biological pathways affected, the number and duration of high-exposure periods, and the magnitude of potential risks facing non-target organisms, including humans. Such impacts could be limited, or even largely prevented, if there are substantial changes in weed-management systems and regulatory policy, including enforceable limits on herbicide-use patterns known to cause relatively high and potentially unsafe residue levels in food, water, and the air.

Setting an acceptable intake level of GBHs

Different countries have established a range of "acceptable" daily intake levels of glyphosate-herbicide exposures for humans, generally referred to in the U.S. as the chronic Reference Dose (cRfD), or in the E.U. as the Acceptable Daily Intake (ADI).

The current U.S. Environmental Protection Agency (EPA) cRfD is 1.75 mg of glyphosate per kilogram body weight per day (mg/kg/day). In contrast, the current E.U. ADI is more than 5-fold lower at 0.3 mg/kg/day, a level adopted in 2002. The data upon which these exposure thresholds are based were supplied by manufacturers during the registration process, are considered proprietary, and are typically not available for independent review.

The German Federal Institute for Risk Assessment is the lead regulatory authority currently conducting an E.U.-wide reassessment of GBHs. Their renewal assessment report calls for an increase of the E.U. ADI from 0.3 mg/kg/day to 0.5 mg/kg/day [45]. However, from an analysis of their assessment, it is difficult to understand the basis on which the German regulators are making this recommendation, since they still rely on the same proprietary, industry-supplied dataset that led to setting a lower ADI (0.3 mg/kg/day) in 2002. In contrast, an international team of independent scientists concluded that the current E.U. ADI is probably at least three-fold too high, based on a transparent, fully documented review of the same dataset [3][1].

In December 2009, the U.S. EPA's re-registration review of glyphosate identified a number of issues of ongoing concern, as well as GBH data gaps [46]. In particular, it noted that data relating to the effects of GBHs on the immune and neurological systems were limited and announced that future registrants would be required to conduct both neurotoxicity and immunotoxicity studies. The U.S. EPA's updated risk assessment and final re-registration decision on GBHs is scheduled to be completed in 2015–2016.

As noted above, most GBH use has occurred in the last 10 years, while most studies considered by regulatory agencies for the assessment of GBHs focused just on the active ingredient, and were conducted in the 1970s through mid-1980s. Since the late 1980s, only a few studies relevant to identifying and quantifying human health risks have been submitted to the U.S. EPA and incorporated in the agency's GBH human-health risk assessment[2]. We believe that the ability to establish appropriate GBH exposure and use levels should be enhanced and grounded in "up-to-date science" to support refined and accurate assessments of GBH health risks and to assure that regulators understand both the likely and possible consequences of the decisions they make.

Table 1 lists a few of the known environmental risks arising from use of GBHs.

Table 1 Environmental Risks

The overview of possible adverse effects associated with rising GBH use is focused on mammalian health risks. There are also many environmental and soil-ecosystem problems associated with heavy and repeated uses of GBHs affecting other organisms (for example: fish, butterflies, earthworms, beneficial soil microorganisms) [47].

These problems arise from the large volumes of GBHs applied across vast areas in many farming areas (for example: 50% or more of the harvested cropland in many counties in the U.S. and provinces or political jurisdictions in other countries are sprayed with GBHs).

Glyphosate binds strongly to some soils, but not others. After repeated applications, it can accumulate and become a long-term source of soil and groundwater contamination [48]. The main pathways of GBH degradation are known and the principal breakdown products (AMPA, formaldehyde) could be toxic to a variety of non-target organisms. Continued long-term use of GBHs could pose a threat to soil health and fertility [17, 49], with possible adverse effects on crop productivity.

Low levels (50 ppb) of glyphosate have been shown to have significant negative effects on the aquatic invertebrate Daphnia magna (50). When measured against the U.S. EPA's Maximum Contaminant Level of 700 ppb, or the Canadian short-term (27,000 ppb) and the long-term (280 ppb) freshwater aquatic standards (51), one quickly sees how the regulatory eco-toxicological risk levels set for glyphosate are orders of magnitude too high.

Section I

With respect to glyphosate-based herbicides, we are certain of the following:

GBH Use, exposure, presence

1. GBHs are currently the most heavily applied herbicides in the world.
   Trends in the volume and intensity of GBH uses have been rising sharply since the mid-1990s, in step with global adoption of genetically engineered, glyphosate-tolerant crops [10, 52, 53]. Use of GBHs is likely to continue increasing if Roundup Ready glyphosate-tolerant maize, soybeans, cotton, canola, alfalfa and sugar beet are approved for planting in regions not now dominated by such cultivars.
2. GBHs contaminate drinking water via rainwater, surface runoff and leaching into groundwater, thereby adding drinking water, bathing, and washing water as possible routine exposure pathways [48, 54, 55].
3. The half-life of glyphosate in water and soil is longer than previously recognized. In field studies, the half-life of glyphosate in soil ranged between a few days to several months, or even a year, depending on soil composition [56]. Studies have shown that soil sorption and degradation of glyphosate exhibit great variation depending on soil physical, chemical, and biological properties. The risk of long-term, incremental buildup of glyphosate contamination in soil, surface water, and groundwater is therefore driven by highly site-specific factors, and as a result, is difficult to predict and costly to monitor.
4. Residues of glyphosate and its principle metabolite AMPA are present in nearly all soybeans harvested from fields planted with Roundup Ready soybeans [13, 16]. The intensity of glyphosate use has trended upward on most GE Roundup Ready crops. In addition, applications are now being made later in the crop cycle on GE crops. In addition, wheat, barley and other grain, and some vegetable crops are sprayed very late in the crop season to accelerate crop death, drying, and harvest operations. For these reasons, average residue levels on and in some harvested grains, oilseeds, and certain other crops are substantially higher than they were a decade ago and, as a result, human dietary exposures are rising.
5. The emergence and spread of glyphosate-resistant weeds requires farmers to spray additional herbicides, including older herbicides posing documented environmental and public health risks and/or newer, more costly herbicides to avoid crop yield losses and slow the spread of these weeds [37]. This is particularly problematic in grain and row-crop fields planted for several years with Roundup Ready GE crops. In the U.S., contending with resistant weeds has already increased total herbicide use per acre by approximately 70 % in soybeans, and 50 % in the case of cotton compared to herbicide rates on these crops in the mid-1990s when GE varieties were first introduced [10].

Section II

We estimate with confidence that:

1. Glyphosate provokes oxidative damage in rat liver and kidneys by disrupting mitochondrial metabolism [57–59] at exposure levels currently considered safe and acceptable by regulatory agencies [4, 25, 26]. Therefore, the ADI governing exposures to GBHs is overestimated. Adverse effects impacting other endpoints are less certain, but still worrisome and indicative of the need for more in-depth research (see following sections).
2. Residues from GBHs may pose higher risks to the kidneys and liver. Metabolic studies in a variety of laboratory and farm animal species show that levels of glyphosate and AMPA in kidney and liver tissues are 10- to 100-fold (or more) higher than the levels found in fat, muscle (meat) and most other tissues[3]. Increases in the frequency of serious, chronic kidney disease have been observed among male agricultural workers in some regions in which there is a combination of heavy GBH use and 'hard' water [60, 61]. These possible adverse effects of GBH exposure on kidney and liver warrant a focused, international research effort.
3. There are profound gaps in estimates of worldwide human GBH exposure. Glyphosate and AMPA are not monitored in the human population in the United States, despite the 100-fold increase in use of GBHs over recent decades. In circumstances where there is substantial uncertainty in a pesticide's dietary risk, the EPA is presumptively required by the U.S. Food Quality Protection Act (FQPA) of 1996 to impose an added safety factor of up to 10-fold in the setting of glyphosate's cRfD. Such uncertainty can arise from gaps in the scope and quality of a pesticide's toxicology dataset, or uncertainty in exposure assessments. Considering the uncertainties regarding both GBH safety and exposure, the EPA should impose a 10-fold safety factor on glyphosate, which would reduce the EPA chronic

Population Adjusted Dose (cPAD) to 0.175 mg/kg bw/day. [Note: the U.S. EPA adopted the new term cPAD to designate a chronic Reference Dose for a pesticide that had been lowered by the Agency as a result of the application of an added, FQPA-mandated safety factor. Virtually all FQPA safety factors have reduced chronic Reference Doses by 3-fold or 10-fold].

4. Nevertheless, imposing a 10-fold decrease in glyphosate's chronic Reference Dose, as seemingly called for in current U.S. law, should only be viewed as an interim step in the reassessment of glyphosate toxicity and risk, and re-adjustment of glyphosate uses and tolerances in food. Considerable work on glyphosate and GBH toxicity, mechanisms of action, and exposure levels must be completed before the U.S. EPA can credibly conclude that GBH uses and exposures are consistent with the FQPA's basic safety standard, namely that there is a "reasonable certainty of no harm" from ongoing, chronic exposures to GBHs across the American population.

Section III

Current models and data from the biological sciences predict that:

1. Glyphosate and GBHs disrupt endocrine-signaling systems in vitro, including multiple steroid hormones, which play vital roles in the biology of vertebrates [21, 22, 24, 62]. Rat maternal exposure to a sublethal dose of a GBH resulted in male offspring reproductive development impairment [21]. As an endocrine-disrupting chemical (EDC), GBH/glyphosate can alter the functioning of hormonal systems and gene expression patterns at various dosage levels. Such effects will sometimes occur at low, and likely environmentally-relevant exposures. Contemporary endocrine science has demonstrated that dose–response relationships will sometimes deviate from a linear increase in the frequency and severity of impacts expected as dose levels rise [19, 63].
2. The timing, nature, and severity of endocrine system impacts will vary depending on the levels and timing of GBH exposures, the tissues exposed, the age and health status of exposed organisms, and other biotic or abiotic stressors impacting the developmental stage and/or physiology of the exposed organism. Exposures can trigger a cascade of biological effects that may culminate many years later in chronic degenerative diseases or other health problems. Exposures leading to serious complications later in life might occur over just a few days to a month in short-lived animals, and over a few days to several months in humans.
3. The study used by the EPA to establish the current glyphosate cRfD used gavage as a system of delivery, as recommended by OECD guidelines for prenatal developmental toxicity studies, which in all likelihood underestimates both exposure and toxicity [64]. This conclusion is derived from two considerations: (i) gavage bypasses sublingual exposure, and thus overestimates the portion of the chemical subjected to first pass metabolism in the liver, and (ii) gavage stresses the experimental subjects inducing endocrine effects that can lead to artefacts including, crucially, a reduction in the difference between control and experimental groups.
4. The incidence of non-Hodgkin's Lymphoma (NHL) has nearly doubled in the U.S. between 1975 and 2006 [65]. GBHs are implicated in heightened risk of developing NHL among human populations exposed to glyphosate occupationally, or by virtue of residence in an area routinely treated with herbicides [66]. A causal link between GBH exposures and NHL may exist, but has not been rigorously studied in human populations.
5. Uncertainty persists over the doses required to cause most of the above endocrine-system-mediated effects. Some published data indicate that doses well within the range of current human exposure may be sufficient [22, 25], whereas other studies demonstrating distinct, adverse impacts have explored high doses and exposures that are unlikely to reflect any real world levels of ingestion. Additional in vivo studies are needed at environmentally relevant doses to distinguish the combination of factors likely to give rise to endocrine-system-driven morbidity and mortality. Nevertheless, the epidemiological data described above provides evidence of heightened cancer risk in human populations at levels of exposure actually experienced in human populations.
6. Glyphosate is a chelating agent with potential to sequester essential micronutrient metals such as zinc, cobalt and manganese [67, 68]. This property of GBHs can alter the availability of these micronutrients for crops, people, wildlife, pets, and livestock. These micronutrient metals are enzymatic cofactors, so their loss has the potential to contribute to a number of deleterious effects, especially on kidney and liver function [69].

Section IV

Existing data suggest, but do not empirically confirm, a wide range of adverse outcomes:

1. Multiple studies on GBHs have reported effects indicative of endocrine disruption [21–24]. Based on knowledge from studies of other endocrine disruptors, the developing fetus, infants, and children are most at risk. Effects following GBH exposure may not be immediately apparent, because some adverse conditions caused by early-life exposure only manifest in later stages of development and/or in adulthood. These include both acute diseases and chronic health problems. In addition, proving links between chronic disease and exposures to GBHs is made more difficult by the fact that people are routinely exposed to complex mixtures of glyphosate and other toxic chemicals.
2. The action of glyphosate as an antibiotic may alter the gastrointestinal microbiome in vertebrates [33, 70–72], which could favor the proliferation of pathogenic microbes in humans, farm animals, pets and other exposed vertebrates.
3. Increased incidence of severe birth defects in Argentina and Paraguay in areas where GE Roundup Ready crops are widely grown may be linked to the ability of GBHs to increase retinoic acid activity during fetal development [23][4]. Glyphosate-contaminated soybean feeds used in the pork industry have also been associated with elevated rates of gastrointestinal-health problems and birth defects in young pigs [32]. Related impacts have been observed in poultry [33].
4. Some developmental studies in rats undertaken at relatively high levels of exposure suggest possible GBH-induced neurotoxicity through multiple mechanisms [73]. Replication of these studies using doses relevant to human exposures should be a high priority. Further work on GBH-induced neurotoxicity should be conducted to test whether glyphosate can act as a disruptor of neurotransmitter function given its similarity in structure to glycine and glutamate[5].
5. GBHs may interfere with normal sexual development and reproduction in vertebrates. Experiments with zebrafish with dosing of GBH in the upper range of environmentally-relevant contamination levels, show morphological damage to ovaries [74].
6. A recent report demonstrates that environmentally relevant concentrations of commercially available GBHs alter the susceptibility of bacteria to six classes of antibiotics (for example, either raise or lower the minimum concentration needed to inhibit growth) [75]. Furthermore, GBHs can also induce multiple antibiotic-resistance phenotypes in potential human pathogens (*E. coli* and *Salmonella enterica* serovar typhimurium). Such phenotypes could both undermine antibiotic therapy and significantly increase the possibility of mutations conferring more permanent resistance traits. Since GBHs and antibiotics are widely used on farms, farm animals may be exposed to both, with a concomitant decrease in antibiotic effectiveness and increase in the diversity of newly resistant bacterial phenotypes that might find their way into the human population. Risk assessors have not previously considered the finding that herbicides might have sublethal adverse effects on bacteria, but this should be considered in future risk assessments.

Section V

Uncertainties in current assessments persist because:

1. A steadily growing portion of global GBH use is applied in conjunction with multiple other herbicides, insecticides, and fungicides. Herbicide and other pesticide active ingredient safety levels are calculated for each active ingredient separately, despite the fact that tank mixes including two to five, or even more active ingredients account for a significant portion of the volume of pesticides applied. Regulators do not require further testing of such mixtures, nor do they conduct any additional risk assessments designed to quantify possible additive or synergistic impacts among all herbicides applied, let alone the combination of all herbicides, insecticides, fungicides, and other pesticides applied on any given field.
2. The full list of chemicals in most commercial GBHs is protected as "confidential business information," despite the universally accepted relevance of such information to scientists hoping to conduct an accurate risk assessment of these herbicide formulations. The distinction in regulatory review and decision processes between 'active' and 'inert' ingredients has no toxicological justification, given increasing evidence that several so-called 'inert' adjuvants are toxic in their own right [42]. Moreover, in the case of GBHs, the adjuvants and surfactants, which include ethoxylated tallowamines, alkylpolyglycosides or petroleum distillates in most commonly used commercial formulations, alters both the environmental fate and residue levels of glyphosate and AMPA in harvested foodstuffs and animal feeds. They do so by enhancing the adhesion of glyphosate to plant surfaces, as well as facilitating the translocation of applied glyphosate from the surface of weed leaves into sub-surface plant tissues, where it exerts its herbicidal function and where rainfall can no longer dissipate the glyphosate.

3. The vast majority of GBH-toxicology studies used for regulatory assessments lack a sufficient range of dose levels to adequately assess adverse impacts that might be initiated by low, environmentally-relevant exposures[6]. Most toxicology studies examine only a high dose between the LD50 (the dose required to kill 50 % of treated animals) and the maximum tolerated dose (a dose that has high toxicity but does not kill), and then typically two lower doses (allowing for the identification of the Lowest Observed Adverse Effect Level [LOAEL] and the No Observed Adverse Effect Level [NOAEL]). Environmentally relevant doses are rarely examined [63]. A further complication arises specifically for endocrine disrupting chemicals: there are theoretical and empirical findings concluding that one cannot assume any no-impact exposure threshold for endocrine processes that are already underway because of endogenous hormones [76].
4. Residues of GBHs in plants are often present in conjunction with: (a) residues of systemic seed treatments, especially neonicotinoid insecticides (for example, clothianidin and thiamethoxam) and their adjuvants (such as organosilicone surfactants), (b) residues of systemic insecticides and fungicides applied during the season, and (c) *Bt* endotoxins in the case of GE, insect-protected *Bt* cultivars. Such mixtures and combinations are never tested, and thus it is unknown how GBHs might interact with these other agents.
5. Large-scale and sophisticated biomonitoring studies of the levels of glyphosate, its metabolites, and other components of GBH mixtures in people have not been conducted anywhere in the world. Biomonitoring studies should include measurement of glyphosate residues, metabolites, and adjuvants in blood and urine to obtain meaningful insights into internal contamination levels and the pharmacokinetics of GBHs within vertebrates[7].
6. Adequate surveys of GBH contamination in food products have not as yet been conducted on a large scale, even in the U.S. The first and only in-depth USDA testing of glyphosate and AMPA residues in food targeted soybeans, and occurred once in 2011 [13]. Of the three hundred samples tested, 90.3 % contained glyphosate at a mean level of 1.9 ppm, while 95.7 % contained AMPA at 2.3 ppm. In contrast, the next highest residue reported by USDA in soybeans was malathion, present at 0.026 ppm in just 3.7 % of samples. Thus, the mean levels of glyphosate and AMPA in soybeans were 73-fold and 83-fold higher than malathion, respectively. Residues in animal products, sugar beet, pre-harvest treated wheat, corn silage, and alfalfa hay and sprouts are unknown, but likely much higher, given the series of recent requests by Monsanto to increase tolerance levels in a range of foods and animal feeds [12].
7. There is no thorough, up-to-date government survey of glyphosate and AMPA residues in U.S. grown Roundup Ready GE soybeans, nor manufactured foods that contain soy-based ingredients. However, changes in the rate of GBH applications on many other crops, and/or the timing of applications, have clearly increased residue levels in some circumstances. In particular, GBH uses late in the growing season as a pre-harvest desiccant have become more common. Such applications speed up the drying of crops in the field, so that harvest operations can be completed before bad weather sets in. Such harvest-aid uses are popular, especially in wet years, on wheat, canola, and other grain farms in some humid, temperate climates, such as in the UK and northern-tier states in the US. While pre-harvest uses have only modestly increased the total volume of GBHs applied, they have significantly increased the frequency and levels of residues in harvested grains, and have required GBH registrants to seek significant increases in tolerance levels. These residues are also contributing to dietary exposures via a number of grain-based products, as clearly evident in data from the U.K. Food Standard Agency's residue testing program [14].
8. Glyphosate residues are generally uncontrolled for in the standard rations fed to animals in laboratory studies. GBH residues can often be found in common laboratory animal chows used in feeding studies, thus potentially confounding the results of GBH toxicity tests [77]. Out of 262 pesticide residues analyzed in 13 commonly used rodent laboratory diets, glyphosate was the most frequently found pesticide, with concentrations reaching 370 ppb [78]. Therefore, GBH residues should be accounted for in animal chows used in controls for GBH studies.
9. The limited data currently available on glyphosate pharmacokinetics in vertebrates are insufficient to predict transport and fate of glyphosate in different mammalian tissues, organs and fluids in the body, and to determine whether or where bioaccumulation occurs, although animal metabolism studies point strongly to the kidney and the liver.

Section VI

The following recommendations are offered to further improve our predictive capability regarding glyphosate risks:

1. Scientists independent of the registrants should conduct regulatory tests of GBHs that include glyphosate alone, as well as GBH-product formulations. [Note: in the latest glyphosate regulatory assessment process by the German Federal Institute for Risk Assessment, the description and assessment of studies was provided by the Glyphosate Task Force, a group of 25 agrochemical companies that combined resources to jointly apply for renewal of registrations for this herbicide within Europe. By way of contrast, in order to avoid conflicts of interests, the Glyphosate Task Force was restricted to a role of observer to the evaluation of data by independent scientists at the recent WHO IARC evaluation of glyphosate's carcinogenic potential].
2. Epidemiological studies are needed to improve knowledge at the interface of GBH uses, exposures, and human-health outcomes.
3. Biomonitoring studies examining reference populations like the U.S. CDC's NHANES program should examine human fluids for glyphosate and its metabolites.
4. More comprehensive toxicity experiments are needed including those using "two hit" study designs, which examine early life exposures to GBHs followed by later-life exposures to chemical or other environmental stressors.
5. Because GBHs are potential endocrine disruptors, future studies should incorporate testing principles from endocrinology.
6. Future studies of laboratory animals should use designs that examine the full lifespan of the experimental animal, use multiple species and strains, examine appropriate numbers of animals, and carefully avoid contaminating GBH and other pesticides within control feeds and drinking water.
7. GBHs should be prioritized by the U.S. National Toxicology Program for safety investigations, including tests of glyphosate and common commercial formulations.

Section VII
Implications

1. The margin of safety between typical glyphosate and AMPA exposure levels and the maximum allowed human exposures has narrowed substantially in the last decade. The margin may well have disappeared for heavily exposed segments of the population in some countries, especially where glyphosate and AMPA are present in drinking water. In addition, farmworkers and rural residents may incur relatively high dermal absorption and/or exposures via drinking water. We conclude that existing toxicological data and risk assessments are not sufficient to infer that GBHs, as currently used, are safe.
2. GBH-product formulations are more potent, or toxic, than glyphosate alone to a wide array of non-target organisms including mammals [42, 43], aquatic insects, and fish [44]. As a result, risk assessments of GBHs that are based on studies quantifying the impacts of glyphosate alone underestimate both toxicity and exposure, and thus risk. This all-too-common shortcoming has repeatedly led regulators to set inappropriately high exposure thresholds (cRfDs, ADIs).
3. The toxicological data supporting current GBH regulatory risk assessments are out-of-date and insufficient to judge the impacts of contemporary glyphosate and AMPA exposure levels on the developing mammalian fetus, the liver and kidneys, and reproductive outcomes in humans and a variety of other animals [3, 25].
4. Most toxicological studies using advanced, modern tools and experimental designs within molecular genetics, reproductive, developmental, endocrinological, immunological and other disciplines have been undertaken in academic and research institute laboratories, and results have been published in peer-reviewed journals. Regulators have not incorporated, formally or indirectly, such research into their risk assessments. Rather, they rely on unpublished, non-peer reviewed data generated by the registrants. They have largely ignored published research because it often uses standards and procedures to assess quality that are different from those codified in regulatory agency data requirements, which largely focus on avoiding fraud [79]. Additionally, endocrine-disruption study protocols have not been codified by regulators[8].
5. While the German Federal Institute for Risk Assessment, rapporteur for the European Food Safety Authority's current reassessment of glyphosate, claimed to have examined more than 900 scientific studies published in peer-reviewed journals, most of the studies were deemed of limited value, and hence had little influence on the outcome of their assessment. Studies were classified of 'limited value' based on degree of adherence to traditional toxicology protocols and 'validated' endpoints, rather than scientific rigor and relevance in understanding the mechanisms leading to adverse health outcomes. Had the German Institute used scientific quality and relevance in identifying useful studies, instead of relying on similarity to outdated methodologies and/or controversial evaluation criteria [80] (such as the Klimisch score), we are nearly certain that they would

have concluded that published studies collectively provide strong evidence in support of at least a three-fold reduction in the glyphosate E.U. ADI and consequently a 15-fold reduction in the U.S. cRfD [3, 21, 25, 26].

Conclusions

GBH use has increased approximately 100-fold since the first decade of its use in the 1970s. It is now the world's most heavily applied herbicide. Major increases in its use resulted from widespread adoption of Roundup Ready crops that were genetically engineered to be tolerant to glyphosate. Applications of GBHs have also expanded in aquatic, estuarine, rangeland, and forest habitats.

Initial risk assessments of glyphosate assumed a limited hazard to vertebrates because its stated herbicidal mechanism of action targeted a plant enzyme not present in vertebrates. In addition, because GBHs kill nearly all actively growing plants, farmers had to apply GBHs early in the year, before crop germination or post-harvest, and so it seemed unlikely that there would be residues in harvested crops and the food supply. However, these assumptions ignored the possibility that glyphosate and its metabolites might act via other pathways, including those present in vertebrates, as well as the profound consequences of major increases in the area treated and volume applied, coupled with changes in how and when GBHs are used by farmers (e.g., on GE, herbicide-tolerant crops, and as a pre-harvest desiccant to accelerate harvest).

Evidence has accumulated over the past two decades, especially, that several vertebrate pathways are likely targets of action, including hepatorenal damage, effects on nutrient balance through glyphosate chelating action and endocrine disruption. Other early assumptions about glyphosate, for example that it is not persistent in the environment, have also been called into question, depending upon soil type. In addition, the prediction that glyphosate would never be present widely in surface water, rainfall, or groundwater has also been shown to be inaccurate.

Existing data, while not systematic, indicate GBHs and metabolites are widely present in the global soybean system and that human exposures to GBHs are clearly rising. Tolerable daily intakes for glyphosate in the U.S. and Germany are based upon outdated science.

Taken together, these conclusions all indicate that a fresh and independent examination of GBH toxicity should be undertaken, and that this re-examination be accompanied by systematic efforts by relevant agencies to monitor GBH levels in people and in the food supply, none of which are occurring today. The U.S. National Toxicology Program should prioritize a thorough toxicological assessment of the multiple pathways now identified as potentially vulnerable to GBHs. The urgency of such work was reinforced in March 2015 when the IARC concluded glyphosate is a probable human carcinogen.

We are aware of current limits on, and demands for, public funding for research. In the absence of government funds to support essential GBH research, we recommend that a system be put in place through which manufacturers of GBHs provide funds to the appropriate regulatory body as part of routine registration actions and fees. Such funds should then be transferred to appropriate government research institutes, or to an agency experienced in the award of competitive grants. In either case, funds would be made available to independent scientists to conduct the appropriate long-term (minimum 2 years) safety studies in recognized animal model systems. A thorough and modern assessment of GBH toxicity will encompass potential endocrine disruption, impacts on the gut microbiome, carcinogenicity, and multigenerational effects looking at reproductive capability and frequency of birth defects.

Endnotes

[1]The E.U. ADI was calculated based on observed kidney (hepatorenal) effects in rat chronic toxicity studies. The "No Observable Adverse Effect Level" (NOAEL) was 31 mg/kg/day, and the "Lowest Observable Adverse Effect Level" (LOAEL) occurred at a dose of 60 mg/kg/day (determined then to be the LOAEL). A standard 100-fold safety factor was applied in converting the E.U.-set NOAEL to the ADI of 0.3 mg/kg/day. The new ADI recommended by the German regulators of 0.5 mg/kg/day is based on teratogenic effects in rabbits. The NOAEL was considered to be 50 mg/kg/day. Independent scientists argue that the 2002 determination was not based on the most sensitive species or dataset, as is required by regulatory authorities. See ref 14. Antoniou M, Habib MEM, Howard CV, Jennings RC, Leifert C, Nodari RO, Robinson CJ, Fagan J: Teratogenic effects of glyphosate-based herbicides: divergence of regulatory decisions from scientific evidence. J Environ Anal Toxicol 2012, S4:006.

[2]The EPA issued an updated registration review of GBHs in 1993. Studies dating from the early 1970s through mid-1980s dominated the reference list accompanying the chapter setting forth the EPA's estimate of GBH human health risks.

[3]Table B.7.3-8 in the document "Renewal Assessment Report, Glyphosate Residue Data" (Vol. 3, Annex B.7, Dec. 18, 2013, RMS: Germany, Co-RMS-Slovakia) provides an overview of the levels of glyphosate and AMPA measured in the meat, milk, and eggs from several livestock species, as well as in the fat, meat, kidney, and livers of the animals. In most cases the levels reported in

liver and kidney exceed those in other tissues by several-fold, and the levels in kidney exceed those in liver by 3-fold to over 10-fold.

[4]Retinoic acid signaling plays a key role in guiding embryonic development, affecting the expression of multiple genes in a variety of cell types. Altered retinoic acid activity causes birth defects (see 58. Duester G: Retinoic acid synthesis and signaling during early organogenesis. Cell 2008, 134(6):921-931.

[5]Glutamate is a common vertebrate neurotransmitter released by neurons into the synapse; and is important for learning and memory (for a review, see 59. Meldrum BS: Glutamate as a neurotransmitter in the brain: review of physiology and pathology. J Nutr 2000, 130(4S Suppl):1007s-1015s. Glyphosate's structural similarity to glutamate creates the potential for interfering with this key signaling process.

[6]"Environmentally relevant" exposures to GBHs are those that fall within the documented exposure levels arising from the way GBHs are typically used.

[7]Pharmacokinetic studies project and monitor the levels of a chemical absorbed by an organism (via ingestion, inhalation, dermal absorption, or some other route of exposure), how the chemical is distributed throughout the body to specific tissues (measuring the concentrations in different organs and in the blood), how the chemical is metabolized (including which metabolites are produced, and whether the presence of these metabolites and their relative abundance is dependent on route of exposure), and finally, how a compound is excreted (e.g., in feces or urine). Pharmacokinetic studies provide a valuable link between estimates of exposure, toxicity studies, and estimates of human risk.

[8]The process of establishing testing protocols for endocrine-mediated impacts has been underway in the U.S. since 1997, in response to a mandate in the 1996 Food Quality Protection Act to consider such effects in assuring a "reasonable certainty of no harm" for pregnant women, infants, and children. Seventeen years later, the EPA remains years away from codifying a new battery of tests capable of identifying the risk of low-dose, endocrine-disruption driven effects.

Abbreviations

2,4-D: 2,4-Dichlorophenoxyacetic acid; ADI: Acceptable daily intake; AMPA: Aminomethylphosphonic acid; Bt: Bacillus thuringiensis; CKAD: Chronic Kidney Disease Adjusted Gross GRR: Chronic Reference dose; EPSPS: 5-enolpyruvylshikimate-3-phosphate synthase; EU: European Union; FQPA: US food quality protection act of 1996; GBHs: Glyphosate-based herbicides; IARC: International Agency for Research on Cancer; LOAEL: Lowest Observed Adverse Effect Level; NOAEL: No Observed Adverse Effect Level; US EPA: United States Environmental Protection Agency

Competing interests

John Peterson Myers received support from the Broad Reach Fund, the Mattila Foundation and the Wallace Genetic Foundation for this work.
Michael Antoniou received support from the Sustainable Food Alliance, Breast Cancer UK, The Sheepdrove Trust (UK) and the Safe Food Institute (Australia). He is also serving as an expert witness on behalf of the State of Vermont (U.S.A.) in a case involving the labeling of food products containing ingredients from GE organisms.
Bruce Blumberg is a named inventor on several patents related to nuclear receptor function and testing (US 8,861,274; 8,200,802; 8,815,168; 8,274,321; 8,891,847; 8,756,491; 8,809,178; 8,984,773), some of which generate royalty income. He has received grant support from the US National Institutes of Health, National Science Foundation, American Heart Association, State of California and the Swedish Environmental Agency FORMAS. He receives occasional research gifts from Advancing Green Chemistry and occasional travel awards from professional societies in the US and elsewhere. None of these constitutes an actual, or perceived conflict of interest.
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Lorne Everett declares no conflicts of interest. He is principle of Lorne Everett Associates.
Michael Hansen declares no conflicts of interest.
Philip Landrigan declares no conflicts of interest.
Brian Leighton served as an expert witness in California for the plaintiffs in a public nuisance case of childhood lead poisoning, a Proposition 65 case on behalf of the California Attorney General's Office, a case involving lead-contaminated water in a new housing development in Maryland, and Canadian tribunal on trade dispute about using lead-free galvanized wire in stucco lathing but he received no personal compensation for these services. He is currently representing the government of Peru as an expert witness in a suit involving Doe Run vs Peru, but he is receiving no personal compensation. Dr. Leighton has served as a paid consultant on a US Environmental Protection Agency research study, NIH research awards and the California Department of Toxic Substance Control. Dr. Leighton has received federal research awards from the National Institute of Environmental Health, the US Environmental Protection Agency, the Centers for Disease Control and the US Department of Housing and Urban Development. He is also the recipient of federal research awards from the Canada Institutes of Health Research and Health Canada.
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Charles Benbrook declares no conflicts of interest. He received support for work on this paper in a grant to Washington State University from the Ceres Trust. He is the principle of Benbrook Consulting Services. He is currently a member of the U.S. Department of Agriculture AC 21 Agricultural Biotechnology Advisory Committee. He has served as an expert witness in cases involving herbicide drift and damage, and the labeling of food products containing genetically engineered ingredients.

Authors' contributions

JPM recruited team members and chaired over 30 conference calls of the authors between August 2014 and May 2015. All authors contributed to the writing and editing, with JPM and CME playing the lead roles. CMB added detailed information about changes in GBH use over time. All authors read and approved the final manuscript.

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FOOD FOR THOUGHT

EPA Weighs In On Glyphosate, Says It Likely Doesn't Cause Cancer

September 17, 2016 · 9:49 AM ET

DAN CHARLES

A central Illinois corn farmer refills his sprayer with the weedkiller glyphosate on a farm near Auburn, Ill. The pesticide has been the subject of intense international scrutiny.

Seth Perlman/AP

No chemical used by farmers, it seems, gets more attention than glyphosate, also known by its trade name, Roundup. That's mainly because it is a cornerstone of the shift to genetically modified crops, many of which have been modified to tolerate glyphosate. This, in turn, persuaded farmers to rely on this chemical for easy control of their weeds. (Easy, at least, until weeds evolved to become immune to glyphosate, but that's a different story.)

Glyphosate had been considered among the safest of herbicides. So it was a shock to many, last year, when the International Agency for Research on Cancer announced that this chemical is probably carcinogenic.

THE SALT

A Top Weedkiller Could Cause Cancer. Should We Be Scared?

Since that announcement, however, others have looked at the same collection of data and come to contrary conclusions. The European Food Safety Agency convened a group of experts who concluded that glyphosate probably does not cause cancer. So did the UN's Food and Agriculture Organization.

Now the Environmental Protection Agency has issued its own report, and it also concludes that glyphosate is not likely to cause cancer in humans. Outside scientists will review the report in October.

THE SALT

Why Monsanto Thought Weeds Would Never Defeat Roundup

The report is part of a lengthy process by which EPA is reviewing many agricultural chemicals, and deciding whether farmers will be allowed to use them.

European regulators, meanwhile, are locked in a political battle over whether glyphosate use will continue to be permitted on that continent. The European Commission has authorized continued sales of the chemical, but only temporarily.

glyphosate weed killer monsanto pesticides

Michigan Historic Cemeteries Preservation Guide

Gregg G. King with
Susan Kosky, Kathleen Glynn & Gladys Saborio

Supported by

Michigan Historic Cemetery Preservation Manual

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with
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PHOTOGRAPH AND ILLUSTRATION CREDITS

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Page 36	Zinc Statue, Gladys Saborio
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Preface

There are hundreds of historic cemeteries in the state of Michigan. However, until publication of this manual, anyone wishing to undertake conservation and preservation of these historic cemeteries had to search through numerous and often conflicting sources for information. There was no comprehensive source outlining sound conservation and preservation practices. With publication of this manual, endorsed by the State Historic Preservation Office, individuals and communities now have one reliable source.

This manual outlines the preservation and conservation process in a step by step manner. It facilitates the process by offering chapters on organizing efforts, surveying and documenting, and conservation of the cemetery. In addition, a chapter on management and maintenance assists in planning for the future care of the cemetery. A final chapter offers suggestions for optimal utilization of the historic cemetery property.

An extensive appendix offers documentation forms, readings, websites, and a glossary of terms that will help add to the body of knowledge of conservators, and community officials and guide them in their efforts. Information from sources such as the National Park Service, The Association for Gravestones Studies, the National Preservation Institute, the Chicora Foundation, the Michigan State Historic Preservation Office and the National Trust for Historic Preservation; interviews with conservators as well as years of practical conservation practice add to the usefulness of the manual. Though technologies change and new products and practices evolve the concepts presented in the manual will serve as a solid foundation for preservation and conservation projects.

Introduction

Many small cemeteries in rural and urban areas throughout Michigan are in need of urgent care. They are often neglected and vandalized, and sometimes abandoned. This manual is intended for municipalities, civic groups, historical societies, genealogists or any others interested in the proper methods of conservation and maintenance of these small cemeteries. It will serve as a readily accessible guide to resources and methods that will enable communities, civic groups and others to document, preserve, and maintain their historic burying grounds. It is not, however, meant for those wishing to conserve large cemetery sculpture or architecture, work that is best left to trained and experienced professionals. Varying levels of skills are required to perform cleaning, repair and documentation of a cemetery. The following three skill levels will be used throughout the manual to make it apparent who can be called upon to perform indicated tasks.

LEVEL ONE	LEVEL TWO	LEVEL THREE
1	2	3
some training (workshops, on-site training, or under the guidance of trained personnel)	experienced, trained personnel	professional

Although specifically written for a Michigan audience, the methodology, the resources, the very description of these cemeteries is much more regional. The practices set forth in this manual are acceptable anywhere and follow sound preservation theory.

For the purpose of this manual we shall call these cemeteries *historic cemeteries*. Other terms such as *rural, country* and *pioneer* are inadequate and misleading, even though many of these cemeteries are found in very country-like or rural settings. Many of these small historic cemeteries exist within the city limits of small towns. Others are located in the midst of urban and suburban development, lost among the new housing stock and adjacent to heavily traveled roadways. No single term exists that completely describes these small historic cemeteries, but they are readily recognizable as an important part of Michigan's rural and rapidly urbanizing landscape.

The term "Rural Cemetery" is often used to describe another type of property typified by Mt. Auburn Cemetery near Boston, one of America's first designed, garden cemeteries.

> In 1831 the Massachusetts Horticultural Society created Boston's Mt. Auburn, the first "rural cemetery" and prototype for many others. Gen. Henry A. S. Dearborn designed its original 72 acres based on the model of Pere Lachaise in Paris. Dr. Jacob Bigelow was responsible for Mt. Auburn's Egyptian gate, Gothic chapel and Norman tower, inspired by structures in English Gardens. (Tishler, p. 121)

Unlike the Rural Cemeteries of the nineteenth century, some of Michigan's small historic cemeteries are unplanned. Others employed a simple grid pattern of layout. Still others were a vernacular adaptation of the design principles of the Rural Cemetery Movement. They may have layouts of curving roadways, planned vistas and other elements found in the Rural Cemetery, or more commonly perimeter trees, a central avenue, a circle for a memorial, and formal plantings. They have changed and developed with their communities while maintaining much of their historic layout, monuments, plantings, and character.

Perhaps the closest definition of a historic cemetery is the one offered by Kenneth T. Jackson. In his book, *Silent Cities: Evolution of the American Cemetery*, Jackson refers to this type of burial ground as a "country graveyard."

> The county cemetery is a familiar site along the highways of the United States. The outskirts of every city and small town seem to include space for at least one burial ground. Such cemeteries are smaller, more open and more egalitarian than their counterparts in the city. Sometimes on top of a hill, sometimes in a clearing surrounded by woods, they tend to cover less than a dozen acres. Rarely do they include the mausoleums, large obelisk, elaborate statuary, high fences, and ethnic markers so common in urban cemeteries. Their typically unpretentious homemade or mail order markers commemorate a cross section of the citizenry, the first settlers, the foreign-born, and some of the "local boys" killed in battle. Tourists, finding the plots historical and picturesque, stop to read the dates when the area was settled, and the names, origins and religions of the local residents. (Jackson, p. 12)

Michigan historic cemeteries sometimes have an ethnic origin bearing grave markers that reflect the language and traditions of the area's settlers. In Washtenaw County, for example, there are several such cemeteries with German inscriptions attesting to their establishment by the local German immigrants. A particularly picturesque example exists in Cheboygan County with Swedish markers. The cemetery's layout and many monuments reflect this ethnicity. These cemeteries are and always have been local in nature. Old trees and other historic plant material are often a part of the setting. Small buildings, mausoleums and other structures are common. Many cemeteries sport decorative fencing, signage and gates typically added in the late nineteenth or early twentieth century. In still-active cemeteries, newer burials are set behind or to one side of the oldest graves. The main similarities of Michigan's small historic cemeteries are their age and their size. In Michigan most originated in the earlier decades of the nineteenth century or more precisely at settlement time. Although each historic cemetery is unique in character, these cemeteries have many commonalties.

- They are usually quite small, often less than ten acres.
- Often they began as a family burying place and expanded over time.
- Frequently the land was set aside by some of the earliest settlers either by donation or direct purchase.
- Many are associated with small country churches or township centers.
- Headstones are less massive and ornate than those found in urban cemeteries.
- If there are historic buildings or structures associated with them, they are typically small in scale and likely to be vernacular rather than high style architecture.

As conscientious members of society it is our responsibility to care for these burial sites of our respected dead. Benjamin Franklin said, “Show me your burial grounds and I’ll show you a measure of the civility of a community.” Accepting this responsibility we help to preserve a resource that will benefit not only us but future generations.

Historic cemeteries are important cultural, architectural and archaeological resources. They provide us with information on our community’s history. Often a cemetery is the only remnant left from early settlements and as such is a vital link with the past. They are an invaluable educational tool whether we seek to research genealogy, educate our youth or delve into local history. They provide quiet places to commemorate the deceased, whether it be of a most personal nature, or on a local, regional, or even national scale. Originally located in agricultural areas that are now becoming more urbanized, early cemeteries can provide a place for quiet reflection and solitude and much needed open space. Buildings, fencing and other ancillary features are artifacts that demonstrate historic stylistic trends and construction methods. Archaeological excavations in cemeteries, whether they are Native American or Euro-American, are extremely controversial. They should only be undertaken if the cemetery is being formally vacated and the interments moved to other burial locations and NEVER without necessary permits and appropriate consultation with descendents of those interred. Simple abandonment of a cemetery does not make it an appropriate venue for archaeological study.

These important places may provide us with some of the earliest written local history. Headstones reveal names and dates for locally significant persons. They offer glimpses into local illness and epidemics and tell of a community’s sacrifices in our nation’s wars. The same headstones provide us with samples of local folk art and, particularly after the Civil War, reflect a substantial amount of popular cultural standardization of monument forms and motifs. They were transmitted through such sources as design books and catalogs. Extant historic plant materials can be collected for study and can be reintroduced in other gardens.

Old cemeteries provide valuable information to those interested in their family histories, information that may not be available elsewhere. Early graveyards remind us of the fragility of life in earlier times and of how the area’s pioneers created lives for themselves against tremendous odds. Sometimes they provide us with more than the bare facts of birth and death; they provide us with tender, tragic or humorous glimpses into the lives of earlier generations. They tell us about the struggle to survive childhood diseases, childbirth, wars and epidemics. But most of all they tell us about the recurring cycle of birth, life, and death and how we are all a part of that cycle.

Cemeteries are integral parts of the cultural landscape. School children and other members of a community may use them as outdoor museums dedicated to an area's history and cultural traditions. Site visits enable visitors to observe first hand important community artifacts. Volunteers trained in maintenance and conservation techniques can learn while providing an important local service. They can assist in the conservation and preservation of cultural artifacts for the education of future generations.

An area's architectural history is evident in its cemeteries. Churches that are associated with historic cemeteries and small buildings such as chapels, mausoleums, and storage sheds all reflect the taste, architectural styles and ethnicity common in the community at the time of their construction. They reflect the architectural preferences of their time and can show a greater connection to the tastes of the nation. Many mid to late nineteenth century cemeteries have small Gothic Revival, Richardsonian Romanesque, or Neoclassical buildings, styles taken from medieval and classical sources and popularized by trendsetters like Andrew Jackson Downing, a nineteenth century architect, horticulturist, and writer. Others have early twentieth century style buildings from Egyptian Revival to Colonial Revival. All these styles borrow motifs commonly associated with age-old funeral and burial practices.

While major repair and rehabilitation of mausoleums and other buildings are beyond the scope of this manual and should be left to professionals, we include a section on repointing masonry. Documentation and repair of artifacts such as monuments, fencing and gates are an important focus of this work. Often these valuable cultural artifacts are in great jeopardy from weathering, environmental damage, vandalism, and neglect. They are in urgent need of conservation and preservation and provide communities, civic organizations, and others a tremendous opportunity to become involved in the "monumental" effort of cemetery preservation.

This manual takes a multi-topic approach to preservation and conservation efforts. While we use the term "preservation" to mean maintaining the historic integrity of a cemetery's site, we use the term "conservation" to refer to those processes used in caring for damaged gravestones and artifacts. Topics are discussed from the general to the specific. The manual begins with verifying ownership, conducting preliminary reconnaissance and preparing a plan. It then continues with identifying, photographing, mapping, and documenting cemetery features.

The next level encompasses conservation of cemetery elements and features and discusses the actual process used in conserving landscape, grave markers, and other features. This approach uses the Secretary of the Interior's *Standards for the Treatment of Historic*

Properties with Guidelines for the Treatment of Cultural Landscapes. The Secretary's *Guidelines* suggest four treatments: preservation, rehabilitation, restoration, and reconstruction.

> Of the four, Preservation standards require retention of the greatest amount of historic fabric, including the landscape's historic form, features, and details as they have evolved over time. Rehabilitation standards acknowledge the need to alter or add to a cultural landscape to meet continuing or new uses while retaining the landscape's historic character. Restoration standards allow for the depiction of a landscape at a particular time in its history by preserving materials from the period of significance and removing materials from other periods. Reconstruction standards establish a framework for recreating a vanished or non-surviving landscape with new materials, primarily for interpretive purposes. (Secretary of the Interior's *Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*, Introduction)

The final discussion concerns planning for educational and recreational activities geared to a variety of ages and interests. This step allows a community to optimize the use of its cemetery, minimize vandalism, and utilize its historic property. The manual concludes with a detailed list of sources for both information and materials pertinent to historic cemeteries.

Chapter 1

ORGANIZING EFFORTS

Organizing efforts should be a step by step process. The process will vary from community to community due to the availability of funds and manpower to perform the necessary tasks. Communities that have limited funding should choose to complete Plan A (below), which will stabilize the historic cemetery, and then develop a plan to implement actions as funds become available. Three flexible plans for cemetery preservation are suggested here, followed by more detailed suggestions to implement them.

Plan A would serve a community volunteer group or private individual with limited resources. This plan provides only the basics to stabilize and document the cemetery.

- Establish ownership and get permission to act. (Chapter1)
- Reconnaissance level survey (with a sketch map and documentary photography to determine needs). (Chapter 2)
- Basic cleaning and stabilization of grounds and stones. (Chapter 3)
- Routine maintenance. (Chapter 4)

Plan B would serve the individual or community that has some funding and trained volunteers.

- Establish ownership and get permission to act.
- Reconnaissance level survey followed by setting short and long-term goals. (Chapter 2)
- Cleaning and stabilization of grounds and stones. (Chapter 3)
- Document cemetery features with a detailed map and photographs. (Chapter 2)
- Research the cemetery's history. (Chapter 1)
- Plan for and implement complete repairs of all tombstones, fences, roads, and other features. (Chapter 3)
- In addition to routine maintenance, make long-term plans for preservation of landscape features. (Chapter 4)

Plan C is the ideal and would serve an individual or municipality with plentiful resources and access to trained professionals.

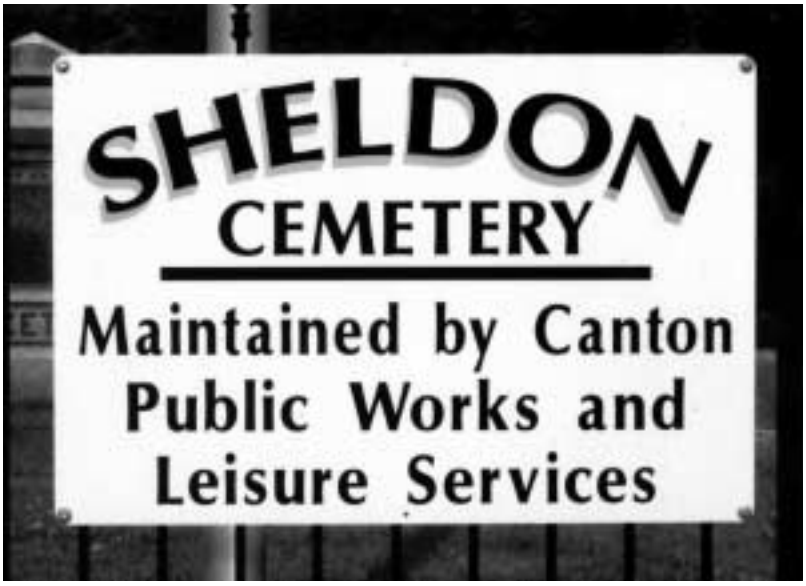
- Establish ownership and get permission to act.
- Reconnaissance level survey followed by setting short and long-term goals.
- Clean and stabilize grounds and stones.
- Form a citizen's group to help with fund raising, educating the public, and other goals.
- Detailed mapping, photography, cleaning of stones, and some maintenance.
- Repair all artifacts.
- Restore landscape (ponds, roads, vegetation).
- Plan for and implement long term maintenance goals.
- Put in place cemetery-related programs such as tours, nature talks, genealogy, etc. (Chapter 4)
- List cemetery in the National Register of Historic Places. (Chapter 1)

All three plans contain some of the following steps. The first two steps, establishing ownership and knowing the legal parameters, however, are steps that everyone must complete before beginning any work in the cemetery. Other steps can often be undertaken simultaneously and do not necessarily demand completion of one step before the commencement of the next.

Communities should exercise caution that initial enthusiasm for clean-up and repair does not precipitate unwise preservation actions. Reign in enthusiasm until suggested actions can be reviewed to make sure that actions do not harm the cemetery.

ESTABLISH OWNERSHIP

The first task to be completed prior to undertaking fieldwork in a historic cemetery conservation project is to establish the ownership of the cemetery. Often a historic cemetery has a sign that is prominently posted giving the hours of operation and naming the entity that has authority over the property. Many cemeteries are located adjacent to religious properties. Even though the cemetery may not be affiliated with the religious property, inquiring there will often produce the information needed to identify the owner. Further inquiries can be made at the local city, village or township hall, or at the county clerk or assessor's office. The county recorder of deeds or assessor's office will provide a legal description of the property. Researching records at the same offices might produce historic legal descriptions, providing a picture of how the property has changed over time. In Michigan, when small, private cemeteries in rural areas are abandoned and are no longer maintained, they become the property of the current landowner.



Often the cemetery will have a sign identifying who is responsible for its care.

KNOW THE LAWS AND REGULATIONS

Once ownership is established, the next step is to become aware of any existing laws or ordinances that might relate to the cemetery and the project. Cemetery associations often have regulations that are in effect. There also may be federal laws that relate to military and Native American burial grounds. This information can sometimes be garnered from the owner of the cemetery.

Most of the Michigan laws relating to cemeteries are contained in the Michigan Compiled Laws (MCL), Chapter 128. Cemetery corporations are covered in MCL 456.1 et seq. Transfer of rights to a municipal corporation is covered in MCL 456.181 to 184.

Act 113 (Chapter 128.61) of 1915 states that "The Township Board of each township shall have the authority and it shall be its duty to cause all cemeteries within its township, except private cemeteries and cemeteries owned by cities and villages located in such

townships, to be properly taken care of." Public Act 293 of 1966 as amended MCL section 45.515, subsection D affords responsibilities in part to the counties within the state (can be found on the Michigan Legislature web site). Chapter 5 includes a discussion on creating a local cemetery ordinance or an historic cemetery ordinance, a recommended step in future planning.

AWARENESS AND TEAM BUILDING

Having established ownership and verified legal restrictions, the next step is to build community awareness of the importance of the resource and the need for its preservation. Conduct a tour for interested citizens; if the cemetery is municipally owned be sure to include city / township officials. Be armed with reasons why this project is worthwhile and necessary for the community. Cite the problems that exist in the cemetery. Point out specific areas needing attention. To get people to support a project they must be convinced there is a need. Some suggestions for raising awareness are:

- Publicize your effort through local newspapers
- Get the local cable TV station interested in the project
- Establish a web site with photographs of headstones in need of attention
- Partner with local schools, scouting, and other organizations to make as many people as possible aware of the project
- Appeal to local church groups and garden clubs
- Garner support from historical and genealogical societies
- Demonstrate to local officials that there is something in the project for them

The last point is especially important because, if there is a local government body responsible for the upkeep of a cemetery, they are often not overly enthusiastic to expend funds on a restoration project. A cemetery is often a non-revenue generating property and funds for maintenance and upkeep can be scarce in tight budgets. If a proposed project offers a more diverse use of the property and a chance to build civic pride it will more readily gain the support of local officials. Municipal support can go a long way towards a continued maintenance program and may even increase resource allotment.

Initially the response may be slow but with persistent effort the project will gain momentum. A wide range of skills is needed in the effort to conserve a historic cemetery. Establishing a broad base of support, expertise and labor is necessary to achieve success.

Step 1: Get Permission

With enthusiasm and a team ready, it is time to approach the owner and request permission to conduct a reconnaissance level survey. It is extremely important that no work of any kind be conducted in the cemetery without first obtaining permission

from the owner. Be prepared to demonstrate that the resources and manpower are available to conduct such a survey. The sample form in Appendix A can be used or adapted to obtain written permission from the owner / governing authority. **It is important to keep this form on file.**

Step 2: Conduct a Reconnaissance Survey

With permission granted, it is time to begin the initial reconnaissance survey. A reconnaissance survey is a quick look at the property and requires little documentation. This survey will provide an overview of existing conditions, features, and landscape elements.

It is essential before any repair or replacement work is undertaken. The survey will aid in setting goals and determining funding needs. The reconnaissance level survey includes the following items:

- **A sketch map that contains the location of:**
  - present boundaries
  - fencing
  - gates
  - buildings
  - roads and pathways
  - water features
  - vegetation such as trees, flowers, shrubs
  - family plots
- An assessment of damaged artifacts and problems with landscape features, such as erosion and fallen branches
- Photography that records each of the above elements

During this survey, disturb nothing. Something as simple as moving rocks could alter the historic integrity of the cemetery. Mowing could destroy historic plant material. What at first appears to be debris could later prove to be of significance.

Along with the reconnaissance site survey it is important to research all former repair, restoration, and documentary projects. This will save duplicating efforts and help in accessing what should be done or undone. Perhaps a prior effort has documented inscriptions on stones. Roads, pathways, and access gates might have been altered or relocated to accommodate modern vehicles and equipment. New plantings, removal of downed trees and other historic plantings, new fencing or expansions of the cemetery's boundaries are often documented. Cemeteries maintained by local governmental bodies, cemetery associations, and by religious organizations might have records of prior efforts that can be used to determine how the cemetery changed over time.

In Michigan the township often has authority over cemeteries within its boundaries. Searching in the township records might reveal important data. Another avenue to pursue might be the records of local service organizations. In the early decades of the twentieth century a strong interest in national, local, and family history led to cemetery research. If organizations such as women's clubs, the Daughters of the American Revolution or other such civic or military groups were active in the area at the time, their records could lead to information about former efforts to document the cemetery. Old newspaper articles often will report community projects such as installation of monuments, cleanup efforts, and changes in cemetery boundaries. Locating existing documentation will save duplication of effort that equates to time and money in any project.

Step 3: Prepare an Action Plan

With the completion of the reconnaissance survey and research, the team is ready to prepare a plan of action. This plan should include setting goals, recruiting volunteers, finding funding, and establishing safeguards and security measures for resources and workers.

Setting Goals

Perhaps the most important first step in preparing the action plan is to delineate and prioritize goals. This will bring the project into focus and clarify which actions are the most pressing. In the process of setting goals, address the following questions. What are the project's priorities? What type of workforce is needed? Can volunteers provide some of the work? What is the minimum that needs to be done to stabilize the cemetery? Will a preservation planner be helpful? After answering these initial questions determine short and long term goals.

These are examples of short-term goals that might be included in an action plan:

1. Form a "Cemetery Friends" group (see The Association for Gravestone Studies' Guide to Forming a *Cemetery Friends* organization).
2. Make a Master Plan.
3. Identify funding sources.
4. Hire a coordinator if needed.
5. Create safety guidelines for both workers and material artifacts.
6. Clarify legal considerations to determine liability for both volunteers and visitors.
7. Address security, vandalism, and theft issues.
8. Retain the original form and fabric of the burial ground by adopting the Secretary of Interior's *Standards for the Treatment of Historic Properties and the Guidelines for the Treatment of Cultural Properties.*

9. Analyze current conditions. Follow up by emergency stabilization of markers and landscape. Once features that may be unsafe have been uncovered, such as loose headstones or deteriorated roads, incorporate these items as priorities in the master plan.
10. Determine which professionals will be needed and at approximately what stages. Make a list of recommended experts.
11. Conduct an intensive level survey of the site using photography, mapping, and forms to document markers, buildings, and landscape. At this point plan to delve into the history of the site to uncover cultural traditions, changes over time, and site features such as historic plant material or buildings.
12. Undertake initial cleanup of the cemetery.
13. Expand public awareness.

Examples of long-term goals:

1. Clean and conserve all markers.
2. Evaluate and repair ancillary features.
3. Prepare a plan for landscape preservation and future maintenance using appropriate materials and techniques.
4. Continue research.
5. Provide educational tools such as tours, lectures, brochures, a newsletter, information posted on the community web site, and documentation of findings in the local library.
6. Prepare regulations concerning site management.
7. Enact a local cemetery or historic cemetery ordinance if none exists.
8. Designate the property as an historic site.

Step 4: Establish Funding

After delineating goals, begin the search for funding sources. First, solicit support from the owner/governing body of the cemetery. Perhaps the governing body will agree to channel the needed funds into the project; however, it will usually be necessary to supplement any small amount provided by an owner or municipality. When no association or municipality will be responsible for managing funds it is important to create an organization that can serve this purpose.

To help with both plans and funding, there are several organizational options to be considered:

- Establish an organizational hierarchy with well defined responsibilities.

- Establish the group as a non-profit Cemetery Association or Cemetery Maintenance District (see Saving Graves web site, an international organization committed to the preservation of historic cemeteries).
- Become a tax exempt entity. (See Saving Graves web site)
- Open a checking account.
- Obtain a tax ID number.
- Consider establishing an endowment account to fund ongoing conservation and preservation efforts.

For a project to reach its potential a budget must be prepared and maintained. Designate a responsible person or entity to handle finances. By operating in a businesslike manner those wishing to donate can do so with the assurance that there is a stable process in place for the allocation of donated funds.

There are many ways to raise both large and small amounts of money for a project. Having the support of the local authorities or historical society is beneficial. Fund raising, enlisting workers and raising awareness are related components of the total project. From the beginning establish "partnerships" with local groups and organizations for potential sources of money, expertise and hands on labor. Some partnership suggestions are:

- The local historical society.
- Programs such as "Adopt a Cemetery" or "Adopt a Statue" where one or more groups become responsible for continued care or a financial commitment.
- Approach the developer of a local real estate project. Sometimes there are requirements that the developer "give back" to the community. This might be a source of essential "seed money" to get the project started or a way to fund a large improvement, such as restoration of a fence or statue.
- A local college may have programs in historic preservation, landscape architecture, archaeology, or history that could provide advice and students for work projects.
- Approach local businesses and corporations for funding and "in-kind" donations of products.
- Enlist local Boy Scout or Girl Scouts to volunteer for projects to earn community service badges.
- Groups such as local genealogy societies, Daughters of the American Revolution, and Veterans of Foreign Wars may be interested in volunteering.
- Local school groups.
- Pro bono contributions from lawyers, CPAs and other professionals.
- Explore the use of volunteers as an "in-kind" match for grants.
- Families of those buried in the cemetery.

By enlisting the help of a local real estate developer, Canton Township was able to replace a worn and broken cyclone fence with a safe, aesthetically pleasing aluminum fence at no cost to the township parks department, which maintains the property.

In addition to the above, seek large benefactors. Appealing to local business owners, corporations or a civic-minded philanthropist could provide for on-going financial assistance. Having non-profit status, (501)(c)(3), is a must for raising money from corporations and foundations as it allows them to use the contribution as a tax deduction (*Fundraising for Non-Profit Groups: How to get money from foundations, and government*, p. 20).

When seeking funding, grants are another avenue to pursue. Obtaining grants for the project could begin with visiting the Funding Research Guide at the Saving Graves web site. A *Foundation Directory* is available at the Grant Information Center of many large public and university libraries. These participating libraries offer access to the Foundation Center web site without charge. This site is privately accessible for a fee. This directory provides information on the types of projects that are funded by each agency. Other sources of grant funding information are: the *Corporate Giving Index*, which specifies the focus of each business's corporate donations, and the *Michigan Foundation Directory*. Most granting agencies will want assurance that the organization is able to raise money locally, some may require matching funds. Be sure to target those funding agencies that have an interest in the type of project proposed and that sponsor projects in the local area.

Check with local foundations for grant awarding possibilities. Some cities have a Community Foundation that awards grants for specific purposes. Regional foundations, such as the Southeastern Michigan Community Foundation, provide grants for arts and humanities projects in specified geographic areas. Local groups such as Questers (an organization that performs community service projects focusing on local history and culture) often provide grants for projects that relate to history and antiquities.

Communities that are participating in the National Park Service's Certified Local Government Program (CLG) are eligible to apply for competitive grant funds through the State Historic Preservation Office (SHPO) in the Department of History, Arts and Libraries (HAL). For more information on Michigan's CLG grants and on other governmental organization grants visit the State Historic Preservation Office on the web at *www.michigan.gov/shpo*.

Although some grants may require a lot of paperwork, others do not. All have definite deadlines for submission. Most granting agencies require the following information:

- Background information – name, purpose, board of directors, copy of the operating budget, and IRS letter of determination (federal tax-exempt status 501(c)(3). (See Saving Graves web site)
- Assurance that the group has been in existence for at least two years.
- Names of key people involved in the project.
- Letters of support from affiliated agencies such as: State Historic Preservation Office, National Trust for Historic Preservation, Michigan Historic Preservation Network, and The Association for Gravestone Studies.

Many agencies offer conferences and seminars on writing grants. The Association for State and Local History offers a grant writing session at their annual conference. The Michigan State Housing Development Authority (MSHDA) and continuing education programs offered through colleges and universities also offer grant writing courses.

Step 5: The Work Force

Well-trained volunteers bring both enthusiasm and hands-on assistance to the venture; however, as the process advances beyond the preliminary effort, it is recommended that a coordinator, preferably a paid position, lead the effort. It is a large undertaking to see that the formal preservation plan unfolds smoothly while coordinating funding, volunteers, and professionals. An organizational person is necessary to set timetables, train volunteers, follow up on various projects, and in general keep everything on track. This person can also coordinate volunteers and their efforts in the cemetery.

Before anyone is allowed to work in the cemetery it is a good idea to have written, specific rules and regulations. Specifying "dos and don'ts" protects workers, the project coordinator and the historic property. Some guidelines for volunteers are:

- Never go into the cemetery alone. There is always the possibility of a falling limb or other unforeseen accident.
- Bring a first aid kit and cell phone, and tell the person in charge what project will be done and when it will be done.
- Wear long pants, a long sleeve shirt, gloves, and sturdy shoes to prevent harmful plants, insects and other wildlife from harming you. Bring insect repellant and put anti-bee sting medication in the first aid kit.
- Be on guard for broken glass, sharp stones, and rusty metal. In the case of any injury that breaks the skin, a tetanus shot needs to be updated if the last one was over five years ago.
- If possible point out any known toxic plants in the cemetery. Poison ivy and oak especially like to grow on fences and trees. An awareness of what they look like and protective clothing are helpful.
- Avoid working during the hottest part of the day, wear sunscreen, and have water available.
- Pay attention to the area traversed. A sunken grave, wet stones or vegetation in the path might precipitate a fall.
- Use proper lifting techniques when working with stones. For heavy stones use a tripod with heavy-duty chain, winch and straps.

Volunteers

Volunteers can be used for the initial cleanup of the cemetery. Cleanup is often the activity that has the greatest attendance and is best publicized. It is also where a significant amount of damage can be done to the landscape by well-intentioned volunteers and staff members, who fail to appreciate the historic context and burial practices of the past.

In the initial cleanup, the first important consideration is to protect and preserve that which has survived on the site. A very conservative approach should be taken. Something as simple as the removal or reuse of rocks found in a cemetery could alter the integrity of a particular area. Rocks, like plants, were often used as markers of loved ones' gravesites. Sometimes a large stone would be placed at the head of a grave with a smaller one at the foot. In other instances fieldstones were used to outline the grave. During the initial cleanup only removal of litter such as large branches and trash (broken bottles, cans, and paper) should be done. Do not mow the grass, or remove plants, broken headstones or any type of marker.

All volunteers should receive some training before working in the cemetery. Training volunteers through workshops, or an extended workshop, is recommended. In Canton Township volunteers from Civitan, Boy and Girl Scouts, historical societies, and students from local schools have participated in tasks such as tree trimming, removal of bushes, leaf clean up, grass trimming, and cleaning of markers. In Canton Township, Michigan, in conjunction with *Make a Difference Day*, a local Eagle Scout (aided by his parents and Canton staff) plotted Downer Cemetery into ten foot- by ten foot squares, recorded all data, and photographed the cemetery. The project took over two hundred hours to complete and as a result, all of the semi-covered and covered stones were located and a complete photographic record of the cemetery was made.

Documenting gravestones by photography, mapping, surveying, and the completion of a form for each grave requires patience and precision. Probing for and cleaning gravestones takes special knowledge and requires specialized skills. In the long run, money will be saved if volunteers have an in-depth orientation to each task. If the community does not provide workshops, there are various organizations that offer them: the Chicora Foundation, the National Park Service, the Center for Historical Cemeteries Preservation, Indiana Pioneer Cemeteries Restoration Project, and the Association for Gravestone Studies, that has a yearly conference that includes workshops. Contact these organizations for more information. With education, the volunteers will gain enough information to discern which tasks can be accomplished and those which must be left to a professional.

Hiring Professionals

Depending on the size of the cemetery, the extent of the damage, and the need for restoration, professional help may be required in addition to volunteers. A historic preservation consultant with planning experience may be the first professional that is needed in order to give a condition assessment, formulate a plan, set priorities, and protect the historical integrity of the site. Other professionals that might be considered are horticulturalists, archeologists, landscape historians, historic site engineers, structural engineers, architectural conservators, restoration artisans, monument dealers, and if the cemetery is within a municipality that cares for burial grounds, the Department of Parks and Recreation. The State Historic Preservation Office maintains a list of architects that specialize in work on historic buildings. They may be able to offer assistance as well in locating professionals with appropriate expertise for the project. The Michigan Historic Preservation Network (MHPN) offers a list of contractors belonging to its Construction Trades Council.

Points to consider when selecting a conservator:

- Inquire about qualifications, types of insurance, experience with similar cemetery conservation projects and membership in the American Institute of Conservators (AIC) or other professional conservator groups.
- Ask about the size of their firm, length of time in business, employee training and experience, and supervision of employees.
- Be sure that the conservator is willing to provide documentation of the work being done. Ask that photographs be taken before, during, and after the work. Be sure that all of the products used are specified in written work orders and estimates, and that Material Safety Data Sheets (MSDS) are supplied.
- Develop a timeframe for the project and get it in writing. Discuss with the conservator what will happen if the project takes longer than anticipated or if there are cost overruns.
- Discuss any concerns the conservator might have, such as overnight site security, questions about utilities or permits.
- Ask if the conservator is willing to train others involved in the project, such as cemetery staff or volunteers. Are they willing to return for routine maintenance? What sort of actions will be taken in the event of a repair failure?
- Be sure to indicate that all OSHA regulations must be followed. Indicate that it will be necessary to use appropriate safety equipment to minimize the risk of accident or injury.
- Inform a contractor that because of the fragile nature of the landscape in which preserving old plants, buildings and markers is a priority, the work in a historic cemetery is handled differently than a residential account.
- Let contractors know that it may be necessary to delay conservation or maintenance in the event of a funeral or burial.

The quality of work that is received from the contractor is directly related to the concerns discussed before the work begins. Be certain to indicate the standards that will be used to judge the completed work, and in most cases the extra effort will be worthwhile. Getting a bid from more than one professional is a good idea.

Step 6: Listing in the National Register of Historic Places

If listing the cemetery in the National Register of Historic Places is considered, contact the state National Register coordinator. The State Historic Preservation Office (SHPO) web site lists the criteria that must be met in order to list a property in the National Register. A summary of the criteria as they relate to cemeteries is:

- **Criterion A:** Properties can be eligible for the National Register if they are associated with events that have made a significant contribution to the broad patterns of our history. A cemetery might be eligible for listing in the National Register under Criterion A in relation to events for various reasons– for example, if it contains the graves of many of the community's early settlers where other properties, such as the early settlers' houses no longer survive to represent this period of the community's history; if it is important for its association with an ethnic group or settlement important in the community's history; or if it is associated with one or more important events, such as a mining disaster that resulted in a substantial number of interments.
- **Criterion B:** Properties can be considered eligible under Criterion B if they are associated with the lives of persons significant in our past. The persons with whom the burial place is associated must be of outstanding importance to the community, state, or nation.
- **Criterion C:** Properties can be eligible for the National Register under Criterion C if they embody the characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction. A cemetery may be eligible under Criterion C as a representative example of a cemetery whose layout and features reflect an important movement in landscape design, such as the Romantic Movement; as an important example of the work of a significant landscape architect or designer; because of the architectural and / or artistic importance of the funerary architecture and / or art present there; or because the cemetery as a whole possesses significance because the entire cemetery, including its planning and landscaping, and its architecture and monuments display high artistic value.
- **Criterion D:** Properties can be eligible for the National Register if they have yielded, or may be likely to yield, information important in pre-history or history. Burial places may be eligible for their potential to yield information about cultural and ethnic groups and burial practices. Such information is generally obtained through archeological investigation.

Contact the SHPO if you are seeking to nominate a cemetery to the National Register. Nomination forms are available at no charge from the State Historic Preservation Office (SHPO) or the National Register of Historic Places. Michigan's SHPO submits all nominations of properties in Michigan– except federal properties– to the National Register. Submitting a *National Register of Historic Places Preliminary Questionnaire* is the first step in nominating a cemetery property to the National Register. The questionnaire is available

(PDF format) on the Michigan SHPO web site. The SHPO staff will review this form and offer an opinion about the property's eligibility.

If the cemetery is deemed eligible by the SHPO, the next step is preparation of the nomination forms and accompanying documentation for submission to the SHPO. Once the final version is approved by the SHPO, it is presented to the State Historic Preservation Review Board for its approval before being submitted to the National Register, National Park Service, U.S. Department of the Interior, for formal listing in the National Register of Historic Places. Forms are available on the web site or by mail by writing to:

State Historic Preservation Office
Michigan Historical Center
Box 30740
720 W. Kalamazoo Street
Lansing, Michigan 48909-8240
preservation@michigan.gov

Chapter 2

SURVEY METHODOLOGY
AND DOCUMENTATION

OVERVIEW OF CEMETERY DEVELOPMENT

The following overview of cemetery development is intended to put the historic cemetery in context as a beginning point for documentation. Cemeteries, along with grave markers, changed as a result of the evolution of society's religious and cultural attitudes toward death. Understanding how the cemetery changed over time will help to place it in its historical context.

In America whenever an area was newly settled, whether in New England or Michigan, the need for burial soon followed. The deceased was usually buried near the place of death and often in an unmarked grave. America's earliest burial grounds were not attractive, tranquil places. Graves were not located in neat rows and maintenance was minimal. Sometimes cemeteries were located on a piece of land that could not be used for farming. The grass was allowed to grow long and animals grazed on the site. It was a utilitarian place, a highly visible reminder to everyone of the brevity of life and the uncertainty of the afterlife. When settlements had progressed beyond the pioneer stage burials became more ritualized.

The family burying ground, with its tall, flat, rectangular stones, was a familiar sight in rural areas, as was the churchyard or community cemetery in villages or township centers.

Often cemeteries that began as family burying grounds later were deeded for use as community cemeteries. The evolution of styles can often be seen. Others, however, were originally platted as cemeteries and had an administrative body for the day-to-day management.

While Michigan was still in the process of settlement during the early 1800s, the Rural Cemetery Movement had already begun in the eastern United States. Several factors led to the development of this movement. One of these factors was public health. Increased urbanization and its accompanying population density caused problems with the air and water in large cities and resulted in epidemics of small pox, cholera, diphtheria, and other life threatening diseases. It was believed that cemeteries contributed to the contamination of the water supply. New cemeteries were thus located on the outskirts of urban centers. (*Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries*, p. 6-7)

A second factor in the development of the Rural Cemetery Movement occurred as cemeteries were being relocated to the urban fringe; the new generation of cemeteries became planned landscapes. Among the first planned cemeteries were New Haven's New Burying Ground and Pere Lachaise in Paris. New Burying Ground was nonsectarian and free from church and municipal management. Features that were copied by later cemeteries:

- locations outside the city in order not to be a health hazard
- geometric pattern layout
- family plots
- roadways wide enough for carriages
- planted with trees (poplars and willows)

A third factor was the rise of the Romantic Movement in Europe. The Romantic Movement was a revolt against the eighteenth century's cultural emphasis on rationality and order in favor of a "romantic" appeal to the senses in the later eighteenth and nineteenth centuries. It was characterized in literature and the arts by liberalism in form and subject matter. It emphasized feeling and originality, and an interest in nature, medievalism and the mystical. The Romantic age influenced all the arts and eventually filtered down to cemetery design. In cemetery design this translated into the development of a picturesque aesthetic that encouraged maintaining and enhancing the natural environment rather than overcoming it.

Mount Auburn Cemetery in Cambridge, Massachusetts, established by the Massachusetts Horticultural Society in 1831, is generally considered the first of the new

generation of Romantic Movement rural cemeteries in the United States. Mt. Auburn was unique in that it was designed to encourage public use for healthful recreation. Its design served as a model for the "pleasure grounds" and public parks built in the late nineteenth century. Key principles that were later imitated:

- it was outside the city limits in a rural area
- park-like character with an informal plan and winding roads that took advantage of topography, natural features and trees
- emulated romantic character of estate design popular at the time
- careful balance of art and nature through use of architecture features and view sheds
- served a quasi-public function (*Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries*, p. 7-8)

Most larger non-Catholic cemeteries established from the 1840s to the 1870s emulated Mt. Auburn in their picturesque planning and landscape. With the evolution of the designed cemetery the earlier term "burial ground" was replaced with "cemetery" from the Latin "to sleep." In 1869 New York art critic Clarence Cook agreed with Andrew Jackson Downing, a horticulturalist and author, in that cemeteries were "all the rage." They were "famous over the whole country and thousands of people visited them annually." (Tishler, p. 121)

Spring Grove Cemetery in Cincinnati, Ohio, marks the beginning of another development in cemetery planning, the "lawn-park cemetery." Spring Grove Cemetery was originally developed in the rural cemetery style in 1845. A change of administrators in 1856 brought about a change in design philosophy and Spring Grove began to evolve in the lawn-park cemetery style under the direction of Adolph Strauch. The lawn-park cemetery had more structured regulation than rural cemeteries. It eliminated the use of small features and family plot boundaries in favor of an open sweep of green lawn with plantings organized to frame or create vistas. Strauch's ideas, for what he called the "landscape lawn plan," influenced cemetery design for the next half century. (Linden, p. 16 and p. 30)

Lawn-park cemeteries were characterized by:

- a balance in formalism and naturalism
- elimination of fencing and fewer, larger monuments rather than a "forest" of large and small monuments
- the use of grouped ornamental planting to frame large expanses of lawn, lakes and monuments to create vistas (Tishler, p. 121-122)

Technological advances, among them the invention of the lawn mower, led to progressively simpler cemetery designs. The memorial park cemetery, which gained popularity in the mid to late twentieth century, forbade the use of upright gravestones, in favor of small flat markers imbedded in the ground. These cemeteries were typically privately owned and well maintained. In the twentieth century cemeteries were designed by cemetery professionals rather than landscape architects and / or horticulturists. Forest Lawn Cemetery in Glendale, California, (1916), is an example of evolving cemetery design. It is considered America's first memorial park cemetery.

Characteristics of memorial park cemeteries:

- Highly planned and regulated
- Monuments are flush with the ground
- Emphasis on lawns
- Sense of openness and spaciousness
- Minimal decorations with few buildings, features or plantings
- Plantings are backdrop for large memorials that emphasize community rather then the individual. ("Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries", p. 10)

After World War II, as the population became more mobile often leaving no family members to care for graves, the professional maintenance and "perpetual care" offered by privately owned memorial parks helped result in their proliferation.

SURVEY AND DOCUMENTATION

1 2 There are two types of surveys. A **reconnaissance survey** is a quick overview of the site, done simply to note significant features on a map and to get a general understanding of the cemetery's design or layout. The reconnaissance survey serves as the foundation for the second type of survey, the more in-depth, **intensive level survey**. An intensive level survey requires researching the site and documenting individual features. A survey is comprised of two elements: research and fieldwork. Fieldwork entails taking a thorough look at the cemetery as it presently exists, noting and recording on maps and through photographs all pertinent features within its boundaries. Research requires gathering historical and present data to document the cemetery's history, its landscape, and its artifacts. The survey process consists of:

- Research and compiling data
- Mapping
- Photographing
- Recording information on survey forms

Research and compiling data

Research consists of investigating a variety of sources of historic data:

- Microfilm copies of old newspapers and other data at local libraries and historical societies
- Deed books at the county register of deeds
- Local and county histories, atlases and maps, and genealogy information
- Records of the cemetery association and/or a church associated with the cemetery
- Archive and library collections such as those in the State Archives of Michigan and the Library of Michigan in Lansing, the Bentley Historical Collection in Ann Arbor and the Burton Historical Collection at the main Detroit Public Library

Data collected is not only an important historical record, but can be used for future planning and maintenance of the cemetery. The documentation should be collected in a systematic way, presented in a professional format and be accessible to both professionals and lay researchers. Appendix A contains the forms recommended by the State Historic Preservation Office for surveying the cemetery as a whole, individual gravestones, and vegetation. These forms can be copied for field use. Afterward the information that is gathered should be entered into an electronic data base.

Surveying the Cemetery's Features

Looking at a landscape through the eyes of both a historian and a horticulturist will help put together the pieces of the cemetery story. Ask the following questions:

- Was the site originally located in a small village, in a rural area, part of a crossroads hamlet, settled by a particular ethnic group, or part of a religious site?
- Where is the cemetery sited? On a rolling countryside? Is the site plain and sparsely planted, or is it covered by a canopy of mature trees?
- What are the basic elements of the cemetery's design or layout? Does it have the romantic elements of Victorian era cemeteries, such as picturesque rolling terrain and artistically designed monuments? Does it show the characteristics of a lawn park cemetery?
- Is it a designed landscape?
- When was the cemetery established?
- What are the dates of additions?

Often the organization or agency in charge of the cemetery's maintenance will have maps showing the existing boundaries and plan. Both old and new county atlases often show

the boundaries of cemetery parcels. If early maps exist, they may help with the analysis of the cemetery's development.

- The survey process requires a site analysis that results in a record of the physical features of the cemetery. *National Register Bulletin No. 41: Guidelines for Evaluating and Registering Cemeteries and Burial Places* (available from the National Park Service) recommends that "Characteristic plant materials, layout of burial plots and circulation features, acreage encompassed, and the purpose or function of areas and features within the site boundaries also are important." The following list of features to be documented is taken from the National Register *Guidelines*:
  - general topography, including slope and elevation, both within the burial ground and in relation to its larger setting;
  - natural features such as streams, hills and native vegetation, and naturalistic features such as ponds, lakes and land forms;
  - plat, or layout of cemetery plots, whether a rigid gridiron imposed on the site or an organization of plots conforming to natural contours;
  - circulation system of roads, driveways, pathways, noting whether such features have axial alignment or are winding or curving; structural features of the system, such as bridges and drainage systems; and distinctive materials, such as cobble gutters or stone paths; views and vistas within the site from principal access points; views and vistas external to the site;
  - characteristic vegetation, including overstory of trees, understory of shrubs and grasses, exotic plant materials used as filler in burial plots, ornamental flower beds, and specimen plantings;
  - gateways, fences, and hedges used for boundary and spatial definition;
  - typical plot defining features such as wooden palings, iron fencing, and concrete curbing;
  - prevalence of individual plot mausoleums, vaults, or above-surface tombs, and indication of the range and variety of individual grave markers;
  - entrance signs, directional markers, outdoor lighting features, and small-scale site furnishings such as benches, planters, ornamental sculpture, and fountains;
  - maintenance and service features such as soil disposal and waste storage areas, greenhouses, tool sheds, and pump houses;
  - buildings such as churches, memorial chapels, gate houses, offices, residences, crematories, mausoleums, and columbaria. (Walton-Potter, Elisabeth, and Beth M. Boland, p. 2-3)

By recording the features listed above, a picture of the cemetery, changed over time, will evolve. The most basic and useful forms of documentation are photographs, survey data forms and a map of all features showing their location.

Interpretation of the site and plans for future use should be based on this information. The Association for Gravestone Studies (AGS) leaflet, titled *Analyzing Cemetery Data*, may be helpful in interpreting some of the information that is collected. When cemetery documentation is complete, the local library and AGS should receive copies. See Appendix A for sample forms.

DOCUMENTING THE VEGETATION

With the initial research complete and after defining the site perimeter, one of the first priorities is assessing and documenting vegetation. Preserving plant life is a very important part of cemetery conservation. Looking at some of the plantings through "modern" eyes may cause you to overlook old species that are indeed heirloom varieties. Look beyond the plantings that you recognize. Since most species were introduced during a specific time period, looking at garden books featuring historic plants or old and new seed catalogs may help to document "changes over time" in the cemetery. Common plantings found in Michigan cemeteries might include roses, sedum (the historic variety known as "live forever"), myrtle, pinks, lilacs, iris, and lilies. These old varieties can be very different from today's hybrids. It is also important to remember that some of these plant memorials were symbolic. For example, the lily is associated with purity, the rose with love, and ivy with immortality and fidelity. Trees were associated with meaning, too. The cedar tree was associated with strong faith, evergreen trees with immortality and the willow tree with grief and death. These plantings were part of memorializing those that are interred in the cemetery and should be preserved. In order to preserve historic plant material, documentation should be done before any clean-up or routine maintenance is performed, or before professionals begin work.

During the reconnaissance survey, the examiner may have noted plantings near gravestones or along the fence line where historic plants have spread and survived because the lawnmower couldn't reach them. A more intensive survey and documentation of plant life needs to be undertaken over three seasons, spring, summer, and fall, to make sure both early and late bloomers are found. Look around gravestones, along both the inside and outside of fence lines, beneath shrubs, in compost/refuse piles, and at the base of trees for historic plants. Record their location on the site map.

A plant historian, master gardener, or plant biologist may be helpful at this point. If a historic cultivar is found, it would be worth having a horticulture specialist identify it to preserve both its historical integrity and biological diversity in the cultural landscape. A local college or university may have a horticulture-related staff member who would be willing to donate time and expertise. The Michigan State University Extension Service could also be helpful.

Record each plant type found in the cemetery with photograph and survey form. Modern plants should also be documented.

The form to document the cemetery vegetation is included in Appendix A. It includes:

- Date of observations (over three seasons if possible)
- Plant genus, species, and common name if known
- Size
- Color
- Condition
- Photographic documentation
- Location on cemetery base map
- Reference number to coordinate photograph, map, and plant list / form
- Historical significance, if known (symbolism, family significance or planted to represent an event)
- Evaluation of integrity and significance. Is the plant rare or an old variety? Was the tree planted to commemorate an important event in the community? Does the plant material have an ethnic or symbolic relationship? Was the person buried in the plot once the owner of a local nursery?

While a cemetery may not be the work of a famous landscape architect or master gardener, its horticulture can give important clues to its history and culture, and is a way of honoring the deceased. Scott Kunst, landscape historian, suggests that when documentation of plantings is complete, a plant palette of plants common to area cemeteries, such as "Canton Township Cemetery Plants," could be made. Knowing what species of trees are planted will also help plan for the future development of the cemetery. For example, the presence of acidic trees, such as pine and oak, can be detrimental to marble and limestone markers. Some cemetery associations, such as Canton Township's Cherry Hill Cemetery Association, have adopted a policy of pre-approval of plant material and its location in order to keep roots from interfering with the graves. Several books and web sites that aid in plant identification are listed in Appendix B.

EVALUATION OF THE MONUMENT

Evaluation of the monument is a four part process that requires the documentation of the material used, the form of the stone, carvings and the inscriptions. This evaluation produces information regarding the age of the stone. It may also reveal whether or not the stone was carved by hand or whether mechanical techniques were used. Research may also disclose the cultural preferences of the area and era in which the monuments were erected.

1. Materials

Many early settlers of Michigan emigrated from New England and New York bringing their cultural traditions with them. These traditions greatly influenced Michigan's early burial practices. As in New England the earliest burials were very simple. The deceased was buried in the family plot or local burial ground with very little ceremony, reflecting the Puritan ethic.

By the time Michigan was being settled in the early nineteenth century, stone markers were common in New England, and early Michigan settlers brought this stone monument tradition with them. The early stone monuments in Michigan were often limestone. This material was relatively soft and easily carved by hand. However it deteriorated easily, and in an effort to use a more durable material marble became popular. White marble, available from sources close to home, was universally popular from the 1830s until the 1850s. With the advent of the railroad in the mid-nineteenth century, stonecutters were able to obtain non-indigenous materials such as "blue" marble from Vermont. However, it soon became apparent that marble, too, was soft and subject to weathering. After the Civil War improvements in quarrying technology and machine tooling made granite the material of choice. Granite was available from many sources, including Vermont and Missouri. It was also indigenous to Michigan, available in many colors including Wisconsin Crystal Grey from Iron Mountain, Michigan.

New materials also began to appear after the Civil War, among them "white bronze," more accurately zinc, a bluish grey non-magnetic, durable metal. According to Barbara Rotundo, the author of *Monumental Bronze: a Representative American Company*, almost all historic cast zinc (white bronze) monuments came from the same source, the Monumental Bronze Company of Bridgeport, Connecticut. The company had subsidiaries in the U.S. and Canada but, according to Rotundo, it is not known whether these plants actually cast the metal or whether they simply joined the sections pre-cast in Connecticut. Monumental Bronze Company operated from the mid-1870s to the late 1930s and opened its first subsidiary in Detroit in 1881. This subsidiary was known as the Detroit Bronze Company and the markings from this company appear on numerous Michigan monuments. Zinc

monuments were both inexpensive and durable and have generally worn well over time. The epitaph or inscription on a "white bronze" monument was cast at the foundry and could be chosen from a list provided by the manufacturer or created by the purchaser.

In addition to individual monuments, zinc was also used for large commemorative monuments. Whether individual markers or commemorative statues, all monuments were custom made after being ordered from a catalogue. Several Michigan communities have "white bronze" statues and monuments in their historic cemeteries. A particularly well maintained and excellent example is the Civil War monument located in the Lake View Cemetery in Quincy, Michigan. It bears the foundry marking "Detroit Bronze Company" and is similar in appearance, to the more expensive monuments found in Dexter, Jonesville, Coldwater, Milan, and numerous other Michigan cities. A community, like Quincy, with a strong amount of patriotic zeal, but a small cash flow, was able to commemorate its local heroes in the same grand style as more affluent communities. Even though these monuments were less expensive, they have frequently endured time much better than some of their more expensive look-alikes.

In addition to individual markers, large statues were made of zinc.

Markings identifying the manufacturer are often found on the base of the marker or statue.

2. Forms/Shapes

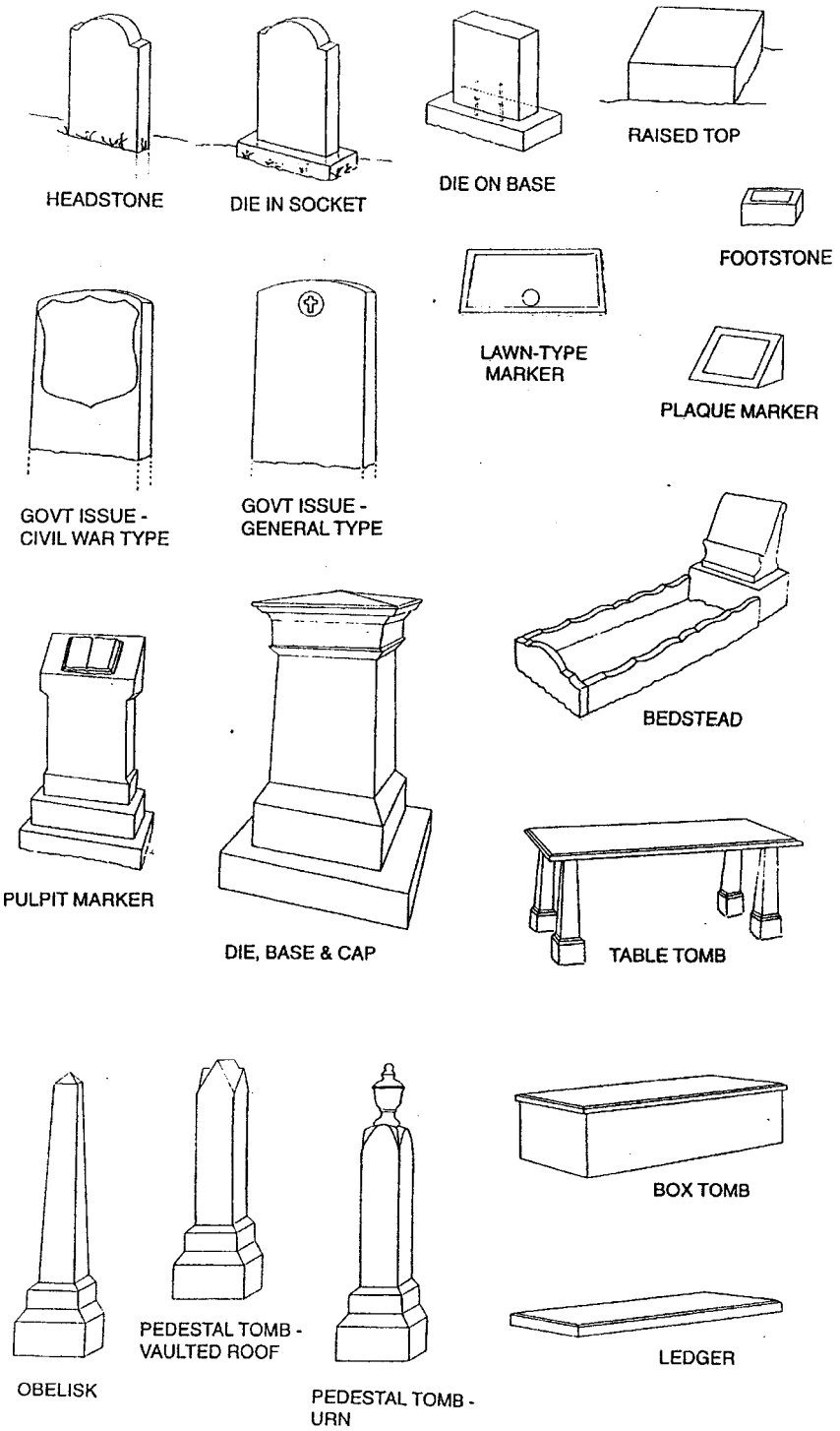
In the early nineteenth century, when Michigan was being settled, headstones were simple rectangular or cambered (curved at the top) shapes. As settlers became established and prosperous, after the mid-nineteenth century, they wanted more elaborate carving and gravestone shapes. Large, three-dimensional, more decorative monument shapes became increasingly common and the carving became more elaborate. Developing technology and transportation improvements allowed for national distribution of monuments. By the late nineteenth century local stone carvers were able to order pre-cut monuments in popular shapes directly from the quarry, and the customer could order from catalogue sources such as Sears Roebuck and Montgomery Ward. Catalogue markers helped to standardize the design of gravestone shape in small cemeteries.

In the last half of the nineteenth century headstones became more ornamental. Three-dimensional shapes were more frequently seen, especially obelisks, pedestals, square planned shafts, and columns. The Romantic Movement, which swept through England and Europe, had spread to America and was influencing literature, art, even headstone design. Gothic (pointed arch) and Romanesque (broad rounded arch) elements taken from medieval themes became prominent in headstone shapes. At the end of the twentieth century laser carving technology was adapted for headstone design. Not only does this allow for very personalized designs including transferred photographs and other biographical information, it also allows for unusual shapes of headstones such as hearts, diamonds, and even semi-trailer trucks.

In the twentieth century, when the lawn park cemetery design became prevalent, headstones, while still three-dimensional, were often smaller in size and simpler in design. Typical twentieth century headstones are rectangular granite markers of varying colors, with epitaphs becoming less common. The memorial park cemetery requires that headstones be flush with the ground for easy maintenance. These markers are usually bronze or a bronze plaque attached to a stone base used because of its durability.

The following headstone shape chart from the Chicora Foundation identifies the most common shapes used for monuments. A copy of this drawing should be provided in fieldwork packets.

QUICK FIELD GUIDE TO MONUMENT TYPES



Though the types of monuments vary greatly, this field guide can serve as a tool to help identify those monuments found in the cemetery. Reprinted with permission by the Chicora Foundation.

3. Inscriptions and Epitaphs

Documenting

An inscription includes all the words and numbers on a gravestone, whereas the epitaph is usually a religious or literary phrase or saying that commemorates the deceased. *Incised* inscriptions are carved into the surface of the stone. *Relief* carving is raised or projects forward from the surface of the stone.

> Different styles of lettering were popular at various times. *Roman* lettering went in and out of fashion. *Roman* lettering fail (sic) out of favor during the early 19th century, when italic lettering became the choice for inscriptions. Due to the ease in reading *Roman*-style lettering, even after weathering, it came back into fashion at the dawn of the Civil War. Both *Roman* and italic lettering from the 19th century was inscribed or cut into the stone. By the 20th century, more raised lettering appeared due to technological advancements in stone carving. (*Grave Concerns, a Preservation Manual for Historic Cemeteries in Arkansas*, no pagination)

The inscriptions on early stone markers were often minimal, usually the name or just the initials of the deceased, his age, and year of death. Later inscriptions were more likely to include the full name, with the month, day, and year of death. Soon inscriptions included epitaphs that often were Latin phrases such as *Memento Mori* (Remember that you must die). (Duval and Rigby, Introduction, p.viii).

Earlier epitaphs, found in New England, reflected the Puritan's belief in predestination and that most humans were destined for Hell. This dire view of life was seen in epitaphs like the following, serving as grim reminders that death would overcome all. (*Deetz*, p. 98)

My youthful mates both small and great
Come here and you may see
An awful sight, which is a type
Of which you soon must be

The aim of later inscriptions, and the type more commonly found in Michigan, was to express the grief of those left behind, and reflect an effort to console and uplift the mourners. (Meyer, p. 249) Epitaphs had evolved from the Puritan dark and dire warnings to the living, to the 1860s cultural tradition aimed at comforting the sorrowful. By then death had come to be viewed as a pathway to a better life. The following is an epitaph on the headstone of a fifteen year old girl (1855) in Canton Township's Cherry Hill Cemetery:

In the morn of life she left us
And her vacant seat is here
Yet how fondly do we cherish
Every emblem of her near.

Epitaphs were often quotations from a religious source, literature, or an original sentiment in remembrance of a specific person.

4. Iconography/decorative carvings

As carved stones became common throughout New England, the same severe Puritan attitude seen in epitaphs was also reflected in the foreboding headstone carvings of winged death's-heads, skeletons, and skull and crossbones. This attitude was already changing by the time Michigan was being settled. The belief that man could earn his salvation through good works gained momentum, thus shifting the focus from hell and damnation to the more positive belief in the resurrection of the soul and eternal reward. (In *Small Things Forgotten* p. 95-98) The cherub motif, which evolved from the winged death's-head, exemplified this change in attitude. James Deetz asserts that the willow tree overhanging an urn is a direct stylistic descendant of the cherub.

In Michigan the earliest carvings were simple, such as the willow tree, which was popular from the 1830s to the 1870s. In southeastern Michigan the willow and urn may be seen separately. The willow as a carved motif and the urn, both a form as well as a motif, had a direct influence on Michigan stone carvers. The willow tree is seen in a variety of forms, and the urn is frequently seen alone and/or partially draped. Also commonly seen from around 1850 to the late nineteenth century was a finger pointing to heaven or hands clasped.

The motifs used on headstones may have several interpretations. The entire stone's inscription should be considered as a whole when interpreting meaning. One interpretation of the willow tree is that it was used to signify the Christian faith because of its ability to survive under the most difficult circumstances. Another was that the willow tree, with its weeping branches, represented the grief of those left behind. The hand pointing upward indicated that the deceased had gone to his/her heavenly reward. The hands clasped meant that God was welcoming the departed, or alternatively, the hope of meeting again in heaven. (*Brown*, p. 25) The finger pointing downward represents that the deceased has been called by God. (Hacker, p. 2 and p. 43) See a more complete list of symbols in Appendix D.

Carving was typically done locally or regionally by skilled craftsman. Motifs were circulated among members of carvers' associations and were used or adapted according to

the carver's skill. One example is the local carver, Joseph L. Arnet, founder of Arnet's Beckers Burrells Monuments (1903) in Ann Arbor. Arnet maintained a studio workroom where both hand and tooled carving were employed.

Ann Arbor stone carvers, among them Joseph L. Arnet of Ann Arbor (right), seated on a newly delivered block of granite ready for sculpting.

In the twentieth century headstones became simpler as society as a whole retreated from sentimentality of the Victorian era. As granite became almost exclusively used for gravestones, mechanized tools were required to work the stone because of its extreme hardness. As a result, carving became more mechanized with deeper lettering and at about the same time design catalogs became available. Thus headstone design became more standardized and simplified. (Linden, p. 107)

At the end of the twentieth century laser carving technology was adapted for headstone design. Not only does this allow for very personalized designs including transferred photographs, symbols of hobbies or interests of the deceased, and other biographical information, it also allows for unusually shaped headstones.

Modern carving tends to be less complicated then that of previous years. Modern technology has produced some very elaborate and often colorful memorials made to specifically address individual characteristics and personalities.

DOCUMENTING THE HEADSTONE

Documenting the four elements of each headstone is a critical part of the survey process. It forms the basis of the conservation / preservation master plan, and will serve as ongoing documentation of all work performed on each headstone. The information recorded is a permanent record. It is the documentation of the exact condition of the stone at a particular point in time, which will be useful in case of future theft, deterioration, or vandalism. Repairs made in the future will also be recorded on this survey form and thus it will serve as a working document for the monument. A headstone survey form can be found in Appendix A.

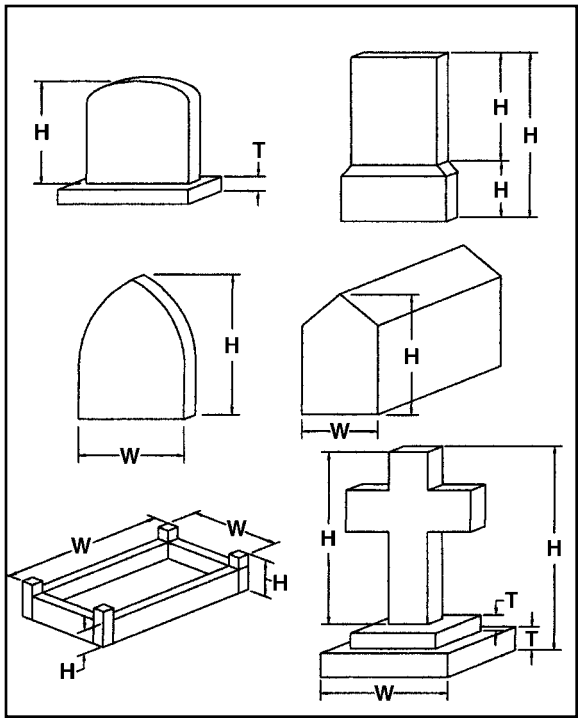
1 2 With training it is possible to utilize volunteers to conduct the monument survey. Prior to beginning fieldwork the volunteers need to be educated about the following:

- the proper method of photographing monuments
- how to use the monument documentation form
- how to identify monument shapes
- how to identify stone types
- describing headstone condition using common terminology
- how to document previous repairs
- techniques for reading inscriptions

When doing survey work it is both more efficient and easier to work with another person– one person to record and one person to photograph, measure, etc. The use of a clipboard and copies of the Michigan Individual Headstone Documentation survey form (Appendix A) will also speed the process. Using a pencil facilitates making changes and pencils will function well in cold weather.

MEASURING MONUMENTS

It is not possible to assess the size of a monument from a photograph; therefore, it is necessary to measure the height, width and thickness of each stone when doing the marker survey. For more complex monuments measure in several places. The drawing to the right has been adapted from the Chicora Foundation to show information needed to accurately measure monuments.



Full and accurate measurements are necessary information. Standardized criteria must be consistently used throughout the process. In this illustration several types of stones and the points of measurement are identified.

Condition

Carefully documenting the condition of each stone is important as this forms the basis of the conservation plan. Note all forms of deterioration, as well as all previous repairs. Employ the following vocabulary of common terms used in cemetery conservation when completing the headstone survey form. (These terms were culled from numerous sources e.g., *Grave Concerns, a Preservation Manual for Historic Cemeteries in Arkansas* and *Landscapes of Memories: a Guide for Conserving Historic Cemeteries, Repairing Tombstones*):

In Situ

A stone that is in its original location.

Displaced

A stone or part of a stone that has been moved from its original location.

Soundness

Condition of a marker that, after reasonable inspection, shows no sign of damage, no improper previous repairs and no excessive deterioration.

Cracks

Narrow fissures or fractures in the stone. Each occurrence should be identified and documented.

Delamination

A condition that occurs when a stone breaks or separates along bedding planes usually resulting in breakage of those areas. This is most prevalent on slate and sandstone, markers not commonly found in Michigan.

Scaling

The peeling away of the outer layer of stone.

Erosion

Gradual wearing away of the surface, resulting in rounded, blurred edges, and damage to carved details. Erosion is caused by the natural abrasion of wind and wind blown particles, and also by dissolution of the surface by acidic rainfall.

Sugaring

A granular, sometimes powdery, condition that is characteristic of some stone, particularly fine-grained marbles and limestone. Sugaring indicates gradual surface disintegration.

Gypsum Crust

Common to marble and limestone. Decay caused by the acidic gases in the air. It is a black crust that, when removed, exposes the softer stone underlayment.

Efflorescence/Subflorescense

Deposits of white salts on the surface of stone. It is an encrustation of soluble salts that could be caused by the use of fertilizers and weed-killers, air or water

pollution, use of gray Portland cement in concrete and mortars, and some cleaning compounds. These salt deposits are called "efflorescence" when they occur on the surface of the stone and "subflorescence" when beneath the surface. Efflorescence is a critical sign that the stone is endangered.

Fallen

Stones that have fallen are susceptible to accelerated damage and deterioration and should be righted.

Tilted/sunken

The extent to which a stone is sunken or tilted will determine the priority it will be given for resetting.

Fragments

Small pieces of broken stone.

Discolored/stained

Discoloration of the stone caused by vegetation, fungus, pollution or chemical reaction should be noted and any indication of the cause of staining should be noted. Different stains require different approaches to cleaning.

Mower Scars

Abrasions caused by grass cutting equipment, usually near the bottom of the stone.

Transcribing Inscriptions

Include the inscription on the headstone survey form. The inscription should be transcribed exactly as it exists on the headstone. Transcribers should work in teams of two with one person reading and one person writing. In the case of transcribing a verse, note the end of one line and the beginning of another. Other things to be noted are capitalization, unusual spellings, and punctuation.

The Chicora Foundation recommends the following standardized method of recording transcriptions:

- A slash / indicates a break in the line.
- Empty brackets [ ] indicate missing information.

Therefore you would transcribe

Here lies /
Our be[ ]ved Son /
John Smith /
D [ ]d 11 Nov[ ]ber 1847

The lettering within the brackets [ ] is worn away or unreadable.

If the actual inscription is known from documented sources, this can also be noted. **In cases where the inscription cannot be read or read only partially, no assumption as to what was carved should be made.** Recording the inscription as it reads at the time of the survey may help to gauge the rate of deterioration of the inscription in the future.

When the inscription is difficult to read, try shining a strong flashlight across the stone from the side to highlight the carving or use a mirror to reflect the sunlight. Another method of reading illegible inscriptions is to peer through a tube about 2 inches in diameter and 12 to 16 inches long. Holding the tube at an angle, place one end of the tube almost onto the stone and let the sunlight enter through the other end. This will help to accentuate the lettering. With extremely difficult inscriptions, have a second team read them and compare the results.

Iconography/Decorative Carving

Many gravestones have decorative carving, known as iconography, that should be documented on the survey form using both written description and photography. If the detail is not sufficiently clear in a photograph, a close-up of the design should be taken. Several photographs may be necessary when the designs are elaborate.

A written description of the carving can be as simple as: "praying hands with fingertips pointing upward" or "a willow tree." A more elaborate description might read: "an open book with flower and fruit garlands cascading around the book and down the sides of the headstone." Having both the photograph and the written description will assure thorough documentation of the headstone carving.

The willow and the lamb were common designs in the 1840s. This photo and the one on page 47 show a well-preserved carving on a memorial and a close-up of the top of the memorial.

Carver/Manufacturer

The name of the local carver, and sometimes the village or city where he/she was located, often appears at the bottom of the headstone. Sometimes the gravestone base will also include the name of the carver or manufacturer. All information should be recorded.

HISTORIC FENCING AND ENCLOSURES

Many small cemeteries are unfenced but it is not uncommon to find historic fencing, gates and entry signs in Michigan cemeteries. Historic fencing materials include wood, woven wire, fieldstone, concrete block, brick and especially ornate ironwork fencing. Beginning around the mid-twentieth century, cemeteries that had been previously unenclosed were surrounded by metal chain link fencing for security purposes. Where historic fencing is extant efforts should be made to repair and maintain it as an important feature of the cemetery. It should be documented along with other ancillary elements and the documentation kept with other cemetery survey data.

Before the Civil War cast iron became readily available and several companies manufactured ornate fencing through the early decades of the twentieth century. Elaborate cast fence posts, entry gates and signs identifying cemeteries were common. Later wrought iron and woven wire became more popular. Many are in disrepair or are deteriorating. Cast ironwork requires special treatment in both repair and maintenance, as it is vulnerable to corrosion and accidental harm from mowers and other equipment. Plans for the conservation and routine maintenance of these metal objects should be made when setting

goals for a conservation project. While it is always advisable to repair historic elements instead of replacing them, historic cast iron requires special handling in both repair and maintenance. See the section in Chapter 3 on conservation of metalwork before beginning any repairs or repainting.

When documenting a cemetery's features try to determine the manufacturer of any ornamental metal work. Often a company placed a plaque on gates or posts that will indicate the manufacturer. Check carefully for any markings on fencing elements. Occasionally a catalogue number will be recorded on a post. This number can be researched through sources such as the Chicora Foundation. Checking local city directories for the late nineteenth century, a time when many of the country's manufacturers of decorative iron work were active, may lead to information about a local company. A good discussion of historic fencing styles and manufacturers can be found at the Chicora Foundation web site. Fence catalogs ranged from nationally known companies such as Sears Roebuck and Company to local Michigan companies like the Page Fence Company of Adrian, Michigan. Chicora's web site gives a brief history of some common Midwestern companies that supplied fencing for cemeteries. The site will be helpful when documenting historic fencing. Identifying the company that manufactured a cemetery's fencing can be helpful when there is a need to replace sections.

In some instances the original company nameplate will remain on the wrought iron fence. This information is valuable when trying to replace or repair fence sections.

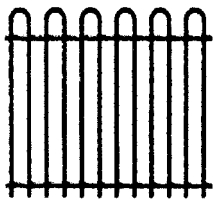
Around the turn of the twentieth century many local fence companies existed in Michigan communities. One example is Adrian, Michigan, which prided itself on being the "fencing capital of the world." Several fencing companies were located in this southeastern Michigan city. And a great deal of Michigan's historic fencing might have come from these sources. Adrian city directories list these companies from about 1889 to 1916:

Page Woven Wire Fence Co.
Lamb Wire Fence Co.
Adrian Wire Fence Co.
Michigan Wire Fence Co.
Monarch Fence Co.
Standard Fence Co.
Bond Steel Post Co.
Peerless Wire Fence Co.

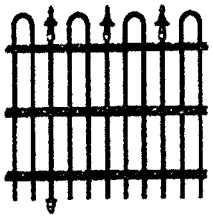
Check the city directory of the community closest to the cemetery for possible sources. The Michigan Gazetteer, published in the nineteenth century, is a good source of information, offering a statewide listing of companies.

On occasion, elaborate fencing and gates can be found surrounding family plots.

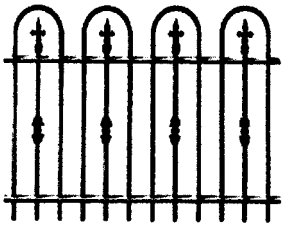
TYPICAL FENCE DESIGNS



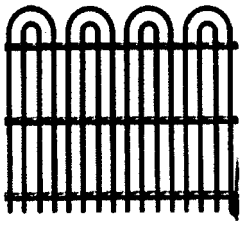
Hairpin



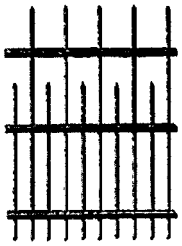
Hairpin & Picket



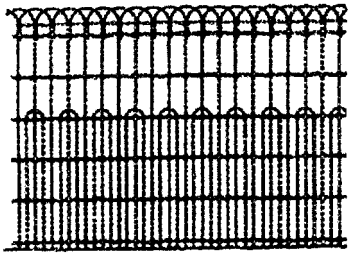
Bow & Picket



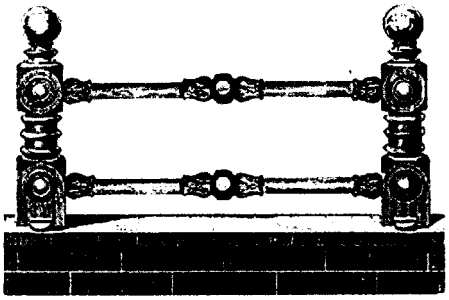
Bow & Hairpin



Milled Point



Woven Wire



Gas Pipe Railing

Drawing used with permission of the Chicora Foundation, Colombia, South Carolina

The above drawings, taken from the Chicora Foundation web site illustrate the most common types of iron fencing. Most of these fences consisted of either two or three wrought iron rails with attached vertical elements in cast iron. "These (fences) are often classified as picket (either beveled or with special picket heads), hairpin, hairpin and picket, bow and picket, and bow and hairpin." Posts were often of three distinct types: line posts, panel, square/solid (usually cast), and open or scroll." (Chicora web site) Pipe fences were common in the early twentieth century. They were less expensive, simple, and durable, and were often used to surround family plots. This type of fencing was fabricated from galvanized pipe with white metal connectors that were usually attached to cement coping. Less common due to its fragility, is the woven fence. While sometimes quite decorative and ornate, it was the least expensive and quickest to corrode. It is also quite susceptible to accidental harm from mowers and other equipment.

Wooden fencing was also used to some extent throughout the state; however, wood deteriorates quickly when left unattended and much of this type of fencing is in poor repair. In the mid-twentieth century chain link fences became common, often as replacements for iron fences.

OTHER BUILDINGS AND STRUCTURES

Chapels, mausoleums, and storage sheds are some of the buildings and structures located within and associated with historic cemeteries. Although worthy of preservation, they are beyond the scope of this manual. Anyone considering repairs and conservation of these elements and structures, other than repointing, should contact appropriate professionals. All structures and their locations should, however, be well documented and noted on any survey form, plan or map prepared for the cemetery.

MAPPING

Mapping is vital to any cemetery plan. Not only does it give a clear picture of existing conditions: a good map will help to document boundary changes over time. The result will be a working document that will be useful in implementing a restoration plan. Before beginning a mapping project gather any existing maps that may already be available.

When preliminary research is completed, it is time to prepare a working map. This is a relatively easy project that can be accomplished using a group of dedicated volunteers. A hand drawn map is the simplest method, and untrained workers can manage this task. The required tools should be gathered before beginning. Little more is needed other than time, a ruler, a pencil, a pad of graph paper, and something to measure with. While a three hundred foot measuring tape should be adequate to the task, an excellent alternative is a measuring wheel, available at home centers or rental companies. The measuring wheel is mounted to a handle and clicks off the measurement as the operator walks behind.

Begin by identifying the parcel using its legal description, making sure that the legal description and the present boundaries coincide. Record on the map. Indicate where changes to these boundaries have occurred over time. Unmarked graves may exist outside of current lines.

Beginning with the accurate boundary map, divide the property into grids. Ten yards by ten yards makes a good workable unit for the grid. Each grid should be represented on a separate piece of graph paper. One approach to mapping these grids is to draw a centerline through the cemetery and draw the grids from this line. If the fence or other perimeter demarcation is adequate, use that edge as a beginning point. Where the size or configuration

of the cemetery renders one base line inadequate, several may be drawn. In using this method take precautions to accurately number and identify grids so that confusion does not arise later.

If a laptop computer is available, there are mapping programs that can be used in the field. See Appendix B for software sources. The advantage of electronic mapping is that it is easy to update. It can also be altered to serve multiple efforts. For example a National Register, state historical marker, or local historic district study committee report will require the inclusion of a sketch map that does not necessarily contain all the information gathered for a working map. Deleting items on an electronically generated map is a simple process. Often communities use GIS mapping and aerial photographs to identify their communities. Maps using these methods can be a valuable starting point. While Global Positioning Satellite (GPS) technology can be used to plot a cemetery map, a unit accurate to six inches to twelve inches or less is required. These units are expensive.

Check with the county or township to see if aerial maps of the cemetery are available.

Cemeteries relatively clear of excessive vegetation can be viewed well from above. Although this sort of accuracy is not necessary, an aerial photograph can be a valuable aid in creating a map.

All maps must include:

- cemetery name
- city, county, township
- north arrow
- date completed
- name of person who created the map
- key

As a guide in preparing a map, the following method is quoted *from Landscapes of Memory; a Guide for Conserving Historic Cemeteries*, published by the Management Board Secretariat Publications, Ontario.

Scale:

Determining the scale of a plan depends upon the size of the cemetery and the number of grave markers to be recorded. The most suitable scales are either one 1/8" = 1' or 1/16" = 1'. Larger scales are better where there are a large number of markers, particularly if they are close together.

Equipment Required:

- Tape measures: Two 100-foot tapes (preferably fiberglass) and one 16-foot hand-held metal tape
- Small hatchet (or hammer and handsaw) for cutting and placing wooden stakes
- A measuring compass
- A hand level: for sloped sites only to keep tapes horizontal for accurate measurement
- Wooden stakes: from 1" x 2" stock, approximately 24 inches long, cut on an angle at one end only
- Nails: 1-1/2"–2" common nails
- Waxed twine
- Cardboard or similar numbering tags (for grave markers)
- Permanent ink felt-tip marker
- Drafting tape
- Drafting paper or film (e.g. Mylar)
- Drafting pencils and sharpener
- Grid (graph paper) paper to use as underlay for sketches
- Drawing surface (e.g. clip-board for small field sketches, or a smooth-faced sheet of plywood)
- Drafting scale

Method

- Select an area free from obstructions.
- Lay down a base line using a 100-foot tape.
- Line up the tape in a straight line and mark the baseline with wooden stakes driven into the ground at even intervals (e.g. every 25 to 30 feet). Subsequent measurements will be greatly simplified if this base line is laid parallel to the majority of the grave markers.
- Attach string to nails driven into the tops of the stakes, to mark the base-line.
- Lay off lines at 90 degrees to this base line, at regular intervals along it (e.g. every 25 to 30 feet). (figure 1)
- Complete the grid by laying off lines at right angles to one another at regular intervals (e.g. 25 to 30 feet), marked by wooden stakes (figure 2)
- Number the wooden stakes, beginning in one corner of the graveyard as shown (figure 3). Mark the numbers on the stakes. Draw the stakes on the graveyard plan, with their numbers. Each square on the grid is identified by the number of the stake. The stake in the lower left-hand corner then identifies each square on the grid.

- Take a compass reading along the base line, and / or measurements from the base line to a permanent feature such as a fence, to record the position of the base-line that was used for the survey.

Measure and Record the Grave Markers and Other Features

Marking the graveyard off with a grid allows different teams to record different squares. Starting at one corner of the cemetery (e.g., A1), record the features in each square, as follows:

- Secure lengths of string along two opposite sides of the grid square, fastened to nails in the top of the wooden grid stakes.
- Lay a measuring tape across the square at 90 degrees to the strings, and at about the same distance along both sides from the grid line. Position the tape as close as practical to a row of grave markers and where it will not touch any markers, bases, fences, etc. Fasten the measuring tape into position on wooden stakes
- Measure the position of the grave markers relative to this tape. Measure along the tape in one direction. Ensure that the hand tape is 90 degrees to the measuring tape on the wooden stakes. Measure to both corners for headstones or footstones, and to all four corners for markers such as box tombs, cairns, or slabs flat on the ground. Also measure the plan dimensions of markers at this time. Show curbstones, walls, fences, trees and other major plantings, as well as grave markers.
- Record the locations and measurements on a sketch plan, drawn in pencil. Show the number of each grave marker. It also helps to show the family name from the marker on this sketch plan, to avoid confusion. Draw the footprint of the marker in the plan. For markers that lie on the ground, the plan view will show the individual shape.

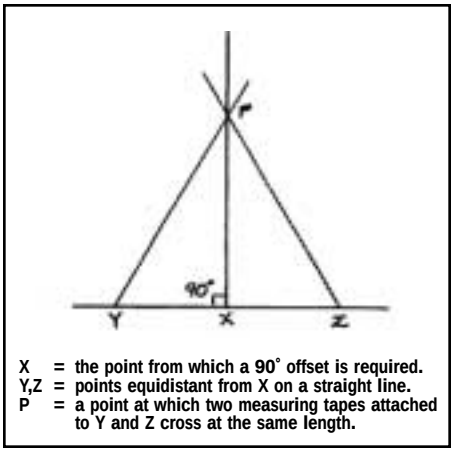


Figure 1: Constructing the Perpendicular. Drawing courtesy of Ontario Ministry of Citizenship, Culture and Recreation.

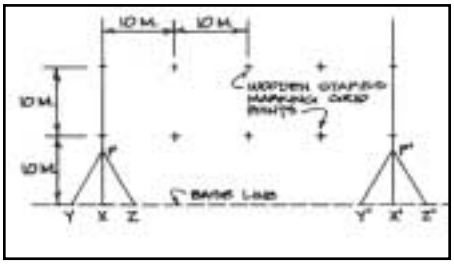


Figure 2: Constructing the Grid. Drawing courtesy of Ontario Ministry of Citizenship, Culture and Recreation.

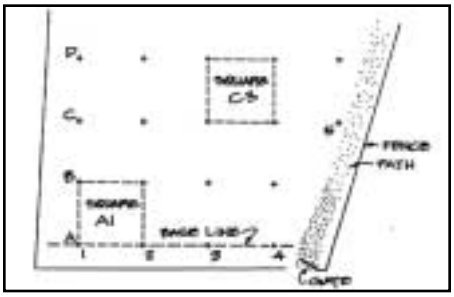


Figure 3: Numbering the Grid. Drawing courtesy of Ontario Ministry of Citizenship, Culture and Recreation.

- Be sure to show the distance of the tape from the grid line–otherwise, the measurements taken do not relate to anything. (*Landscapes of Memory: A Guide for Conserving Historic Cemeteries, Repairing Tombstone*, p. 46-48)

Whether using the above "Ontario Method" or any other to prepare the map, the second step is to identify all the elements of the cemetery. Each marker, ancillary feature, building, and landscape feature, including fencing, signs, family plots, roadways and paths, within the confines of the boundary should be identified on the map. Using the prepared grids, assign each feature a number within the grid, and record it on the map. This number can then be used as that feature's identification number for all survey forms and for referencing a particular item. Include a key with the map that explains the numbering system so that others can readily understand the system. Maps should be generated in such a manner, perhaps using overlays, that adding or deleting items is easily accomplished. For example, being able to remove items such as vegetation, and leaving only markers allows the map to be used for varying purposes. Planning in advance for various uses saves time later on, when the map is used for specific purposes. Using overlays will make it easy to record earlier boundaries and any other changes that may have occurred over time.

IDENTIFYING VOIDS AND VACANT SPACES

A clear picture of the cemetery emerges when the survey and mapping are completed. Often this completed map will show areas where no headstones exist (voids) or where the ground appears to have depressions among existing gravestones. When this is evident, probing (subsurface investigation using specified tools) is called for. See **Probing** below. If probing indicates unmarked graves these too should be identified on the map.

In order to have an accurate survey, it should be determined whether or not voids are actually "vacant" spaces. There are many reasons for open areas in a cemetery:

- A plot may have been purchased and never used
- Headstones may have fallen over and subsequently become overgrown
- Headstones may have been vandalized or stolen
- Some graves may not have been marked with a headstone
- Some plots may not have been sold

The identification of unmarked graves begins with looking for rectangular depressions in the soil that follow the line of existing headstones. Most historic cemetery burials have followed an east to west orientation, which is a reflection of the belief that on judgment day the dead will rise to face the rising sun. Though the east/west orientation is the "norm," it in no way precludes the possibility of a north/south orientation.

Probing

1 2 A simple and economical way to locate a grave without any visible depression is to use a probe. Probing is also an excellent way to locate sunken headstones and headstones that have fallen over (or been broken) and become overgrown. Before beginning to probe ask the local utility companies to mark any electrical or gas lines within the cemetery border. Probing can safely be done by volunteers that have been trained in the practice.

By using a probe like this young volunteer is using, previously broken or covered stones can be found and replaced to their original position.

Plumbing supply stores sell a device called a "smart stick" which is useful for probing. The smart stick is a rod of metal or fiberglass, about three to four feet long, with a handle mounted at one end to form a "T." The rod itself is a one-fourth inch to three-eighths inch dowel. Some commercially available probes have replaceable tips and are available at environmental companies such as Ben Meadows (Appendix B). It is important to remember that the length of the probe should not exceed four feet because older graves are often less than six feet deep and it is necessary to prevent the probe from entering the burial chamber. In addition a probe that is four feet long will afford the greatest "feel." Before beginning, probe marked graves and known open areas in order to tell the difference between undisturbed soil and softer less compacted soil.

When probing for lost stones or graves a methodical approach must be employed. Use the same grid system that was created when mapping the cemetery. Begin probing any suspected voids or depressions in a systematic way, starting at one corner of the grid. Insert the probe into the ground every eight to twelve inches, noting any variances in the resistance. When the probe hits biological material it will produce a duller feel than when contacting a headstone, which produces a higher pitched "tink." Indicate any soft spots with a marking flag, and then continue probing, attempting to delineate the shape of the softer area. Large rectangular shaped areas will often be graves; smaller rectangular areas may be submerged headstones or graves of children. Smaller or rounded areas could be animal burrows or rotted trees. Carefully note the location of newly identified graves or headstones on both the survey form and the cemetery map. Move along one side of the grid and continue probing until all of the area has been investigated.

A more advanced method for locating lost headstones, and one that requires professional training or is done under the direct supervision of a professional, is the use of a Soil Compaction Tester (penetrometer). This device measures the density of the soil. It should be inserted into the ground no more than 6 inches. A gauge or digital readout on the handle indicates the compaction level in psi (pounds per square inch). The shaft has measurements so that one can monitor and record the different changes in compaction levels. As with a probe begin by examining known graves so that the normal density of existing graves is determined. See Appendix C for resources.

A third method of discovering lost graves, requiring professional experts and equipment, is to use ground penetrating radar imagery (GPR). This method is noninvasive and produces a cross sectional profile of subsurface features. It operates by sending pulses of ultra high frequency radio waves into the ground as the GPR unit is pulled over the surface. The radio waves are reflected from various buried objects. The reflected signals return to the GPS unit where they are received by a digital control unit. The signals are plotted on the ground penetrating radar profile as different color bands by the unit. In some instances a three-dimensional image can be made to better define the area where graves are located. Although the cost of a GPR investigation can be expensive, because it requires a trained professional, a great deal of land can be covered in a short period of time. An internet search on "grave locating ground penetrating radar" identifies companies that will perform the survey as well as information on past investigations by agencies such as the National Park Service.

PHOTOGRAPHY

All features in the cemetery, including general views, will need to be photographed. The two types of photographs needed to document a cemetery are:

1. Photographs of individual features such as monuments, plantings, gates, fencing, ponds, roads, and buildings. These features should be depicted with individual photographs that clearly show important details.
2. General views that show how the individual features interrelate in the landscape. Enough views should be taken to give a good sense of the look and feel of the cemetery's significant features.

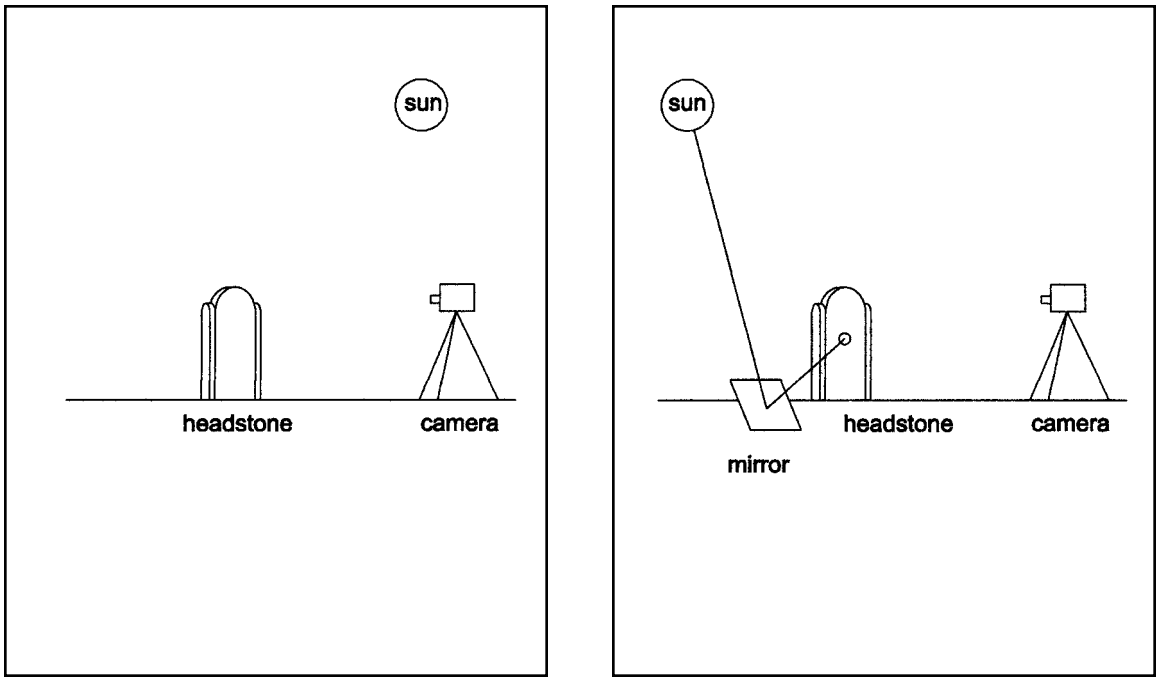
These photographs can be documented on a master survey database and/or inventory form, and number-coordinated with the map.

The National Park Service suggests, "When landscapes are documented in photographs, *registration points* (points of reference) can be set to indicate the precise location and orientation of features. Registration points should correspond to significant forms, features, and spatial relationships within the landscape and its surrounds. The points may also correspond to historic views to illustrate the change in the landscape to date. These locations may also be used as a management tool to document the landscape's evolution, and to ensure that its character-defining features are preserved over time through informed maintenance operations and later treatment and management decisions." (National Park Service Bulletin Number 36, *Protecting Cultural Landscapes*) If the cemetery has been mapped on a grid, photography can be done in sequence using the grid system.

The Association for Gravestone Studies leaflet entitled "Recording Cemetery Data" includes the following suggestions for photographing gravestones such as:

- Know when to photograph. Bright sunlight is best for gravestones. The sun should pass across the face of the stone from side to top at an angle no more than thirty degrees.
- A framed mirror as big as the gravestone can be used when the sun is not bright. Place the mirror in a spot of bright sunlight 100 feet or less from the marker. Try to work with the sunlight behind the stone. Experiment to get the best position. The reflected rays will light up the stone enough to get an accurate photographic record.
- A 1/4 inch piece of plywood painted gray and placed behind the stone will prevent the stone from competing with the background of the cemetery.
- Snow on the ground prevents good photographs.

- Clean the stone with a soft natural-bristle brush and water to remove dirt before you photograph.
- Place a stick with the pointed end facing north on one side of the stone to indicate direction.
- Any camera with a good lens is acceptable. A 35mm camera works well for prints 8"x10" or smaller. Most photographers will find an exposure speed between 1/125 and 1/250 to be adequate. A digital camera also works well. If using a digital camera, have prints made by a professional who uses archival paper.
- Film recommendations include Tri-X (ASA 400 for overcast days and 200 for sunny days) for black and white prints and Ektachrome 200 (ASA 200) for color. Black and white photos are required for a National Register nomination and are more permanent.
- Identify each stone by inserting a numbered marker into the ground beside the stone to be photographed. Renumber the marker for each stone. Do not place the marker on or in front of the stone.
- Tape a coat hanger to a yard stick with some of the wire extending a few inches beyond the length of the yard stick. Put the extended wire in the ground next to the stone so that the yard stick will indicate stone size in the photograph.



Bright direct sunlight is necessary to photograph monuments. Light shining across the marker at a 30° angle produces shadowing that highlights the markings very well. When direct sunlight is difficult to achieve, a mirror can redirect the light to highlight the inscription.

For advice on photographing vegetation, a guide such as the Brooklyn Botanical Garden's handbook, *Garden Photography*, may be helpful.

The photograph should be labeled on the back using a soft lead pencil with the date, identification number assigned to the gravestone or feature (the same number will go on the documentation form), cemetery name, county and township, direction the photographer is facing (i.e. north, south, east, or west), and the photographer's name. Additional information regarding the gravestone, plant, or other artifact can go on the individual documentation form. Sample documentation forms can be found in Appendix A.

If you are interested in nominating the cemetery to the National Register of Historic Places, there are special photography requirements for the application. See p. 63 of National Register Bulletin 16A: "Guidelines for Completing National Register of Historic Places" form. The National Park Service also publishes a bulletin entitled "How to Improve the Quality of Photographs for the National Register Nomination."

The survey product

When the survey and map are completed they should be duplicated and stored in several locations in the area. The local historical museum, historical society, and library are all appropriate places for this documentation. Send one copy of the information to the State Historic Preservation Office and another to the Association for Gravestone Studies where it will be stored in their databases and be accessible nationwide.

Mapping, photography, and transcribed records will form the foundation for a cemetery conservation and maintenance plan. In case of theft, vandalism, accident, or as the result of damaging acts of nature, a detailed record will exist for reference. Continuing to update this documentation with any changes will facilitate future efforts.

Chapter 3

CONSERVATION OF THE CEMETERY

In cemetery conservation there are four major areas to be addressed: landscape, gravestones, ancillary features, and buildings and structures. This manual is intended to provide a guide to conservation of all elements except buildings and structures, which are beyond the scope of this manual. Using the analysis already prepared, set goals to prioritize conservation efforts. Initial stabilization of all areas should be accomplished before any conservation measures are undertaken. Keep in mind these principals:

- Do no harm
- All actions should respect the original fabric of the cemetery
- Use the gentlest and least invasive means possible
- Attempt to do that which can be reversed
- Quick or easy fixes may not always be a reasonable choice
- When in doubt, consult a professional

LANDSCAPE FEATURES

1 2 Look at the landscape to determine its character. In Canton Township and much of southern Michigan, settlement era cemeteries date from the early 1800s to around 1850. Some were the burial ground of extended families and most were sparsely planted and were surrounded by open fields. In the later part of the nineteenth century cemeteries took on a Victorian image with more plantings from that era. Some were associated with ethnic or religious groups. Previous research will shed light on the historic period of the burial ground and which plants are appropriate for that timeframe. This information can be used to make a conservation plan. If the cemetery consists of separate sections added over time, the landscape conservator can preserve each area accordingly. Landscape conservation planning can be difficult because, unlike other cultural artifacts in the cemetery, the vegetation is always changing.

2 One of the first conservation measures is to stabilize and protect plant material and topography, such as an eroded slope or fragile earthwork. If areas of the lawn need reseeding use a low maintenance slow growing, drought resistant seed mix. See the Lawn Maintenance section for a complete listing of grass seed suggestions for both shade and sun. Planting a ground cover is a way to stabilize an area where erosion has washed away the turf or where the slope is such that mowing is difficult. Using a ground cover planting taken from elsewhere in the cemetery is preferred. If there is none, use a compatible plant from the same historic period. For example, for the period of the late nineteenth century, moss phlox (P.subulata), dwarf dianthus (D. chinensis), periwinkle (V.minor and V.major) or lily of the valley would be appropriate choices.

In the National Trust publication, *Preservation of Historic Burial Grounds*, Lynette Strangstad recommends moving monuments slightly (documenting the change) to accommodate significant plants and trees when roots disrupt the grave site. In some cases it is best to remove the vegetation. Base your decision on the plant and the historic significance of the marker, the damage that may be caused by moving either one, or how extensively one intrudes upon the other.

Minimal mowing is historically accurate and to a certain extent helps prevent damage to markers and plants. When community standards do not allow longer grass, installation of historically accurate ground covers can be an alternative. Irrigation systems are not historically correct and may be likely to cause water damage to the stones. Volunteer species should be removed regularly, including volunteer trees and bushes.

Here are some tips suggested by Scott Kunst, historic plant expert and owner of Old House Gardens in Ann Arbor, Michigan:

- Start by educating yourself about historic plants and their importance in the cultural landscape.
- Use weed whips and herbicides carefully and only when necessary. Make sure cemetery cleanups are done judiciously and do not eradicate historic plants.
- If plants need to be moved, only move them a short distance if possible, or move the marker instead — but only as a last resort.
- Propagate historic plants by saving seeds or taking a cutting.
- Avoid using new plants on historic burial grounds, but if this is allowed, be sure to document both plant name and location.

Pathways and Roads

The preservation and maintenance of pathways and road is important in maintaining the historic design of the cemetery. Early nineteenth century burial sites typically had paths of dirt, gravel, cinder, or stone dust. Later in the century brick, concrete, and macadam were used. When conserving roads and pathways, consideration should be given to historic appropriateness as well as cost and maintenance. In the *Preservation of Historic Burying Grounds* Strangstad says:

> Such preservation includes maintaining existing widths and contours, small triangles or small circles often found at intersections, and the original paving surfaces. Brick gutters should be maintained rather than ignored or eliminated. Introduction of asphalt for the convenience of modern vehicles seriously alters the site and erodes its integrity. To preserve certain existing roadways, traffic can sometimes be limited to pedestrians only. Replacement of original crushed stone or early brick with new brick pavers or other paving materials likewise compromises the site. If brick was the original material, roads or paths should be resurfaced with as much of the original brick as possible and reproduction brick that match the original in color, size, texture, and strength. When a custom-made brick is required, restoration brick firms generally have little difficulty in producing good replica brick. (Strangstad, p. 20-21)

Ancillary Features (metalwork, gates, signage, family enclosures, walls and fencing)

Metalwork, including wrought iron, cast iron and zinc (often referred to as white bronze) is frequently found as an ornamental element in cemeteries, and to a lesser extent in grave markers and monuments. The care and maintenance of these materials is an important

part of any conservation and maintenance plan for an historic cemetery. Special care and treatment is required if good preservation practices are to be followed.

Due to environmental concerns and the hazardous materials required, very little can be accomplished in the field or by unskilled volunteers and untrained workers. There are varying opinions, even among the experts, as to which is the best cleaning and repair methods for historic metals. As it is most likely that any but minor cleaning and repairs will require an experienced professional, the following section discusses several methods and techniques in order that an informed selection of a professional is possible. The preferred methods will be discussed first, followed by others that may be useful in particular situations. Talk with a professional and be comfortable with his or her recommendations before contracting any work. Be sure that the contractor shows an understanding of the need to treat historic materials with care. Remember that quick and easy fixes will most likely result in a solution that is short-lived at the best, and at the worst will cause damage to the historic element. The discussion does not include metals such as aluminum or tin as they are seldom encountered in historic cemeteries. Historic bronze requires professional treatment and a professional should always be consulted when dealing with this metal.

Several sources are available that thoroughly discuss preservation methods for historic metalwork, *Caring for Iron Fencing* (Saving Graves web site), *St. Louis Cemetery No. 1 Metalwork Protective Coatings* (University of Pennsylvania web site), *U.S. General Services Administration (GSA): Historic Preservation Technical* Briefs numbers 05010-13, 05010-01, 0700-03, 05523-01, 05010-11, and 05010-04 (GSA website), and *Preservation Briefs 27 and 28* available through the National Parks (NPS) Service website.

METALWORK

Cast and Wrought Iron

The metal most likely to be encountered in Michigan cemeteries is wrought or cast iron. For an understanding of this metal, its use and maintenance, a good beginning point is the National Park Service (NPS) *Preservation Brief Number 27*. It is intended for extensive restoration projects like building façades, but the methods and the considerations are the same for smaller elements such as fencing and decorative work. NPS *Preservation Brief 27* begins by defining cast iron and explaining how it differs in composition from wrought iron.

> Cast iron is an alloy with a high carbon content (at least1.7% and usually 3.0 to 3.7%) that makes it more resistant to corrosion than either wrought iron or steel. In addition to carbon, cast iron contains varying amounts of silicon, sulfur, manganese, and phosphorus.

Molten iron for casting is easily poured into molds, which allows for a broad scope of both decorative and structural objects to be cast. When cooled it becomes a hard, brittle, but strong metal that cannot be worked by hammering (poor tensile strength). It does not buckle easily and therefore was used in building construction where it could support great weight loads (strong compression strength). But it is cast iron's ability to be molded that has produced much of the ornamental fencing, gates and other decorative items found in cemeteries.

Wrought iron, on the other hand, "is relatively soft, malleable, tough and readily worked by forging, bending and drawing." It is much lower in carbon content, usually considerably less than one percent.

When looking at ironwork objects there are several clues to look for that will help to determine which metal it might be.

Cast iron elements are:

- complex in form
- can be very large
- uniform in appearance
- may show mold lines
- may have flashing, casting flaws, and air holes
- frequently repetitive in design (fence sections)
- pieces often bolted or screwed together.
- tends to have a sand-like finish

Wrought iron elements are:

- one of a kind hand-worked
- show hammer or rolling marks
- softer and malleable
- simpler in form and detail
- tend to be smaller objects

Condition Assessment:

Having verified the presence of cast iron elements in the preliminary survey of a cemetery, and before repairs are attempted, a thorough assessment of the type and extent of damage is paramount. NPS *Preservation Brief 27* indicates that in order "to thoroughly access the condition of the ironwork, a close physical inspection must be undertaken of every section of the iron construction including bolts, fasteners and brackets." When performing

an assessment of the condition of historic ironwork keep in mind that most work undertaken will require professionals since hazardous materials are found both in the original finishes and in the chemicals needed to properly clean iron before repainting. These materials are harmful to both the worker and to the environment.

Light brushing and repainting are often the only tasks that can be undertaken in the field. More often iron elements will have to be removed then repaired and recoated in the shop. When disassembling fencing be sure that each piece is marked so that the reassembly process can be done in the reverse order. Where items are to be removed and stored while awaiting repair, proper storage, away from dampness and potential damage is required. Leaving gates or fence sections leaning in a corner of the cemetery awaiting conservation invites problems with exposure to the elements, thieves and vandals.

Deterioration

Although cast iron and wrought iron are two distinct metals, they have problems in common and these problems often share a common solution. The most common problems found in historic ironwork are

- Oxidation (rust, corrosion)
- Missing elements
- Impact damage
- Structural failure
- Broken joints
- Damage to connections
- Loss of anchorage in masonry

Moisture is the number one enemy of damaged, poorly maintained, or untreated ironwork. Moisture, when allowed to penetrate a protective coating, or allowed to pool around elements, will soon take its toll. Once the metal has been allowed to go unpainted, or has been damaged, moisture begins the corrosive procedure and must be properly abated or rust will soon completely destroy the metal.

Corrosion

All iron is susceptible to two main types of corrosive damage, oxidation and galvanic corrosion. The more familiar is oxidation or rust. It occurs when unprotected metal comes into contact with the oxygen in the air and with moisture from rain, fog, dew, and other sources. Other airborne elements such as carbon dioxide, soot, and sulfur compounds will hasten the process.

Oxidation/Rust

The typical deterioration or corrosion process for cast iron is a one-step, straight line process of **oxidation** (or rusting) which begins upon exposure to air and moisture and will continue (unless interrupted) until the metal is gone.

> Rust (ferrous oxide) is an orange colored surface coating, ranging in texture from scaly to powdery. It is loosely bound and the outer layers will usually come off when rubbed by hand or brushed against. It is not a deposit on the surface and the presence of rust indicates that some of the original iron material has been converted to iron oxide and irreversibly lost from the cast iron piece. (U.S. General Services Administration. Historic Preservation Technical Procedures #05010-04, *Cast Iron: Characteristics, Uses and Problems*)

A careful assessment of the iron element will determine if the rust is present on the surface or if seepage into cracks and air holes has done considerable sub-surface damage.

Galvanic or electro-chemical corrosion occurs when two differing metals come into contact with one another and an electrolyte, such as water containing salts or hydrogen ions. Because of their chemical differences, metals such as copper, lead, and wrought iron can cause a galvanic reaction with cast iron. In this type of corrosion the carbon present in the cast iron combines with the other metal and the iron is dissolved as rust. Galvanic corrosion severely alters the strength of cast iron. For both types of corrosion the prevention is the same, protection from moisture with a sealing coating.

Graphitization, although less common, is another type of deterioration seen on cast iron. It occurs when the metal is left unpainted for long periods of time and acidic rainwater is allowed to penetrate joints. It can be tested for by carefully scraping the surface to reveal the crumbling of the iron beneath. If the damage is extensive the only recourse is to replace the effected parts.

Other damage

Since cast iron is brittle, breakage from vandalism, accidents, or neglect is also of a concern. Fencing along busy roads is susceptible to damage from automobile accidents as well as salt or other deicing agents. All of these will lead to damage of the protective coat allowing moisture to penetrate and corrosion to begin.

Cleaning and Paint Removal:

Keep in mind that "Before undertaking any project involving paint removal, applicable state and federal laws on lead paint abatement and disposal must be taken into account and carefully followed. State and Federal requirements may affect options available to owners on both paint removal and repainting." (NPS *Preservation Brief 28*) These restrictions will most likely preclude doing any but the most minimal fieldwork. Be sure when choosing a professional that they have experience with historic resources. The Michigan Historic Preservation Network Construction Trades Council can provide information on experienced contractors.

1 If the condition assessment indicates that damage is **minimal**, hand brushing with a stiff brush may be all that is required and unskilled workers may be able to help with cleaning. Whatever cleaning is undertaken remember to begin with the gentlest means possible. This should always be a first option when working with historic resources. Care should be taken not to damage decorative work. Be thorough, if all rust is not removed and the metal quickly sealed the corrosive process will continue and further deteriorate the metal.

2 3 Restoring historic ironwork, however, will most often require cleaning to the bare metal, removing old paint and corrosion and then sealing and recoating. There are several methods that can be employed. Although they will require skilled workmen or professional curators it is worthwhile to become familiar with the techniques and recommendations. Doing so will help in choosing the proper professional for the job and will help insure that the work performed is satisfactory and will not harm the artifact.

Techniques that can be employed include, (simplest and least expensive)

- Hand scraping, wire brushing and chipping
- Rust conversion (with caution)

Extensive hand scrapping, wire brushing and chipping require craftsmen **(level 2)** in order to protect the metal from scoring and other damage. They are indicated for light rust only since they do not remove rust and paint as effectively as other methods.

> *Note:* The removal of heavy rust, scaling, or corrosion should be left to a trained professional **(level 3)**.

A reasonable and **preferred** alternative to hand removal is the use of a rust converter. This method is recommended in that it removes the least amount of the original fabric from an object and it is considerably less labor intensive than hand removal. The process involves

removing a minimal amount of rust by hand and then applying the converter much like applying paint. A rust converter stabilizes by converting rust into a more stable chemical that when cured, accepts paint well. The use of a converter also assures the user that even tiny cracks and pits are sealed. This is not the case with hand rust removal. After the converter is applied and allowed to cure, two coats of appropriate top-coat should be applied. (See Appendix for sources)

The following treatments are more complex and expensive and can do more damage to historic material. Therefore they are not recommended and should only be used as a last resort when gentler cleaning methods have failed.

- Low pressure grit blasting
- Flame cleaning
- Chemical rust removal

Some conservators do not recommend abrasive or chemical cleaning under any circumstances. The Secretary of the Interior's Standards for Rehabilitation states, "Chemical or physical treatments such as sandblasting that cause damage to the historic materials **shall not be used**. The surface cleaning of structures, if appropriate, shall be taken using the gentlest means possible." According to the Chicora Foundation, the use of abrasives will remove the mill scale, an oily coating, on the metal that serves as a natural protective agent. If however, abrasives are the only alternative a soft abrasive such as ground shell should be used at a low psi of sixty to seventy pounds with a working distance of at least twelve inches. Any type of grit blasting can damage stone or brick, potentially causing damage to nearby gravestones. This must be taken into consideration, as well as the amount of dust generated, before a decision is made to use this method in the field.

Flame cleaning always requires skilled workers. It is an expensive and dangerous treatment that uses an oxyacetylene torch.

Chemical treatments are seldom appropriate. Articles that receive this treatment must be scrupulously cleaned. If not, chemicals left on the surface can seep into crevices and cause damage. If the surface is not completely cleaned the remaining chemicals can interact with the newly painted surface causing it to fail.

Beyond surface cleaning few repairs are suitable for those untrained in the practice. The following list of common repairs and accepted methods will help in the decision as to whether to contract the aid of a professional.

- **Repairing internal areas of balustrades, statues, and other features.** It is **never** recommended to fill cast iron cavities with concrete. Concrete shrinks as it cures leaving a gap that allows moisture to come into contact with the metal. It also does not dry quickly leading to the chance of prolonged moisture contact that will cause corrosion.
- **Repairs requiring welding.** Wrought iron is easy to weld because of its low carbon content. Cast iron tends to melt at a low temperature and should not be welded using modern techniques. Modern welding applies extreme heat over a small area. Cast iron is rigid and when one area is heated the surrounding unheated areas resist and crack. Spot welding produces pitted areas where water can collect and contribute to the corrosive process. Spot welding is **not recommended**. All welds should be continuous and when finished almost invisible.
- **Brazing** (soldering with a metal having a low melting point, especially a nickel alloy) is a suitable alternative to welding and a professional should evaluate the fixture and make the decision.
- **Replacing screws, nuts and bolts.** Replacement should always be with a high quality stainless steel. Screws, nuts and bolts should be coated with the same material as used on the rest of the feature. Where new holes are needed they should be drilled slightly larger in diameter to allow for contraction and expansion.
- **Joining elements** (such as sections of fencing). Slip joints (slotted holes) should be used between connecting rails and embedded elements in fencing so as to allow lateral movement during expansion and contraction in extreme temperatures.
- **Sealing joints.** After cleaning, joints need to be sealed to prevent moisture penetration. A product such as *Silkaflex 1a* or another polyurethane based elastomeric sealant is appropriate.
- **Cleaning.** Lightly soiled cast and wrought iron can be cleaned with water under low pressure. **(Level 1)**
- When more intensive cleaning is required, only a non-ionic cleaner should be used. First test the painted surface to be sure it will hold up under the products application. Non ionic cleansers are available at conservator supply and photographic supply stores. Dilution guidelines are identified later in this chapter, and specific storage and mixing instructions are provided by the manufacturer. Proper precautions must be followed when using these cleaners. If possible it is best is to remove the ironwork and to clean it off-site.

If all cleaning efforts fail and the wrought or cast iron feature must be replaced, then professional help is required. Asking the following questions will aid in choosing a professional to assist in the work:

- Do you propose to do the work on-site or remove and repair the elements off site?
- What products and methods do you propose to use in cleaning the metal?
- Will you hand clean or do you propose to use a rust converter?
- How will you perform repairs?
- If welding is required what method do you propose to use and how will you eliminate the chances of cracking the original metal?
- What type of coatings will you be using and how will they be applied? Hand application as opposed to spray application is recommended to allow for more thorough coverage.
- Does the professional have experience with historic resources?

Painting and Coating Systems

Rust is the main cause of deterioration of both cast and wrought iron. Although rust cannot be prevented its return can be delayed with proper surface preparation, caulking and paint. A good coat of paint is the best protection for historic ironwork. The following paragraphs summarize the appropriate preparation of surfaces and the proper application of a protective coat of paint. Experience has shown that in Michigan paint should be applied every three to six years. This recommendation is based on the incidence of rust encountered during routine maintenance.

Initially evaluate the problem by determining what is causing the corrosion. Especially vulnerable to water seepage are areas where elements of ironwork are joined. Where water is drawn into joints by capillary action, corrosion can become severe.

Galvanic corrosion becomes a problem where cast iron and wrought iron come into contact. This is noticeable where, for example, a cast iron rail is placed atop a wrought iron connector. The difference in composition of the two metals causes the cast iron to be pushed up and to split from the chemical interaction of the two metals.

> Simply sealing this joint doesn't eliminate the problem . . . it only seals in the moisture and corrosion continues unabated. It is necessary to stabilize (and often) remove the corrosion . . . only then can the joint be sealed (red lead putty was originally used, but today, a clear silicone sealant is usually more practical). (*Cemetery Ironwork*, Chicora Foundation web site)

Secondly, it is necessary to seal the metal with a rust inhibiting primer as soon as possible after the surface has been cleaned and repairs have been made. Two coats should be applied per the manufacture's specifications. One coat will not sufficiently seal the surface to prevent recurrent corrosion. When applying paint, multiple thin coats are preferable to one thick coating. Thicker paint coats are more likely to fail than thinner coats and the excessive paint will likely conceal intricate patterns in the ironwork.

For paint to properly adhere to the surface it should be applied within the following temperature and humidity parameters. At the time of application the temperature should not exceed 80 degrees Fahrenheit, nor should it be expected to fall below 50 degrees Fahrenheit for the next 24 hours and the humidity should be less than 80 percent. Additionally, rain or moisture should not be in contact with the surface for at least 24 hours. In Michigan, this will often require removal of the elements to an indoor location for proper recoating. Refer to manufacturer's specifications.

Historical accuracy is important in choosing both the color and the finish of paint to be used. Not only should paint be applied with a brush to ensure a solid bond with the metal, it is inconsistent with historical accuracy to apply a sprayed or rolled finish. Historically cast iron was painted a flat black. Semi-gloss or gloss finishes would be inappropriate.

While in the past lead based paint was the norm, today because of health and environmental concerns it is only available in commercial and industrial grade paint. Because they cause immediate oxidization when they come into contact with bare metal, latex-based products should not be considered. Alkyd based paints and primers are the present recommended choice.

Replacement

If damage is excessive or an extensive amount of elements (such as fencing sections) are missing, replacements should be considered. The mixing of old with new elements is often not advisable because the composition of new metals could lead to *galvanic corrosion*. If total

replacement is being considered every attempt to follow the Secretary of the Interior's Standards and Rehabilitation Guidelines are encouraged. Old photographs and other documented records should be used to find or create a historically correct replacement. The list of resources in Appendix B offers the names of some companies that can supply historically accurate, reproduction ironwork. Sometimes molds for casting new fencing can be made from old fence elements. If the property never had an ironwork fence, consider a material or design that does not impart a sense of inaccurate history.

Zinc

Because of the unique character of this metal, repairs should only be done by trained professionals. Zinc is a nonmagnetic, brittle, bluish-gray metal that is heavier than iron but not as heavy as lead. It is quite resistant to corrosion even when untreated, and was used for monuments and statues in historic cemeteries.

There are three main types of damage to zinc monuments: breakage, corrosion and a phenomenon called *creep*. Other than simple painting, treatments of all three types of damage require a professional conservator (such as Architectural Iron in Milford, Pennsylvania; Karkadoulias Bronze Art in Cincinnati, Ohio) and are extremely expensive.

Due to zinc's brittle characteristic, breakage and separation at the seams is the most notable type of damage. Such common occurrences as falling branches, careless mowing and vandalism can damage the metal. Successful methods of repairing breakage are soldering or other repair techniques such as the use of epoxy or polyester resins.

Zinc monuments were cast from almost pure metal and the joining material was also zinc. After the castings were removed from the molds, the panels were sealed by pouring super-heated zinc onto the seams. The molten metal would soften the edges of the cast piece, thus forming a tight seal.

Zinc monuments, because of their unique characteristics, have deteriorated very little over time.

Because of its innate characteristics, zinc, even when unpainted, is not as susceptible to corrosion as cast iron. Over time it develops a patina of zinc carbonate, which protects the surface and gives it its characteristic bluish-gray cast. Bare zinc holds up well and should be left untreated. Sometimes zinc was painted, bronzed, or coated with copper. Painting and re-bronzing for statues that originally had these coatings is the suggested protection. Pitting can occur where zinc was originally coated in copper and left exposed to the weather. Repair of any corrosion problems of coated zinc, if severe, is a task for professionals.

An unusual characteristic of zinc is a tendency to sag where the underlying support system is inadequate. It is subject to deformation as it slowly sags under its own weight. This is called *creep* and can be disastrous for the monument causing the panels to split and / or the metal to sag and spread at the base. Attempts have been made to repair statues by filling their hollow core with concrete. The results have been ruinous. The expansion of the fill material causes the monument to split at the seams causing irreparable damage. This method should never be employed. The suggested repair method requires shoring up the structure with stainless steel support mechanisms that should be installed by professional conservators. Two excellent sources for information on this metal are briefs by the Association for Gravestone Studies and the Smithsonian Center for Materials Research and Education.

IDENTIFYING MONUMENT AND HEADSTONE MATERIAL

Before any headstone is cleaned or repaired it is important to know what type of material it is. The most common material for monuments in Michigan cemeteries is stone: usually granite, sandstone, limestone, or marble. Monuments of iron, concrete, zinc, and even wood are found to a lesser extent in Michigan cemeteries. An unusual example is the wood markers found in Emmett County's Middle Village Cemetery.

Below is a brief discussion of some of the most common monument materials found in Michigan. The following information on granite, sandstone, limestone and marble is from *Landscapes of Memory: A Guide for Conserving Historic Cemeteries, Repairing Tombstones*, published by Management Board Secretariat Publications Ontario and the GSA Technical Procedures website.

Sandstone

Sandstone is a medium-grained sedimentary rock made up primarily of quartz grains and cemented by a variety of binding agents (silica, calcite, or iron oxide). It is porous, soft and easily worked; with the strength depending upon the binders. Sandstone was used for monuments, but not commonly.

Sandstone is typically buff, gray, brown, red, purple, or pink in color (the latter four colors are commonly called brownstone) (General Service Administration, #04470-01). Some nearby sources of sandstone were: Medina varieties in southern Ontario (red-brown, gray or mottled); Ohio sandstone from the Berea beds south of Cleveland (light gray or buff); Ohio Briar Hill sandstone (variegated rusty color); and Michigan Lake Superior sandstone (red).

Sandstone weathers best when its end-grain faces the weather (ie, naturally-bedded). "In many nineteenth century applications however, the grain was placed parallel to the weather-side (face-bedded) for aesthetic reasons." Spalling, which is the separation and breaking away of layers or small pieces of stone; is exacerbated by the freeze-thaw cycle, and is especially common where sulfur pollution is involved (General Service Administration, #04470-01).

Limestone

Limestone is also a sedimentary stone composed principally of calcium carbonate (calcite) or calcium and magnesium (dolomite). The majority of the limestone used in Michigan was formed in a shallow sea that covered the Midwest more than 300 million years ago. It is not uncommon to see calcite streaks, fossils, or shell formations in the stone.

Limestone varies greatly in texture and porosity. It is usually white, gray, or buff in color. Under normal conditions it weathers to a light silver gray or white depending on the stone variety, but is usually darker in color than the bright white of marble. Limestone, unlike marble, does not take a polish well and therefore has a matte appearance. (General Service Administration, Limestone: Characteristics, uses and problems 04460-01) As with sandstone and marble, pollution causes significant deterioration. Breaks and cracking often occur along the bedding planes.

The Woodmen of the World organization, an agency that sold life insurance, began in the late nineteenth century. It provided plans to local carvers for member's monuments. They were originally carved limestone in the shape of tree trunks. The book *Your Guide to Cemetery Research* states that carvers preferred limestone from Bedford, Indiana, for these markers, because it was easiest to re-create the look of tree trunks. The markers are not an uncommon sight in Michigan.

Marble

Marble is a hard metamorphic stone composed of calcium carbonate. It is formed as a result of the recrystallization of limestone under the intense pressure of geologic processes.

The limited porosity of marble makes it less vulnerable to the leaching effects of water. However, it is very susceptible to damage from acidic agents. Marble can be of two types: calcite or dolomite. Dolomitic marble is much more resistant to acid damage than calcite marble. The color of marble ranges from the brilliant white of calcite to black, blue-gray, red, yellow and green, depending on the mineral composition. (General Service Administration #04455-01)

Marble used in tablets and other monuments in cemeteries is typically the brilliant white calcite type. Common problems with marble are dissolution by acid rain, and sugaring. Sugaring is a gradual disintegration of the surface of the marble, causing a rough granular, crystalline or sometimes powdery appearance. (General Service Administration #04455-01) Marble, when exposed to pollution containing sulfuric acid can have its surface converted to gypsum. This gypsum when combined with other elements forms a black crust that ultimately blisters and crumbles away the surface of the stone.

Marble was predominantly used for headstones in the 1880s and 1890s. In order to properly restore or repair marble it is important to appreciate the differences among the many varieties. Much of the marble used in Michigan's cemeteries was quarried in Vermont, for example Vermont blue marble. According to the American Standards for Testing Materials (ASTM) "marble possesses an interlocking texture and a range of grain size from cryptocrystalline to 5mm. All marble as defined here must be capable of *taking a polish*." Using this definition, a limestone such as "Tennessee Marble" (which is actually limestone) may in some instances be considered a marble.

Granite

Granite is a coarse-grained igneous rock which is composed chiefly of quartz, feldspar, orthoclase or microcline, and mica. Depending upon the mineral content, granite may range in color from light pink and gray, to red, brown and black. There are three distinct types of granite: fine grained, medium, and coarse-grained. This very hard stone was introduced into cemeteries only after the 1870s, when improvements occurred in quarrying and carving technology. Granite takes a polishing well and is relatively acid resistant. Granite is one of the most durable stones for architectural and artistic purposes.

Concrete

Concrete is distinguished by its ability to be molded into an infinite variety of shapes, as well as the potential for a wide variety of surface textures, depending on the finishing techniques and the aggregate used. Markers were often finished to resemble limestone. Concrete is gray or white unless artificially colored. Its hardness and strength when cured

depends on the mix – the proportions of Portland cement, sand, and aggregate (gravel or stone) mixed with water. Concrete is much less expensive than natural stone.

A good example of the use of concrete is the intricately shaped "tree stump" markers. Concrete's ability to be molded simplified the process compared to the much more labor-intensive process of carving limestone. The molding could be very detailed, including the bark and some limbs. Once a master form had been created, the marker could be reproduced in concrete with a minimum of additional effort.

In the late nineteenth century molded concrete tree stump markers were fairly common. Concrete was also used for small markers in Potter Fields and for table and box tombs.

Zinc (white bronze)

Zinc (white bronze) is a bluish-gray nonmagnetic, metallic element that is generally brittle but can be worked when heated. The metal is heavier than iron, but much lighter than lead. Often zinc was used for tall, commemorative monuments, though smaller markers such as tablets and ground markers were also available. The monuments are hollow and retain much of their original definition. Although durable and inexpensive, these markers came to be perceived by many as "cheap and faddish." *(Massachusetts Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries,* p. 37*)*

Zinc markers were often tall monuments such as the obelisk on the left. Tablet markers as tall as 3 feet can be found as well as smaller 1-foot markers (next page) such as these found in Newburgh Cemetery.

One-foot zinc tablet headstone.

Ground markers made of zinc, though rare, can still be found.

Small iron medallions placed beside the grave often indicated the deceased's affiliation with particular groups.

Iron

Some historic Michigan cemeteries have iron monuments or crosses. Many cemeteries also contain small iron medallions placed beside the gravestone, which indicates the deceased's affiliation with fraternal or military associations.

CLEANING HEADSTONES AND MONUMENTS

In planning for a cemetery's conservation, the care and maintenance of headstones is extremely important. It must first be decided whether or not to clean the monument. Do not attempt to return the stone to its original brightness, which would involve removing all patina.

> Often people mistake the patina of age for *dirt*. They want marble stones, for example, to be as white as when originally purchased – and this is a tragic mistake. Not only does such aggressive cleaning cause irreparable damage, but it destroys the stone's patina – and history – making it look like the stone was placed in the cemetery only yesterday. (Chicora Foundation web site)

A monument that is located in constant shade may be prone to biological growth. Cleaning the monument may remove the growth, but it will soon return, thus starting a cycle of frequent cleaning. Each cleaning has the potential to harm the stone and therefore it may be better not to start the cleaning process. (Chicora web site)

Certain plants and biological growth have the potential to harm a headstone and thus should be removed. This section of the manual provides information on the type of damage inflicted on headstones. It will also provide information on the appropriate technique, equipment and agents for cleaning monuments.

Damage to headstones falls into three classifications:

1. Environmental:
   - carbon-based deposits from industrial and vehicle emissions
   - improper cleaning and / or repair methods
   - air pollution / acid rain

2. Natural sources:
   - aging and weathering of stone
   - settling of the stone
   - organic growths, including lichen, algae, and fungi
   - climbing plants and vines

3. Human-inflicted:
   - neglect
   - vandalism
   - improper use of maintenance equipment such as mowers and weed whackers

All three types of damage will most likely be encountered. The following guidelines will help in determining what can and should be done. Some of the tasks require an experienced conservator and should be handled accordingly. Before beginning any cleaning program, become familiar with the following important principles. These principles have been compiled from a variety of sources such as *Grave Concerns, A Preservation Manual for Historic Cemeteries in Arkansas; Landscapes of Memories: A Guide for Conserving Historic Cemeteries, Repairing Tombstones;* the Chicora Foundation, and the National Center for Preservation Training and Technology.

Before you begin:

- A condition survey should be completed on the stone prior to cleaning. Photograph the stone before starting, and again when the cleaning is complete and the stone is dry.
- Keep a record of the cleaning date, the methods and chemicals used, and any immediate change that was noted. Photography is also recommended to record the critical cleaning steps and results. These records should be stored with other cemetery documentation.

Cleaning parameters:

- Do not attempt to return the stone to its original brightness, which would involve removing all patina.
- Do not clean any stone if there is a possibility of freezing temperatures within the next seventy-two hours.
- When possible, clean stones on a cool, overcast day so that evaporation and drying will occur more slowly.
- Limit cleaning of stones to not more than once every four to six years. Cleaning may result in some wearing away of the surface of the stone.

Guidelines for Cleaning Monuments:

1. Evaluate the general condition of the monument. Only a sound stone should be cleaned. Carefully sound (gently tapping the surface with a knuckle) the stone to determine if there are any underlying hollow areas, as evidenced by a hollow tone. If hollow areas are detected, do not continue with cleaning or handling; an experienced conservator should be consulted.

2. Do not attempt to clean the monument if any cracks, flaking or scaling, or eroding granular surfaces are present. Again, any attempt to clean a stone that is less than fully stable should be left to an experienced conservator.

3. **Determine the type of soiling** in order to select the most effective manner of removal. Types of soiling include:
   - carbon or soot
   - ordinary dirt
   - organic (algae, fungi, lichens, mosses)
   - climbing plants
   - efflorescence (salts)

4. **Always start with the gentlest effective method for cleaning headstones.** Often a simple rinse with water and a natural bristle brush is all that is needed. If rinsing with water is not sufficient, carefully proceed with a recommended cleaning agent.

5. **Test the entire cleaning process in an inconspicuous area** on the monument before applying it to the total monument. Allow to dry for several days and check for adverse reaction.

6. **A good supply of water is <u>mandatory</u> when cleaning stones, and when using any type of cleaning agent.** Running water from a garden-type hose is preferred, but spray bottles will suffice for small jobs. Clean, *unused* garden sprayers that hold one gallon or more of water are convenient.

   **Note: Potable water is the ideal (but not absolutely necessary) because this implies that the water is free from objectionable amounts of chemical, minerals and impurities which could possibly harm the headstones. (John Spaulding, AGS Research Clearinghouse Coordinator)*

7. **Do not allow cleaning solutions to dry on a monument.** Keep the agent wet during the cleaning process. If allowed to dry, residue from chemical cleaning solutions can create a blotchy appearance, provide a medium for future bacterial action, resulting in more staining and accelerated deterioration.

8. **A cleaning procedure that is recommended for one specific application is not applicable for all situations.**

Equipment needed for cleaning monuments:

- A variety of sizes and shapes of high quality natural bristle brushes. Use only brushes without dyes in the bristle. A variety of sizes and bristle stiffness is recommended. Brushes with colored handles are **not** recommended because inadvertent contact with the monument may leave a colored streak on the stone.
- Protective eye glasses or goggles, and rubber gloves
- Toothbrushes for intricate carvings
- Wooden craft sticks or shims for scraping debris or growth off stones
- Clean sponges (closed cell, cosmetic-type sponge only; this avoids remnants of the sponge remaining on the stone)
- White rags
- Plastic pails (**avoid metal containers** which may damage stones by incidental contact)
- Q-tips for test spots, and toothpicks for small recessed areas
- Compressed air (60 psi maximum) will assist in clearing off loose debris and dirt. The compressor should have a pressure regulator to avoid damage due to excessive pressure. A small broom can also be used.

Tools and Equipment to Avoid:

- **Never use metal tools** while cleaning stones. Tools such as wire brushes, putty knives, and shovels etc. can severely damage old stones.
- **Do not use any type of adhesive tape**, which may leave a residue on the stone.

General Cleaning Process

1. **Pre-wet the monument** with **clean** water before applying any chemical solutions. Wetting the surface avoids excessive penetration of both cleaning solutions and soil into the stone, and helps to soften the soiling material.
2. Clean the monument **on all sides from bottom to top** to avoid stains and streaks. Rinse frequently during the process.
3. Do not use a dry brush on the stone. Dip frequently in water to reduce friction on the stone – or have a hose running with a constant flow of water over the stone as you brush.
4. To ensure that stones have been properly rinsed, check the pH using a test strip. A pH of about seven is desirable.
5. **To repeat: never allow a cleaning solution to dry on the stone.**

Often after simply training and with proper supervision, even young volunteers can be used to clean headstones. Here a young volunteer uses water and a natural bristle brush to do the initial cleaning.

Removal of Climbing Plants/ Vines

Climbing plants, such as vines and ivy, although rooted in the ground, will sometimes attach themselves to a headstone. Allowing plants to remain on headstones poses several preservation problems, including:

- Holding moisture against the surface of the stone
- Damage to the soft surfaces of the marker by root expansion in the interior of the stone and subsequent chipping of small areas on the surface
- Erosion of mortar joints by invasion of the roots
- Obscuring the inscription
- Impeding access to the stone for making repairs

The following recommendations are taken primarily from Chicora Foundation's training seminars. Before attempting to remove such growth, carefully examine the stone to see if the roots of the plant have compromised mortar joints, or have become imbedded in the surface of the stone. Caution: never pull vines off of a monument because it may damage the stone.

- Cut the plant off at the base of the growth using pruning shears.
- If the vine is large, cut it every six to twelve inches, leaving any growth adhering to the headstone.
- Peel back the bark one to two inches on either side of the cuts.

- Apply an herbicide, such as Chevron *Brush-B-Gon* or Monsanto *Round-Up*, with a small paintbrush to treat the exposed plant layers. Also apply the herbicide to cut areas on the stump.
- Be careful that no herbicide comes in contact with the headstone. Do not allow any herbicide to touch the ground or it may wick up into the stone.
- Allow the chemical to work its way into the plant and kill it. This may take a few days.
- After the plant is completely dead and brittle, remove the remains. Using a wooden scraper, such as a cedar shim, work the remains of the plant from the monument. Wetting the stone will facilitate removal.
- After all surface vegetation has been removed; gently remove any remaining plant matter by scrubbing the area with water and a natural bristle brush.

Removal of Organic Growths

In urban areas, headstones may be covered with a layer of sooty carbon residue from industrial and vehicle emissions, which can prove very difficult or impractical to remove. It is usually black in color and for this reason can be confused with certain other growths such as fungus and algae. The following test will determine whether the soiling on a headstone is dirt, carbon or soot (inorganic), or an organic growth:

- Dip a cotton swab in household bleach and touch the black deposit in an inconspicuous place (e.g., the lower rear corner of the marker).
- If the soiling remains black where the bleach swab touches the area, it is likely to be dirt, soot and other inorganic stains, which will not change color.
- If the test area turns light brown, green, or disappears, then the condition is organic growth. *(Chicora website; Landscapes of Memories: A Guide for Conserving Historic Cemeteries, Repairing Tombstones,* p. 18)

Lichen, mosses, algae, and fungus commonly grow on headstones. Some of these growths may appear to be black; resembling the sooty deposits left by carbon residue, but upon closer inspection may appear multicolored. These organic growths trap moisture on / under the surface of the stone, and their roots may invade the stone, causing damage to the binding agents that hold the stone together.

Some lichens secrete organic acids that can destroy calcium carbonate, which is the primary component of limestone. These lichens are considered *lithophagous* because they "eat" the surface of the stone. They are particularly harmful to limestone, marble and sandstone. *(Landscapes of Memories: A Guide for Conserving Historic Cemeteries, Repairing Tombstones,* p. 18)

Lichen and other organic growths can be treated with the architectural anti-microbial product, D-2, to prevent the damage that these growths cause. D-2 can be sprayed or brushed onto the growth to loosen a broad spectrum of biological deposits. D-2 has several attributes that make it very desirable:

1. It is non-toxic and biodegradable
2. It kills most bacteria within several minutes
3. There are no special precautions for handling and storage
4. It does not cause damage to headstones
5. It is harmless to landscape plants

When using D-2, thoroughly wet the surface of the stone, apply the liquid product, either full strength or diluted (1:1 to 1:4 with water), using roller, brush or sprayer. Then gently scrub the surface with a high quality, natural bristle brush and allow the D-2 to stay on the surface for one to ten minutes (taking care not to allow the stone to dry). It may be necessary to repeat the process. Finally rinse the surface thoroughly with water. (Chicora Foundation website and Cathedral Stone Inc.)

Pressure Washing and Sandblasting Not Acceptable

Use caution when working with monument and restoration specialty companies, because some still use high-power pressure washing for cleaning stone and metalwork. Experience has shown that older stones that have developed small fissures and subtle weaknesses are more likely to fail, even under the lower pressure of a typical 1000 psi consumer pressure washer. Sandblasting, whether sand, baking soda, or walnut shell as media, is too abrasive for older headstones

Instead of power washing or sandblasting, it is recommended that a garden hose, delivering a maximum of 60 psi, be used. Pressure higher than 60 psi has the potential to remove the outer surface of the stone, and can blast off raised lettering and deteriorated surfaces before the operator becomes aware of the damage.

Be sure to have an ample supply of water available so that any deposits or cleaning agents can be thoroughly rinsed off before drying. When cleaning products are not totally rinsed from the marker, accelerated soiling and damage can occur.

CLEANING AGENTS

When working with volunteers, it is recommended that cleaning agents be limited to water, D-2, and non-ionic detergents such as Vulpex, Photo-Flo, and Orvus. However, when conservation workers are more qualified, or when volunteers are working under the close supervision of a professional, the other options listed below may be used.

Cleaning Agents — According to Type of Agent

Tracy C. Walther, a member of the *Association for Gravestone Studies* and an architectural conservator, recommends the following:

A. Soaps and Detergents

Recommended:

1. Non-ionic detergents (e.g., Photo-Flo, Orvus and Vulpex) are recommended because they are electrically-neutral cleaning agents that neither contain nor contribute to the formation of soluble salts. Because they provide better wetting of the masonry surface, non-ionic detergents facilitate removal of general soiling.

Agent	Mix Rate (by volume)	Availability
Vulpex	1 part Vulpex per 6-7 parts cold water	Conservation, janitorial, and photographic suppliers
Orvus	1 oz per 5 gal water	Farm and feed store
Photo-Flo	1 oz per 5 gal water	Photo supply store

Not Recommended:

1. Soaps (e.g., Ivory) are *not recommended* because they are rendered insoluble by calcium ions present in masonry and hard water. Soaps may also produce free alkali and fatty acid salts that can damage stone.
2. Commercial household detergents (liquids and powders) are generally chemically complex synthetic compounds that frequently contain additives that may be detrimental to masonry. Detergents may cause the formation and deposition of soluble salts in masonry.

B. Acidic Cleaning Materials — Acidic agents are never recommended

Hydrochloric or muriatic acid, phosphoric acid (e.g. Lime Away, Naval Jelly), or oxalic acids can damage headstones. Hydrochloric or muriatic acid may result in ferrous chloride (rust) staining and the deposition of soluble salts.

C. Alkaline, Corrosive, and Biocidal Cleaning Materials — Recommended:

1. Calcium Hypochlorite (also known as Chlorine, HTH, Shock Treatment), a *granular* product, is **recommended for the removal of biological growth**. This product must not be confused with liquid chlorine or sodium hypochlorite (household bleach) — *which are not recommended*.

   Calcium hypochlorite is **recommended for use only by experienced conservators (Level 3)**. It is available from swimming pool suppliers. A suggested cleaning mixture is one ounce calcium hypochlorite per gallon of hot water. This product should be used only when a water hose with good water pressure (e.g., 50-60 psi) is available for rinsing the cleaning solution from stones.

2. Ammonium Hydroxide (e.g., household ammonia): Solutions of household ammonia are **recommended for cleaning of light colored stones. Ammonia is particularly effective for the removal of biological growth**. A suggested cleaning mixture is one cup of ammonia to one gallon of water. When using household ammonia be certain that it does not contain dyes or fragrances that may prove harmful to certain stone.

> *Caution: When using a cleaning mixture that includes household ammonia, damage to bronze or other metal components can result.*

3. Quaternary Ammoniums (e.g., algaecides or biocides for swimming pools) have a slightly different chemical structure than ammonium hydroxide. They are **especially effective for the removal of biological growth, particularly stubborn black algae**. Quaternary ammoniums, which are available from swimming pool suppliers, list ingredients such as alkylbenzyl trimethyl ammonium, benzyl alkyl dimenthyl ammonium chlorides, or benzyl aklyl dimethyl ammonium bromides.

Not Recommended:

1. Sodium Hydroxide (e.g., Borax), and Sodium Hypochlorite (e.g., Clorox, liquid chlorine) *are not recommended* for general cleaning of stone.

2. Trisodium Phosphate (e.g., TSP, Calgon) is *not recommended* for cleaning monuments. It can cause the formation and deposition of soluble salts. "Calgon" contains trisodium phosphate and a number of additives that may be detrimental to monuments.

3. Fantastic All Purpose Cleaner, Formula 409, Spic and Span, and abrasive cleansers are *not recommended* for cleaning monuments. Avoid products containing sodium chloride, sodium sulfate, sodium carbonate, sodium bicarbonate, and ammonium carbonate, due to the propensity to form and deposit soluble salts in monuments.
   (Walther, Tracy C. 1990, *Cleaning Masonry Burial Monuments*. The Association for Gravestone Studies, Greenfield, Massachusetts)

Cleaning Agents for Specific Stone Types

Another leading authority on cemetery preservation, Lynette Strangstad, in her book *A Graveyard Preservation Primer*, recommends cleaning solutions according to stone type. They are listed in reverse order of cleaning strength; i.e., weakest first (which is the preferred order of application):

Marble and Limestone:

1. Water only.
2. Non-ionic cleanser such as Photo-Flo, (available at photographic supply houses) Triton-X 100, Igepal (available from conservators' supply houses), and water.
   – *Use one ounce to five gallons of water*.
3. Vulpex (a soap) – available from conservators' supply houses).
   – *Use one part Vulpex to two to four parts water*.
4. Household ammonia. (diluted)
   – *Use one cup per four cups of water*.
5. Calcium hypochlorite. Use only to remove biological growth. Available as swimming pool disinfectants.
   – *Use one pound (dry weight) to four gallons of water. The water must be warm*.

Sandstone:

1. Water only
2. Non-ionic detergent and water (see Marble)

Subflorescence and Efflorescence

Subflorescence is caused by the deposition of crystalline salts below the surface of a stone.

Some of the causes of subflorescence are:

- wicking of moisture (contaminated with salts, fertilizers or herbicides) into the stone
- using incorrect cleaning compounds
- using the wrong kind of mortar for masonry repairs
- air and water pollution.

Subflorescent salts can be drawn out of a stone by applying a poultice. Application of a poultice may require hiring a professional conservator.

Efflorescence is caused by the deposition of the salts on the surface of a stone; resulting when subflorescence migrates to the surface of the stone and becomes visible.

> Efflorescence is an indicator of excessive salts. In order to prevent or reduce the damage from subflorescence, causes need to be identified and steps taken to eliminate the source(s). Delamination (breaking off of layers) of the stone surface can eventually result from subflorescence.

Poultices are water-based pastes made from *diatomaceous earth, fuller's earth* or *kaolinite* applied over stained areas on the monument. The following are the steps in applying a poultice:

- Mix the chosen product with water to the consistency of peanut butter.
- Apply the poultice to the soiled area – 1 / 4 – 1 / 2 inches thick.
- Wrap the area with plastic sheets to avoid premature drying.
- Remove the poultice when nearly dried – as indicated by cracks in the poultice material. In the process of drying, the poultice draws out the stain in most instances.
- After removing the poultice, the stone must be thoroughly cleaned with water to remove poultice residue.

> For specific stains, special products can be added to the poultice to enhance performance. Conservator supply companies, such as Granite City Tool, offer premixed poultices.

Sealants

Do not apply any type of sealant or consolidant to a headstone. The Chicora Foundation, NPS Preservation Briefs, and the Association for Gravestone Studies all agree with this advice. A stone in contact with the ground continues to wick-up moisture and must be allowed to "breathe" and expel the moisture, although some sealing products claim to seal the surface of stone while still allowing the stone to breathe. Because of the risk of preventing the migration of moisture, applying any type of sealer or consolidant should be left to trained conservation professionals, and used only in very specific applications.

REPAIRING HEADSTONES AND MONUMENTS

Overview – The following are important conservation principles for repairing or otherwise conserving grave markers / headstones. The Association for Gravestone Studies, the National Center for Preservation Technology and Training, and other cemetery conservation groups, offer seminars on the topic and are sources of additional information that may be helpful.

While the repairs in this manual are primarily applicable to stone monuments and markers, the general principles may apply to any preservation or conservation repair. The italicized comments are intended to clarify the repair criteria, some of which may seem to be contradictory:

- The repair is less strong that the original.
  Additional damage to the stone could result if the repair material is stronger than the original stone. If a new break occurs, the intent is to avoid any more damage to the original stone; i.e., the repair should fail, not the stone.
- The repair is reversible.
  A repair should be able to be disassembled without damage to the stone. This is desirable because improved repair procedures may become available in the future.
- The repair respects the original material of the marker.
  The repair methods and materials are compatible with those of the original marker, and minimize the possibility of further damage or discoloration to the stone.
- The repair is as historically accurate as is reasonable and possible.
- The repair does not inhibit the natural permeability and breathe-ability of the stone.
  Avoid adhesives, coatings, sealers or other repair materials that may retain moisture or affect breathe-ability, which can result in secondary damage.
- Before attempting to repair headstones in a historic cemetery, inspect stones carefully to assure that they have not developed previously unforeseen cracks, spalling or other weaknesses that would affect the repair.

General Caution. Repairing old stones requires training in specific skills and patience. Before starting complex projects such as multiple-break repairs or infill repairs, the practitioner should become totally familiar and comfortable with the repair methods.

Familiarity with the types of stone, with characteristics of mortars and epoxies, and with other equipment is required prior to working on an actual historic headstone.

> If possible, practice on discarded stone fragments or on landscape stones. Each type of repair material; e.g., two-part epoxies and mortars, have unique characteristics. A wide variety of mortar recipes and proprietary infills are available (e.g., Jahn restoration mortar products from Cathedral Stone Products, Inc.).

Documentation

Before starting a repair, photograph each side of the stone. Rinsing gently with water may reveal parts of the inscription not previously visible, as well as the name of the stone carver. Document all information regarding the condition of the stone and any existing repairs that are visible, including materials and methods, and any pins, braces or straps previously used. If a previous repair has failed, record that fact and the reason for failure, if known. The purpose of accurate documentation is to help future conservators if new methods in the future provide the opportunity to improve the condition or the permanence of the repaired stone.

Record the repair process with photographs and notes, and document the condition of the stone when the repair is complete. Document all information on a headstone survey sheet. Identify all actions taken from start to finish, including the type of adhesive material or mortar mix used. If holes are drilled for blind pinning, record their locations and size, and the type and size of dowels used. Specifications or formulas for metal or other materials used should be documented, as well as any other treatment such as cleaning or infill. No action should be overlooked or considered too insignificant. If a commercial mortar product was used, Material Safety Data Sheets [MSDS] should accompany the records. The MSDS, available from chemical and mortar manufacturers and suppliers, should be kept with all other repair information records.

Fragility and Soiling

Always handle stones as extremely fragile items. When wet, stones are much more susceptible to breaking. A stone that has been lying on the ground absorbing moisture can take as long as a month to dry, depending on conditions. When stones have dried,

efflorescence may appear on the surface. Any efflorescence or soiling should be removed prior to the repair. A poultice can be used to draw out the contaminating salts. See "Cleaning" section for specific poultice application practices.

Lifting and Moving the Stone

Headstones weigh 160 to 180 pounds per cubic foot. Use extreme care when lifting or moving stones to avoid personal injury or damage to the stone. When moving the stone, support the weight of the stone evenly, using nylon straps and boards to equalize the load. Larger stones can be moved by two persons using a lifting pole with nylon straps, or with lifting devices such as a portable crane, or a tripod with chain hoist. Stones should be protected from contacting chains or other metal lifting objects. Only experienced conservators should move heavy stones.

> Handling Cautions: Metal bars and shovels should not be used to pry or lift a monument or headstone. Do not try to lift heavy stones without the assistance of another person. Even when using lifting equipment, another person should be available to assist if needed.

COMMON REPAIRS

The following are the most common types of repairs on stones in historic cemeteries, all involving slab markers/tablet stones. Repairing large or complex stones should be reserved for conservation professionals with the necessary experience and equipment. The following repairs are listed from easiest to the most difficult:

- Correcting tilted stones that were set directly in the ground
- Resetting fallen stones that were set directly in the ground
- Stabilizing and resetting a stone or a concrete base
- Replacing a marker into a base
- Making concrete bases for partial slab or tablet markers
- Repairing a snapped marker
- Infill of missing stone fragments using mortar

Correcting Tilted Slab or Tablet Markers Set Directly in the Ground (Not In Bases)

Tilted markers are among the most common problems in older cemeteries. Slab or tablet markers, installed directly in the ground (with approximately one third of the stone below grade), may have been standing for a century or more. Stones, especially in sandy soil, may have tilted due to shifting or the effect of gravity; or may have sunk, partially concealing the inscription. A stone that is leaning may become warped. In the worst case, if not corrected, the stone could eventually fracture due to its own weight. Generally, if the marker

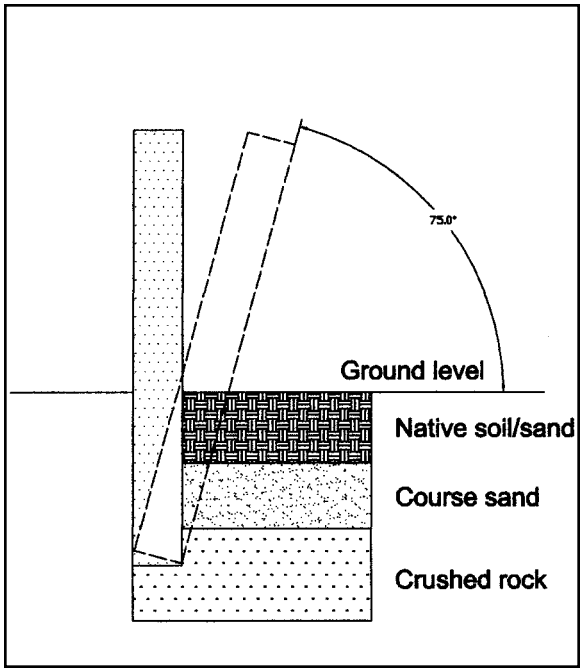
is leaning less than fifteen degrees from the vertical, intervention to set it upright is not suggested. A stone that has sunk only minimally will usually not need to be removed unless the inscription is obscured below grade.

Straightening a tilted marker is fairly straightforward project and involves minimal cost. Trained and supervised volunteers can usually do it. Check to be sure that there are no unseen conditions that would preclude straightening the stone without damage. Removing the stone completely from the ground will usually not be necessary.

Straightening Tilted Markers

2

- Hand-dig the ground around the stone. Remove the sod with a spade-shovel so that it can be easily replaced. Do not allow metal tools to contact the stone. Unless the stone has sunk so that the inscription is obscured or repairs to the stone are needed, it is usually not necessary to remove the stone from the hole.
- Excavate to the depth of the bottom of the stone. Assure that the sides of the hole are wide enough so that when the stone is straightened, the edges of the stone will not hang up on the sides of the hole, causing undue stress.
- Straighten the stone to vertical, checking for plumb. While supporting the stone, backfill the hole one-third full with heavy aggregate such as broken brick or 21-AA stone (from a cement yard) and tamp. Add coarse sand and gravel mix (aggregate) and tamp, leaving three to four inches for topsoil and sod. Place landscape fabric atop the aggregate, to maintain drainage by preventing dirt from filtering into the aggregate.
- Replace the topsoil and lightly tamp. Mound up soil to allow for settling. Replace the sod. After two or three weeks, check for settling around the base of the stone, adding more soil as required.



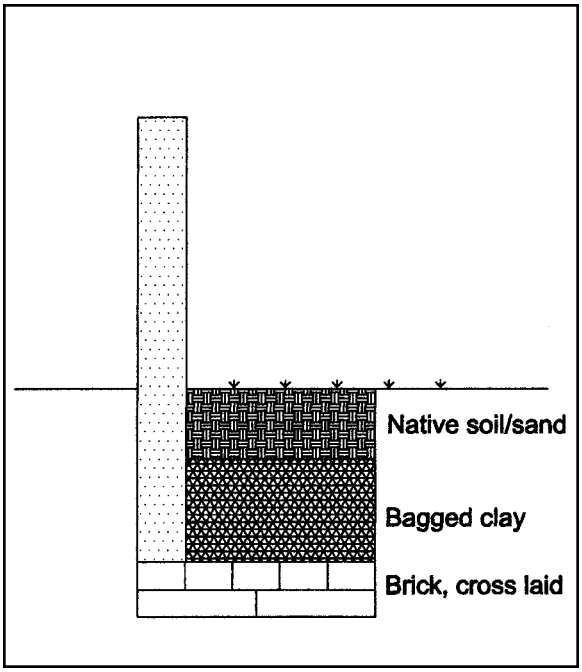
Straightening a marker is a common task done usually when the marker is out of plumb by 15 or more degrees. Always use caution when moving a stone. Trying to force a stone can cause it to snap.

Straightening Markers When The Stone is Removed

2 If the stone must be removed temporarily, additional preparation of the bottom of the hole is required to prepare for reinstallation. See the *Lifting* section for instructions on removing the stone from the hole.

- Excavate the existing hole to a rectangular shape, with vertical sides, and level bottom. The front wall of the hole remains at the original location of the front face of the stone. To achieve a solid base, tamp the bottom with a length of 4 x 4 lumber or other tamper.
- The depth of the hole is established by the desired height of the headstone above the ground. If possible, set the height so that the lowest inscription is visible – ideally a minimum of two inches above grade. The actual height at which the stone was previously set may be visible from staining on the stone (witness marks). The depth of the hole may vary depending on the following alternative "fill" method selected:
  - Alternative 1 – Stone and aggregate fill – Lay dry flat stones in the bottom of the hole. Lower the headstone into the hole with the front face of the stone against the front wall of the hole, centered side-to-side. Straighten to vertical, checking for plumb. While holding or bracing the stone, backfill with heavy aggregate (such as broken brick or 21-AA stone from a cement yard) to half-fill the hole, and tamp. Next add coarse sand and gravel mix to within a few inches of the top, and tamp. Place landscape fabric atop the aggregate, to maintain drainage by preventing dirt from filtering into the aggregate.
  - Alternative 2 – Clay bricks and bagged clay fill – As an alternative to aggregate fill products above, line the bottom of the hole with unfired clay bricks, and use bagged clay as backfill. A first course (layer) of unfired clay bricks is laid on the bottom, with a second course laid perpendicular to the first. Lower the headstone into the hole with the front face of the stone against the front wall of the hole, centered side-to-side. Straighten to vertical, checking for plumb. While holding or bracing the stone, backfill with bagged clay to half-fill the hole, and tamp. Add topsoil to within a few inches of the top and tamp until firm. Clay provides a concrete-like and extremely solid base and support for the stone, and is easier to transport and more volunteer-friendly than aggregate. Clay is used on baseball and softball fields; and may be available in municipalities' parks departments, as well as commercial nurseries. (One of the authors of this text developed this technique using clay material in collaboration with other professional conservators.)

- Add more topsoil and lightly tamp. Mound up soil to allow for settling. Seed or replace the sod. After two or three weeks, check for settling around the base of the stone, and add more soil as required.



The drawing shows the cross section of a repair when clay bricks are used as a base and bagged clay is used to strengthen the repair.

Resetting Fallen Markers Set Directly in the Ground – Not in a Base

2 Slab or tablet stones in historic cemeteries may have fallen to the ground, and often are obscured from view by leaves, dirt, and turf. The stone may be stained by the decaying of organic materials, and damaged by maintenance equipment or by people walking across the stone. Stones lying on the ground are also continually subject to absorption of moisture, which weakens the stone. Markers that have fallen can be reset using the following procedure:

- Preparation – Gently remove any debris or turf covering the fallen marker. Using wooden shims carefully excavate around the perimeter of the stone. Extreme care should be exercised because moisture-saturated stones are very brittle and susceptible to snapping or chipping. Photograph the stone to document its condition.

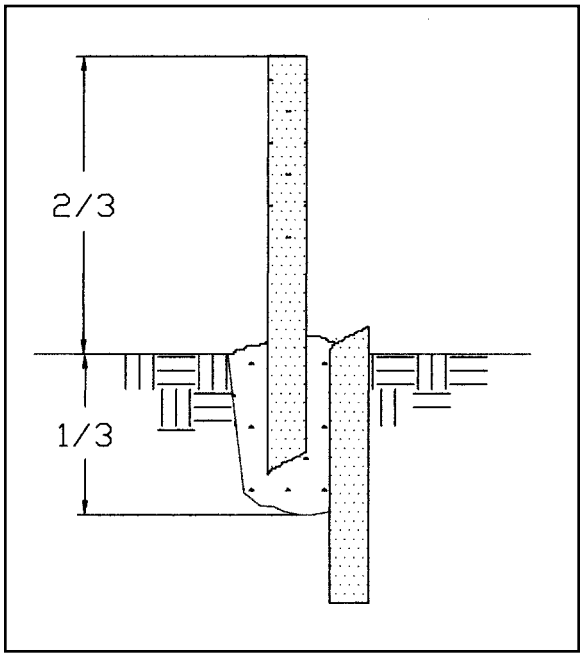
- Removing and Resetting the Stone – Carefully excavate under the stone to allow for insertion of nylon lifting straps. Hoist the marker from the ground

using nylon straps, supporting the weight evenly. Transfer the stone to a level base of two-by-fours to support the full length of the stone, and permit air circulation to allow the stone to dry. Allow space for replacing the nylon straps under the stone later for lifting. Depending on the weather, it can take a month or two for the stone to dry. Moving the stone into a heated building will accelerate the drying process. Remove any residual dirt by gently brushing. Total cleaning, including removal of efflorescence, should be accomplished after the stone has been fully dried and reset. Align and reset the stone using the method described in Straightening Tilted Markers (above).

Temporary Repairs of Snapped Headstones

2 When time and resources are limited it may be prudent to temporarily reset pieces of monuments until a better repair can be made. If stones have been snapped off and their "cousin piece" is still in the ground, this temporary fix can help to prevent additional damage. See sketch.

Remove the broken top half of the stone from the ground. Excavate a hole for the broken stone in front of the remnant, to a depth of one third the height of the fragment. Place the stone in the hole in an upright position. Fill the hole using clean sand or gravel as backfill (to avoid staining) and tamp firm. Although temporary, this repair can be an effective stopgap measure that can preserve the stone by keeping it upright until proper repairs can be made, as well as improve the appearance of the cemetery.



As a temporary fix simply resetting the broken piece in front of the parent stone is a reasonable action and one that can quickly improve the look of the cemetery.

Types of Monument Bases Supporting a Headstone and Marker

There are two styles of monument bases:

1. Slot-style monument bases, which may be made either of stone or concrete, have a narrow recess or slot in the top surface into which a tablet marker is inserted.

2. Flat-top bases made of stone that matches or complements the headstone, are usually set above grade and support a flat-bottomed marker. (See picture of stone base(s) with marker). The marker is adhered to the base either by a mortar bed, or occasionally with dabs of epoxy.

Tablet markers (photo A) are often inserted into a slot style base (photo B).

A ›

‹ B

Obelisks (photo C) as well as larger, thicker tablets can be set onto a base (photo D).

‹ C

D ›

Stone bases, whether slot-type or flat-top, usually protrude above grade from about two inches up to the full height of the base. Cast concrete bases are usually set slightly below grade (i.e., not visible).

A typical problem on the slot-type base is damage around the slot where the tablet is inserted into the base. If not repaired, installation of the marker is likely to fail. Broken pieces on stone bases can often be repaired with epoxy. Missing pieces can be recreated with infill mortar mix. Shifting of the base may have occurred, due to tree roots or heaving due to frost. Damage to a concrete base is usually corrected by re-casting it in concrete vs. repairing (See *Making a Concrete Base*).

The following sections will cover resetting bases, repairing the slot, replacing the marker, and making concrete bases.

Resetting Monument Bases

Tree roots or frost heaving can cause a monument base to shift or lift. The process for leveling and stabilizing a shifted base applies to both stone and concrete bases:

- Carefully excavate around the base of the marker. Rough unfinished surfaces on the periphery of a stone base can often provide an indication of the portion of the base originally set below grade. "Witness marks" or staining on the base may also indicate where the stone contacted the earth. After the sides of the base are exposed, check for damage.
  - If the stone base is damaged *around the tablet slot*, repair the slot prior to resetting the base and inserting the marker. This procedure is covered below.
  - Rejoin large broken sections of the stone base using epoxy. The resulting repair can usually be expected to withstand the forces encountered when the base is lifted.
  - Smaller repairs in other areas of the base, including infill replacement of missing sections, can be accomplished after the base is reset, before replacing the earth fill.
- If the base must be lifted, use the appropriate lifting techniques (previously described) to lift and place it on a lumber base for support. <u>If the marker is still attached to the base, the following instructions will avoid damage to the marker</u>:
  - Do not lift the base using the marker.
  - Always support the marker while lifting the base.
  - Do not lay the base and marker assembly on its side as the marker or the base could be damaged.

- The surface on which the base will be replaced must be firm and level. If the ground has heaved, reestablish a flat surface. Remove any roots that originally caused the problem, but do not disturb the soil any more than necessary. Level the surface and add *cement sand* or other fine aggregate on top of the soil. Firmly tamp each layer, as loose soil makes for a poor foundation.
  - If necessary, a concrete pad can be poured atop the aggregate to raise and/or stabilize the base. The pad, which is one or two inches wider and longer than the base and two to three inches thick, is hidden below ground. However, an aggregate base is usually adequate.
- Before lowering the base onto the amended and tamped aggregate, or onto the cured concrete pad, apply a one inch-thick layer of mortar to stabilize the base. Use the recommended mortar in this book.
- Lower the base onto the prepared mortar surface. Support the base at the corners and adjust the base to level. After the mortar has dried (usually two days), complete any necessary infill repairs on the stone base (see procedures below). Backfill the soil around the base, and seed or sod the area.

Replacing a Marker in Its Base

A common restoration project involves replacing a tablet marker (two to three inches thick) into the slot in a stone base. The slot is about one to two inches deep, and 3/4 inch wider than the thickness of the marker. Patching concrete or epoxy adhesive should not be used, because concrete is not compatible with stone, and an epoxy repair is not easily reversible. The following is the recommended procedure:

- Inspect the base for damage, especially the area around the slot. Inspect the stone to be placed in the base.
  - If the base is damaged in the area of the slot where the tablet is inserted, the slot must be repaired prior to the next step. Use epoxy to join those pieces that have a close fit, and use infill mortar mix (see Infill section – below) if needed to fill voids from missing pieces of stone.
  - Missing areas *on the periphery of the stone* can be repaired after the base is replaced – using *infill mortar techniques* – before replacing the earth fill around the base.
- After the repairs to the base have cured, reset the base in the ground and install the marker:
  - Remove all fragments of old mortar from the base and stone prior to applying new mortar. Dampen the slot and the bottom of the stone with water spray so that the stone does not absorb moisture from the mortar.

- Using the recommended mortar mixture (see below), or a proprietary mortar such as Jahn Products, apply a one-half inch layer of mortar to the slot in the base. Place two or three one-quarter-inch thick 'setting cushions' (plastic pads available at monument dealers) in the bottom of the slot to maintain the thickness of the mortar. *Note:* proprietary mortars may require certification from the supplier to purchase.
- Lower the stone into place into the slot and support with wooden braces. Work mortar into the gap between the base and the stone, using wooden shims. Continually check the stone for plumb. Fill the gap around the headstone and create a small one-eighth inch fillet of mortar at the base to help shed water (a larger fillet [smooth, concave bead] would be prone to failure).
- While the mortar is still wet, re-check for plumb, and check the braces for stability. After the mortar has dried, usually in a day or two, the braces can be removed.

After the repair has been made, securing the marker is imperative. The use of clamps, wooden braces and shims assures the marker is not touched by the metal clamps, and also prevents the marker from moving while the repair treatment cures.

Making a New Concrete Base for Broken Slab or Tablet Markers

Unconventional repair methods may be required in cemeteries that have been vandalized or left unattended. One method is setting a fallen stone fragment upright in a base of poured concrete. Resetting the stone in a base protects the stone and displays more of the surface than if the stone were to be set into the ground. A new concrete base can be poured in a workshop under controlled curing temperatures and protection from rain.

> *Note: Creating a base is the only application for concrete in historic cemeteries endorsed by organizations such as the National Park Service, the Association for Gravestone Studies, and other professional conservation groups. "Common" concrete is normally inappropriate for historic cemetery restoration work. When properly installed, the headstone is protected by the layer of mortar from the damage that would result from contacting the surface of the concrete.*

Construct the female form for the base using dimensional lumber – 2 x 10s or 2 x 12s:

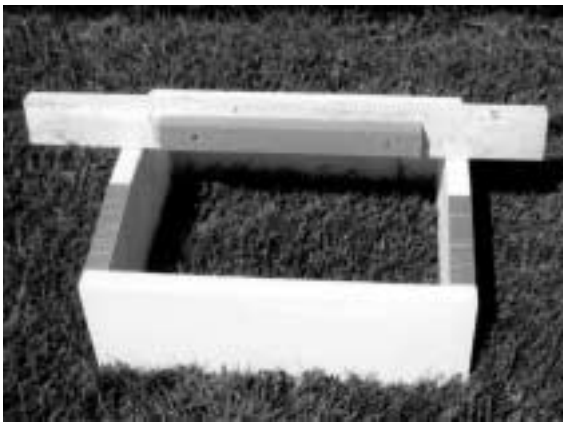
- Minimum depth – six inches plus one half inch for each 12 inches of stone height.
  e.g., the base of a three foot tall stone is about eight inches deep
- Minimum inside dimensions – top view: six to seven inches larger than the thickness and width of the stone, respectively.
  e.g., the base for a stone sixteen inches wide by two inches thick would have dimensions of twenty-three inches by nine inches
- The form for the base should create a slight (five to ten degree) downward pitch from the slot to the edge, allowing water to run away from the stone. Use screws or duplex nails (double-headed nails) to facilitate disassembly after the concrete is cured.
- To prevent the concrete from adhering to the form, cover the sides of the form with a thin plastic sheet (garbage bags or 0.5 mil drop cloth), or coat the form with linseed or motor oil.

Craft a male form or plug from wood to create the slot in the top of the concrete base:

- The male form is approximately one inch wider and one inch longer than the width and thickness of the stone, and at least two inches deep. The intent is to create a virtual half-inch gap all-around when the stone is inserted into the base. Cover the form with a thin plastic sheet to prevent the concrete from adhering.
- Screw the male form to the center of a 2 x 4 cut long enough to span the form for the base.

- Next pour the concrete into the form for the base, trowelling to shape.
- Depress the male form into the wet concrete, flush with the top of the female form. Attach the 2 x 4 to the ends of the form with screws. Trowel the concrete smooth, following the angle for water run-off.
- After the concrete has begun to harden (when the surface becomes dull-looking), remove the screws attaching the 2 x 4 to the female form, and carefully remove the male form exposing the slot. The intent is to remove the form before the concrete is completely cured (to permit easy removal). If the concrete around the slot *slumps*, replace the form immediately if possible, and continue curing. Allow the concrete base to harden for two days before removing the outer female form.

A wooden form constructed of 2x12 lumber makes an excellent material for making replacement bases. The shaded areas are angled away from the center so when the cement dries and the base is placed into service, water will run away from the marker.



A die is made from lumber so that when inserted into the uncured cement, a slot will be formed and the tablet stone can be inserted when the cement has cured.

In this picture the die is screwed to the form in the correct position so that a slot will be formed.

Set the base onto the prepared surface as described above. When resetting a partial stone, the top of the concrete base should be placed slightly above grade level (as opposed to hidden below-ground).

If the headstone that is being replaced into the base does not have a squared or flush bottom, reinstallation into the slot must be delayed until the headstone has been repaired so that it will sit squarely into the slot. Ideally the bottom area of the headstone that is missing could be recreated using infill mortar mix as described later. Another option is to craft the male form (see above) to replicate the shape of the bottom of the headstone into the base, so that the base accepts the out-of-square portion of the stone and holds it securely. Only as a last resort should any part of the headstone be removed to square up the bottom of the stone. Removal of stone should *never* be done when the artistic features or inscriptions will be compromised.

SNAPPED MARKERS – CONCEALED REPAIRS

Snapped tablets are common in older cemeteries. Repairing broken markers with epoxy or mortar requires extreme care. Improper repair methods can permanently alter the stone. However, the quality of the repair is not totally dependent on the conservator. Factors that may significantly contribute to the quality of the repair include the type of stone, the age and overall condition of the stone, the type of break, and condition of the surface. Three types of repairs are described in the following section, starting with the least complex method.

Two-part Epoxy Adhesives – Overview

Epoxy adhesives are a strong and an effective way to repair broken markers exposed to the elements. Epoxies are recommended not only by adhesive manufacturers but also by conservators. However, conservators should be aware of the following concerns with using epoxies on historic stone:

- Epoxy is not vapor-permeable. For this reason a preferred approach to covering the mating surface with epoxy may be to use only dabs of epoxy. This approach will permit the stone to breathe.
- Epoxy is very difficult to remove from the stone after curing.
- Epoxy tends to yellow and may break down with exposure to ultraviolet light.
- Working with epoxy requires the user to be neat, and to be very careful to avoid spills, oozing, and smearing. Any excess must be removed immediately with acetone to avoid additional damage to the stone.

Epoxies available at home improvement centers are typically not suitable for repair of historic stone and masonry. Those involved with epoxy repairs should be trained and comfortable with application practices before repairing any historic markers.

Types of Epoxy

Two types of epoxy that are recommended and used in historical cemeteries are *gel epoxy* and *low modulus/ low viscosity epoxy* (having the consistency of white household glue).

- **Gel Type –** This type is often referred to as gel or knife grade epoxy in that the consistency is much thicker (similar to peanut butter) than the low viscosity type. It is less messy to work with because it tends not to flow or leak out of cracks as easily as the low viscosity type. Some conservators recommend using knife grade epoxy for use in drilled holes when blind-pinning repair of stones.
- **Low-modulus/low viscosity –** A flexible (low-modulus) two-part epoxy that provides flexibility under stress from impact and thermal change is recommended for bonding close-fitting stone pieces, and for blind-pinning of broken stones. See appendix for recommended sources of epoxy products. Many conservators prefer low modulus, low viscosity epoxy, because it can be used for several tasks; e.g., pinning, crack stabilization, and bonding broken stone fragments.

Brands of Low Viscosity Epoxies that are recommended:

- Mastico – Available in a clear and a white version from Hilgartner Natural Stone Company. A good color match can often be achieved by adding stone dust to the clear product. www.hilgartner.com.
- Akepox 2010 – A very economical solution. Available from Architectural Stone in Troy, Michigan. The complete line of Akemi epoxy products is available through most monument dealers. Tinting agents are available.
- Barre Pak – A conveniently-packaged product that is pre-measured for consistent results. This product is very volunteer-friendly. Available in gray color in a seventy gram plastic pouch. Mixing is done in the pouch. Available at Miles Supply Company Inc., PO Box 237 Barre, VT. 05641-0237. (802) 476-3963.

Using Two-Part Epoxy

General directions for mixing epoxy (always consult manufacturers' recommendations):

- Prior to any repair, and especially before mixing or applying epoxy, the stone pieces should be dry-fitted to observe the fit of the mating pieces, and to assess the best method for repair.
- Carefully read and understand the manufacturer's specifications. Mix the two epoxy components per instructions provided.
- *Working Time* is the length of time during which the epoxy mixture is still workable and can be applied; i.e., before the epoxy begins to set. Working time at 70˚ F can vary from only a few minutes to an hour or more, depending on the type of epoxy and the amount of hardener used in the mixture. Cooler temperatures will increase the working time; at higher temperatures the epoxy begins to set up faster. *Consult manufacturer's specifications.*
- *Cure time* is the time after which epoxy achieves a high percentage of its maximum hardness and working strength; typically 24 hours at 70˚ F. Cooler temperatures increase the required cure time; at higher temperatures epoxy cures faster. *Consult manufacturer's specifications.*

Preparation of Fractured Surfaces for Repair with Epoxy

2 Inspect the mating surfaces for cracks or "sugaring" on the surfaces. If cracks are observed, consult a professional curator. If sugaring is found on the mating surfaces, abrade the surface with a wire brush to provide a sound surface for bonding.

- Dry-fit the stone pieces, and inspect for gaps and/or missing pieces. Missing pieces can be replaced later with infill mortar – see below.
- Clean the mating surfaces using water and a brush. Use denatured alcohol to clean any remaining residue. Apply acetone to dry the surfaces.

Types of Repairs

1 Type 1 Repair – Epoxy Only

The simplest method for joining sections of broken markers is using epoxy-only. This method works best for a clean break with close-fitting stone pieces. The primary advantage is that the epoxy tends to fill the cracks to the edge, with no grout or infill required. A strong disadvantage is that the epoxy, which covers the mating surfaces, minimizes the vapor permeability between the joined sections of the stone, and the repair is more permanent than the second alternative (using epoxy dabs and grout). However, because it requires no drilling or other modifications to the stone, and uses only one repair material, it may be a preferred method for non-professional conservators.

- Before applying any epoxy, the mating surfaces must be clean and dry. Mix per manufacturer's instructions and apply epoxy on both sides of the mating surfaces, leaving 3/8 to 1/2 inch uncovered margin around the edge.
- Carefully replace the upper half of the stone onto the bottom piece, and shift or rock slightly to insure full mating of the epoxy, for a good bond. If any epoxy oozes out of the crack, clean it immediately with acetone, or trim or gently peel off later when a skin has formed on the epoxy (well before it has fully cured). After assembly, use bar clamps or "C" clamps, with lengths of 1 x 2s to protect the stone from the clamps. Brace the assembly if required to prevent shifting. Remove the braces after the epoxy has cured. *See manufacturer's specifications.*
- No epoxy should be visible after the repair has been completed. The tendency for epoxy to yellow and weaken when exposed to UV rays makes this consideration important. Based on the condition of the break, it may be necessary to fill the remainder of the crack with infill mortar mix or grout.

2 Type 2 Repair – with Epoxy "Dabs" and Grout

The second method for repairing snapped markers uses dabs of low-modulus epoxy adhesive with cementitious (mineral-based) grout in the remaining cracks for additional adhesion. The grout is applied after the epoxy is cured. The following repair is for tablet stones with the top portion of the marker broken off, and the bottom portion still soundly mounted in the base or in the ground.

The three advantages of this repair: 1) It is less likely to damage to the stone, compared with blind pinning (see below), 2) the repair can be accomplished by trained volunteers, and 3) because the broken surface of the stone is not fully covered with epoxy, the stone therefore is allowed to breathe. However, applying grout, which is the most difficult part of the procedure, may require drilling injection ports (holes) in the area of the crack, and careful attention must be paid to avoid possible staining of the stone by the grout.

Applying the Epoxy – Before applying any epoxy, the mating surfaces must be clean and dry. Mix epoxy per manufacturer's instructions. Apply two or three quarter-sized dabs of epoxy (one inch [2.5 cm] in diameter) on both sides of the mating surfaces. Applying excess epoxy (i.e., over the entire mating surfaces) should be avoided, to make the repair more reversible, and to provide clean mating surfaces at the edges for the grout to bond to the stone.

Joining the Stone – Carefully replace the upper half of the stone onto the bottom piece, and shift or rock slightly to insure full mating of the epoxy for a good bond. If any epoxy oozes out of the crack, clean it immediately with acetone. After assembly, use bar clamps or "C" clamps, with lengths of 1 x 2s to protect the stone from the clamps. Brace the assembly if required to prevent shifting. Remove the braces after the epoxy has cured (see manufacturer's specifications).

Filling Gaps with Grout – Apply a mineral-based, vapor-permeable, low viscosity grout in the cracks as a supplement to the dabs of epoxy, which will improve the overall strength of the repair. If the corners of the mating surfaces are beveled or rounded, grout will fill the resulting gaps of 3/16 to 3/8 inch. Jahn M40 Crack Injection Grout (available from Cathedral Stone Products) or an equivalent product is recommended. Before working with grout, refer to the details available on the *Cathedral Stone* website. Grout injections should be attempted only after practice attempts on discarded stone fragments or on landscape stones, and only when the repair team has become comfortable with the repair process. The following is a brief summary of the manufacturer's recommendations for preparation and application:

- Wash the cracked surfaces using water to remove dirt and foreign material.
- Mix the grout per manufacturer's directions. Immediately before injecting the grout, wet the crack by flushing with water. Apply *non-staining, non-oil-based clay* (available from Cathedral Stone Products, Inc.) to the crack to act as a dam to retain the grout when injected. The intent is to prevent grout from escaping from the crack and soiling the face of the stone. *Detailed instructions for Mixing, Application, and Curing are contained on the Cathedral Stone website.*
- This method requires drilling ports or holes in the crack, using a carbide-tipped drill, to permit injection of grout. The diameter of the hole is approximately the size of the crack, and is intended to permit distribution, via injection of the grout throughout the crack. Follow the detailed manufacturer's instructions.
- Allow the grout to dry for approximately forty-eight hours. After the grout has cured remove the clay from the stone.

> *Caution:* If grout is left to dry on a stone, it will permanently damage the stone. Clean up any grout overflow immediately with water. Extreme care should be exercised.

Type 3 Repair

Blind Pinning (modified from the Oregon Historic Cemeteries Association website / CRM Bulletin)

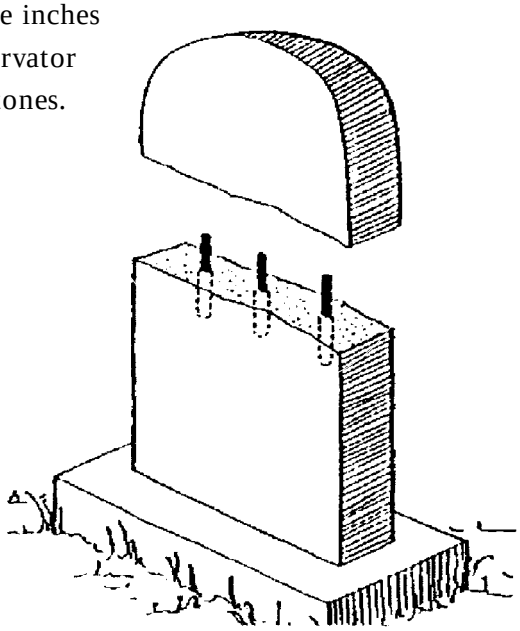
Overview – A clean break between sections of gravestones may be repaired by blind pinning, which involves drilling holes into both stone fragments and inserting nylon or stainless steel reinforcing pins or rods. Epoxy is used in the holes to adhere the pins.

Blind pinning is the most difficult of the three repair processes, as well as the most risky and most permanent repair, compared with repairs that do not use pins. Therefore, it is usually not the preferred method of repair, especially for non-professional conservators.

Another serious concern is that pinned stones in cemeteries that experience frequent vandalism may experience collateral damage if re-broken; i.e., the drilled holes can be blown out, requiring extensive and visible infill repairs. This option however is the repair method chosen when the break is located near to the ground, and additional support is required to prevent future snapping. Often, repairs close to the ground (within two or three inches) fail prematurely when epoxy alone is used.

Special Concerns:

Only professional conservators and skilled craftsmen should attempt this type of repair. However, this method has been learned and applied by trained and skilled individuals. Blind pinning should only be undertaken on a stone in sound condition. Pinning is usually done only on stones that are three inches thick or greater. Only an experienced conservator should attempt pinning on two inch thick stones.

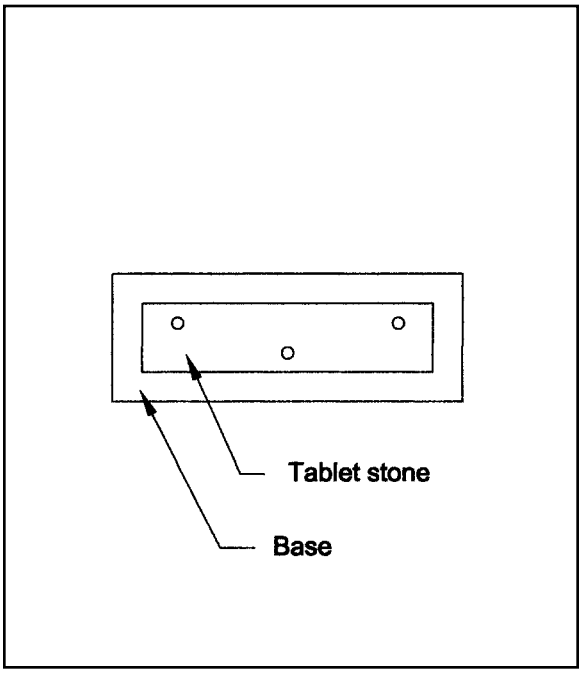


Repair of snapped marker using nylon or stainless steel dowels epoxied into their holes. Dabs of epoxy can be used to secure the two pieces together while grout can be injected after the epoxy has cured to reinforce the repair. Knife grade epoxy can be used for the dabs of adhesive and for securing the dowels to the holes.

2 3 Blind Pinning – Instructions

1. Clean surfaces to be joined and allow to dry. Dry-fit the mating pieces. If the stone is out of the ground or has fallen from its base, arrange the pieces on the workbench and determine the location for the holes to be drilled. If not, the difficult job of aligning and drilling the holes will have to be done on-site.

2. Drill two or three holes for pinning using carbide-tipped bits. If the third hole is used, offset its location from a straight line to minimize the chance of splitting along the grain of the stone (see sketch). Impact drills should not be used because of possible damage to the stone.



When using dowels in the repair it is best to offset the middle dowel to avoid the chance of weakening the marker along a bedding plane.

a) Accurate placement and alignment of holes is difficult and critical. Drill the holes parallel to the axis of the monument and accurately aligned with opposing holes.

b) Hole size – The diameter of the holes should be about 1/4 inch larger than the pins, which allows for some misalignment of the holes. Hole depth in *each* stone should be about two inches; with total depth of four inches– about one inch greater than the length of the pin.

c) Save the small amounts of stone dust for possible use in tinting mortar. Clean out the holes with compressed air.

3. Pin size – For a three inch-thick stone, use 3/8 or 1/2 inch diameter pins– three inches long. (For a two inch-thick stone, smaller 1/4 inch pins are used to minimize the chance of splitting). Use non-corrosive pins such as nylon with threads or grooves for good adhesion. Non-stainless steel rods are not desirable, because of rusting or staining, and higher thermal expansion vs. stone.

4. Dry fit with pins installed. Apply epoxy adhesive to the holes in the stone. Coat the nylon pins with epoxy and place in holes.

5. Apply two or three quarter-sized dabs of epoxy (about one inch diameter) on opposite sides of the mating surfaces per the Type 2 Repair (above). *Note:* Type 1 repair methodology (above) – with epoxy spread over the mating surfaces – may also be used when the mating surfaces have a close fit.

6. Set detached pieces (with pins) in place. Gently rock to assure full mating of the epoxy. Clamp the stone to align the two stone pieces, using bar clamps with wood spacers. Avoid contacting the stone with metal clamps or tools.

7. Excess epoxy can be removed with acetone, or trimmed by carefully scraping before fully cured. After the epoxy has cured, remove the clamps. Fill any voids left in the stone using grout or color-matched mortar (see above).

8. Cementitious mortar can be used to fill any remaining gaps.

2 III 3 Missing Stone Fragments

Missing fragments of damaged headstones or bases can be replaced using mortar infill to approximate the original shape of the monument. Proprietary (premixed) mortars are available, or mortars can be made on-site from a specific formula.

The color of the mortar can often be closely matched to the stone; when dry, infill-patch can achieve a similar texture to the stone. When attempting to match the color of infill mortar to the stone color, it is desirable to err with a color lighter than the stone. Infill can be darkened with judicious use of stain after curing, but a darker color cannot be lightened. Stone dust (crushed stone made from stone fragments available at monument makers) can be used to achieve the desired color. Stone dust is also available from conservator supply companies and masonry supply stores.

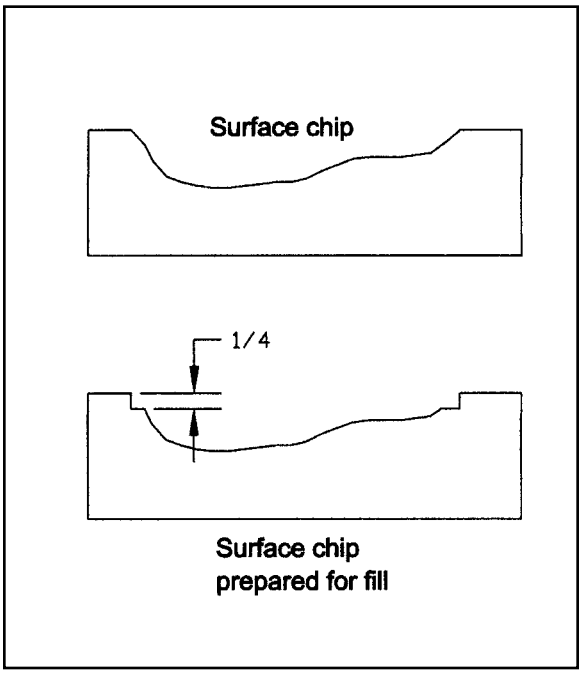
Extreme care should be exercised with infill repairs. Avoid spilling infill material on areas where not required, because discoloration or staining of the stone can occur. Use only proprietary mortars, or specific mortar formulas suitable for the application. Only experienced teams should carry out infill repairs. Before attempting infill on historic markers, conservators should practice on discarded stone fragments or on landscape stones. The following process is time consuming and requires meticulous workmanship.

Preparing the Stone for Infill

The following instructions were taken from the Cathedral Stone Products, Inc. web site.

2 3 Do not apply mortar on a section of stone that has an obtuse (blunt) angle on the fracture at the surface. The resulting feathered edge of mortar would be weak and vulnerable to chipping and premature failure.

To correct this problem, grind a square-cut 1/4 inch notch or recess into the beveled/fractured surface. (See sketch) This provides a more square (vs. sharp-edged) mortar section, which also increases the bonding surface area and decreases the possibility of future joint failure. Minimize any grinding on the *finished* surface of the monument, which would affect its appearance.



Chips and breaks need to be prepared as shown in this illustration. A feathered edge repair is prone to failure.

Similarly, when preparing to use infill to fill any voids in the stone, grind a square-cut notch to minimize the sharp thin edges of the mortar. This process is recommended by Cathedral Stone Products Inc., as well as other professional conservators.

Applying Mortar

- Prior to applying mortar, wet the stone with water to avoid absorption of moisture from the mortar by the stone and a resulting weak mortar joint. Avoid leaving puddles of water, which will weaken the cured mortar.
- Apply the mortar by building up thin layers to minimize voids. Work the mortar into any cracks or crevices along the break line. The surface of the mortar should be one-quarter to one-half inch higher than the desired final surface when the initial application of mortar is completed.
- When the surface of the mortar fill has begun to *partially* set, gradually tool (scrape) the mortar to the finished size and shape. Use a stainless steel "screed" or other flat tool that will not stain the mortar. Contouring the infill surface to the desired shape (prior to complete curing) is similar to the work of a sculptor or mason. As the mortar hardens, continue tooling until the remaining high (proud) surfaces are flush with the original surface, or to the desired contour. Practice on discarded stone fragments or on landscape stones.
- Carved designs, tooling marks or textures, and even partial word inscriptions can be added using sculpting tools when the infill mix is still workable. Photographs or other records can be helpful in determining any wording or other original features that may be missing. Texture or surface finish close to that of the original stone may be achieved by using a variety of brushes or tools. A smooth finish will usually dry to a lighter color than a slightly textured or stippled finish.

Keep Infill Moist During Curing – Infill repair areas should be kept moist and covered for at least twenty-four hours, especially if a large amount of fill has been used. Use damp towels to keep the area moist for one day, and / or keep the area covered with plastic sheets. Shrink wrap available at office supply stores can be used to wrap the repair after it has cured to the extent where the application of the wrap will not alter the desired form. Dampen the surface several times for several days using a spray bottle of water if shrink wrap is not used.

Note: Always check the manufacturer's directions for brand-specific detailed instructions for proprietary grout mixes; i.e., preparation, mixing, application, curing and other specific information. For example, Cathedral Stone Products, Inc.'s website contains comprehensive instructions for proprietary Jahn M70 mortar.

Clean-Up

Remove uncured mortar from the periphery of the repair area before it is dried. Use clean water and a closed cell sponge. Repeat several times to prevent a halo-effect (staining of adjacent masonry).

Repairing a Stone Monument Base Using Infill

Infill mortar mix is often used to repair the area of the base (slot) where the tablet is inserted. First reattach any stone fragments using epoxy. Where fragments are missing, the remaining voids will require application of infill. Because of the high stress in the slot where the stone is set, nylon or stainless steel pins (set in holes in the stone, protruding into the infill) may be needed for reinforcement (see Blind Pinning section for instructions on drilling holes).

A male form or plug is crafted to form the slot in the infill for the tablet (see concrete base fabrication section). Remove the plug after the mortar has been allowed to partially cure. Premature removal will result in the uncured infill sagging into the slot. Trowel the mortar for the final contour. (Tooling practice is described in Applying Mortar section.)

Selecting Mortars and Grout

Mortars are used in a variety of applications in the cemetery. Because of the many different applications, including the various stone materials, no one mortar will work for all re-pointing tasks. Because of the interaction between the stone and the mortar, the type of stone and application will dictate the selection of a mortar mix.

It is important to use mineral-based mortars (containing white Portland cement and lime) when repairing damaged historic markers. Premixed products containing latex or acrylic additives commonly found at home improvement centers are *not compatible* with stones in historic cemeteries. Because these "modern" products are so commonly used, it is often difficult to find a mason with experience using traditional lime-based mortars. The International Masonry Institute and Michigan Historic Trades Network are good resources for masons that have experience working with lime based mortars. (The addresses are in the source appendix.)

Material properties of stone and characteristics of mortar mixes are discussed on many internet sites, several of which are identified in the appendix.

Mixing mortar from scratch components, using a formula, is not difficult, and may be less expensive than proprietary mixes. It also offers the user the greatest latitude for custom-matching aggregate size, and to some extent, strength and color characteristics.

However, premixed (proprietary) mortars offer tested performance and uniform characteristics, with little variation from batch to batch. Although slightly higher in cost than mixing mortar from recipes, proprietary mortars offer volunteer workers an easy-to-use alternative with proven results.

Ingredients of Mortar

Mortar is made up of four basic components: water, sand, lime, and white (not gray) Portland cement. The strength of mortar can vary significantly depending on the proportions. Increasing the percentage of Portland cement yields higher strength mortar. More lime results in a softer, more plastic mix with improved workability.

Sand – A primary ingredient in mortar, sand gives the mortar its color and texture. Washed sand crystals that have worn, rounded surfaces (vs. sharp crystals) should be used for work on historic stone. Washed sand improves the workability of the mortar mix, and will result in a finished appearance similar to the historic mixes.

Binders – Portland cement and lime are the two commonly used binders. A high lime mortar is a soft mortar that can resist failure due to temperature changes, and is water-soluble and able to reseal hairline cracks. High concentrations of (white) Portland cement give higher hardness, but shrink more upon setting, resist migration of water, and have greater thermal expansion and contraction. These properties are undesirable on historic stone. It is important to use a suitable mixture for the type of stone and application.

As a point of reference, American Society of Testing Materials (ASTM) Type K mix is a low-strength (75 psi compressive strength) mortar, consisting of one part cement, three parts lime and ten parts sand.

Other Mortar Specifications – ASTM C 270, Specification for Mortar for Unit Masonry defines four types of mortar; with different compressive strength, air content, and water-retention abilities (cured products):

- Type S (avg. compressive strength of 2,500 psi.)
- Type M (avg. compression strength of 1,800 psi.)
- Type N (avg. compression strength of 750 psi.)
- Type O (avg. compression strength of 350 psi.)
- Type K (average compressive strength of 75 psi.) — Not included in ASTM C270 since 1984 but still used in historic applications.

Special Properties of Mortars

Mortars are selected on the basis of their ability to react to the environment similar to the substrate (stone). Avoid mortars with acrylic or latex binders because they inhibit the ability of the stone to breathe and allow salts to become trapped, causing damage to the stone.

Proprietary mortars such as the Jahn products, offered by Cathedral Stone Products, Inc. in Maryland, are single-component, cementitious, mineral-based mortars designed for specific stone types and applications. **Some proprietary mortars require special training and certification to purchase and install.** Firms that make mortars for historic repairs can be found in the appendix and on the internet.

> *Note: Mortar repairs are to be viewed as sacrificial; i.e., if the repaired stone breaks again, it is intended that the repaired joint will fail, not the material of the stone.*

Non-proprietary Mortar Mixes

The white Portland and lime mixes described below have both the plasticity necessary to insure a good bond, and lower hardness compatible with historic stones. Because these mortars closely approximate the strength, permeability and appearance of older mortars and stone, they are appropriate for their respective application (from *John Walters Recipes for Mortar Mixes* – www.rootsweb.com/-inpcrp/mortarmixes.html).

Slot Mix – A mixture used in the *slot* of a monument base when replacing a tablet stone. Mix the following dry components (by volume):

- One part white Portland cement
- Four parts hydrated lime
- Eight parts clean sand
- Water (Very little water is needed for this mix. It should be very stiff and dry looking.)

Stack Mix – A mixture used to set (stack) a marker onto a *flat stone* base. Mix the following dry components (by volume):

- One part White Portland cement
- Three parts hydrated lime
- Water (Very little water is needed for this mix. It should be very stiff and dry looking.)

Both the headstone and the stone base must be clean and sound. Remove all dried mortar from the base or stone. Masking the base stone to the size of the footprint of the headstone will avoid excessive clean up. Dampen the bottom of the headstone and the base with a spray bottle of water, to insure that the stone does not absorb water from the mortar.

- After pre-wetting the base and stone, apply a one-half-to one-inch-thick layer of mortar onto the top of the stone base, covering the outline of the stone. Set the headstone on the base. Use wooden braces for support if required.
- Completely fill the gap around the stone and the base. Create a one-eighth inch mortar fillet at the intersection of the stone and the base to help shed water. After the mortar has dried, usually in a day or two, the braces can be removed.

Infill Mortar Mix – Another basic mix, often used in historic cemeteries to replace missing fragments of stone. The intent is that the dried mortar closely matches the stone being repaired both in color and texture. The choice of aggregate (e.g., sand or stone dust), will dictate the color and texture to some extent. Stone dust, available at sand and gravel / landscape suppliers, or made by crushing stone fragments, can provide a variety of colors and textures. Experiment with different aggregates and check for color-match when dry. If a close match cannot be achieved, choose a lighter colored aggregate, and color the mix with grout dye to match. Mix the following dry components (by volume):

- Two parts White Portland cement
- Four parts Hydrated Lime
- Seven parts stone dust (aggregate) from the parent stone if available
- Water (Very little water is needed for this mix. It should be very stiff and dry looking.)

An infill repair is done not only to improve appearance but to reinforce a repair. Here the repair is done so that the finished edges are of the same worn appearance as the rest of the marker. From a few feet away the repair is indiscernible.

MASONRY REPAIRS AND REPOINTING

Structures in the cemetery such as brick walls, public vaults and other masonry features, while considered *permanent*, are subject to deterioration of the mortar joint. Properly mixed and installed mortars shed water from the masonry, and act as a cushion or buffer against thermal expansion and contraction. Damage caused by stress is intended to occur in the mortar joint, rather than in the stone or brick. Repointing deteriorated joints is an important factor in assessing the maintenance needs of historic masonry structures. A well-prepared and installed joint should last at least twenty to thirty years, although much longer life can be expected under optimum conditions.

Repointing

2 Repointing is the process of cleaning loose mortar from a deteriorated joint, and replacing it with fresh mortar. Using a hammer and chisels, or a grinder, clean out all old mortar from the joint to a depth two to three times the width of the joint. Using an incorrect mortar mix can result in premature failure of the joint and damage to the structure itself. Improper preparation and cleaning of the joint, or a joint with insufficient new mortar, can also lead to premature failure.

The philosophy that “stronger is better” is a common mistake in selecting mortar. Mortar used on historic stone must be flexible to allow for movement while maintaining the bond to the substrate.

A mason experienced with historic lime mortars may be a better choice for larger repointing projects. However, if the following factors are considered in selecting a mortar mix, experienced non-professionals can achieve satisfactory results.

- Compression strength of the mortar – the objective is to match the strength of the existing mortar.
- Type of stone with which the mortar will interface.
- Permeability – a more rather than less permeable mix is usually desirable.
- Type of mortar existing in the joints. (with which the replacement mortar will be interacting)

Pack the mortar in the joints carefully to avoid voids and gaps. Avoid getting mortar on the surface of the bricks. Every attempt should be made to finish the joint with the finished profile and texture the same as the original joint.

Using laboratory tested pre-mixed proprietary mortars may be cost-effective compared with failure of the mortar and masonry.

> *Caution: Pre-mixed mortars available at home centers are too hard and strong for use in historic applications. If possible, have the existing mortar tested to determine its properties.*

GSA Recommended Mortars

Listed below are four mixes recommended for the respective applications in the U.S. General Services Administration Historic Preservation Technical Procedure 04100-03.

Dry components are combined before water is added. *Very little water is needed for these mixes; they should be very stiff and dry looking.*

Historic Masonry Set in Lime Mortar

- One part White Portland Cement
- Three parts lime
- Eight to twelve parts of sand to match existing texture (exact mix will vary due to grain size and will also affect final compression strength)
- Water to give a dry but workable consistency

Historic Masonry Set in Standard Mortar (approximates the ASTM Type "O." See Appendix)

- One part White Portland Cement
- Two parts lime or lime Putty
- Six to nine parts sand or stone dust to match existing texture
- Water to give a dry but workable consistency

Mortar for Use on Limestone (approximates ASTM Type "N." See Appendix)

- One part White Portland Cement
- One part lime
- Four to six parts aggregate
- Water to give a dry but workable consistency

Mortar for Use on Granite (approximates ASTM Type "S". For granite that shows deterioration, or walls indicating movement, use ASTM Type "N" as indicated for limestone.)

- Two parts White Portland Cement
- One part lime
- Seven to nine parts aggregate
- Water to give a dry but workable consistency

EXISTING REPAIRS, SPECIAL BRACES, AND GIRDLING

Older cemeteries display ingenious ways of retaining and supporting markers and marker fragments. While many of these historic repair methods are contrary to traditional conservation standards, many of these repairs have been at least effective. With their unique characteristics, they have become a part of the historic fabric of the cemetery. How the repair is treated (and conserved) becomes an important consideration.

"Do No Harm" Criteria

In some situations, the condition of the stones, or the resources available, may warrant using similar unconventional methods. *The rules identified earlier of "do no harm" and "do that which is reversible" still apply*. It is generally accepted that a stone fragment is 'better off' standing up than lying in the ground; therefore some of the unconventional methods can make good temporary fixes. Braces to hold up the stone, or girdling / banding to hold the stone together, may be effective. While this type of unique repair is sometimes acceptable, it should not be implemented on a large scale; thus widespread use is not advisable. Repair materials selected should cause no damage to the stone, including rust stains from iron or steel used in a repair.

In rare circumstances, unorthodox repairs such as this application serve its purpose. The metal braces used are stainless steel and do not restrict movement of the stone while it still holds the marker upright.

OLD REPAIR METHODS

Iron & Steel

Some older stones have been reinforced or repaired with steel angle or channel, or fastened with bolts or threaded rods through the stone. Steel banding or other bracing devices may also have been installed. Careful evaluation of these old repairs is critical. If the stone does not appear to be in imminent danger of failing, it may be best to leave it alone. If it is necessary or desirable to rework old repairs, a professional conservator should be consulted for corrections. Using steel or iron to shore up a monument is not an acceptable practice.

Drilling through a marker to affix braces is never an acceptable alternative.

Girdling

Professional conservators have used stainless steel channel to girdle stones that have broken, or are judged susceptible to failure. Although not desirable, girdling may be appropriate to prevent theft, accidental breakage and damage, or accelerated deterioration.

- A channel section, slightly wider than the thickness of the stone, is fabricated from high-grade 304 stainless steel, and installed along both edges of a tablet stone. The width of the front flange (3/4") is usually shorter than the rear, to minimize obscuring the inscription on the face. The channels are set in concrete footers to support the stone. Use metal tools with caution around gravestones.
- To stabilize and isolate the stone from the channel, lead wedges, lead rope, or lead wool (available from plumbing suppliers) is packed into the gap between the stone and the channel. Using lead requires attention to safety measures, including all applicable OSHA regulations.
- Use materials that will not adversely react with the stones; e.g., 304-grade stainless steel (vs. mild steel). Do not use silicone sealant or caulks. Because repairs should be reversible, drilling holes through the tablet to secure the channel is not desirable.

Professional conservators have in unique situations, girdled a marker with stainless steel channel. Here the repair is not easily seen and has not compromised the stone.

Tablet Stones Laid In Concrete

2 **3** In older cemeteries, broken stones are sometimes laid flat (imbedded) into a bed of concrete, with the intent of protecting them. Although this reflects an earlier attempt to make a repair, we now understand that the integrity of a stone in this position is compromised because it is now more susceptible to damage from maintenance equipment or from pedestrians. It may also be stained from being covered with leaves and turf, and has little chance of ever completely drying out.

However, removal of the stone from the concrete bed would result in even greater risks to the stone, and should not be attempted. Modifications to prior repairs such as this should be attempted only if the prior repair poses a safety hazard to maintenance crews and the general public.

Instead, carefully clean debris from the stone and the concrete, and identify the edges of the cement pad. Divert vehicle and pedestrian traffic by installing black anodized aluminum landscape edging into the ground around the concrete pad, secured with spikes, and extending approximately two inches above grade. Holes can be drilled into the edging for drainage if required.

Setting broken markers in cement is not an acceptable practice, but removing stones that have been set in concrete is too risky.

Temporary Removal

It may be necessary to temporarily remove a marker of special/unique character from the cemetery for safekeeping until appropriate repair methods can be implemented. Before it is removed, record the location of the stone for future replacement. If the marker will be removed from the grave for some time, a temporary marker should be placed in the location of the original.

Burying a Stone Temporarily

When facilities for temporarily storing broken stones are not available, or when a cemetery is subject to vandalism, another option (and a last resort) is to bury a piece (or pieces) of stone for safekeeping. Bury the stone where it was located. The location must be identified, and the record placed with the cemetery survey to assist in future replacement.

- Dig a hole in front of the existing stone – about eight inches deeper than the thickness of the stone, and large enough so that the stone pieces can lay flat. Tamp the bottom surface and place pea-stone on the bottom to facilitate drainage.
- Place the stone in the hole on top of the pea-stone and cover the marker with geo-textile fabric (available at landscape supply houses). Cover the stone and fill the rest of the hole with clean fill sand. Gently tamp – avoid cracking the marker.

SPECIAL REPAIRS – TABLE AND BOX TOMBS

Because of their special conservation needs, trained and experienced professionals should service these monuments.

Table Tomb

Table tombs may be warped due to improperly installed or deteriorated supports. The conservator may be able to reverse warping by removing the tablet, placing it upside down, and supporting it in a pool of water; with the intent of allowing it to gradually return it to its original (flat) shape. Add additional structural elements to support the top of the tomb, or repair and reinforce existing supports. The details for this work are outside the scope of this book. A professional conservator should be contacted for an assessment.

Box Tomb

Box tomb repairs should also be left to trained conservators. Often the corners, which may be pinned with metal fittings, are damaged as the pins rust and expand. As a result, the top of the tomb may have collapsed, damaging both the top and the sides.

Special Repair Criteria for Box and Table Tombs:

- It is important to retain as much of the original structure of tombs as possible. Even when the inscriptions are illegible, these tombs constitute an important element of the historic fabric of the cemetery.
- Lime mortars should be used as described above. Concrete is used only where footings need replacement.
- When replacing metal components, use high quality 304 stainless steel.
- All surrounding vegetation should be removed (or relocated if the plant is an heirloom variety) to avoid damage due to future plant growth.

A table tomb in very good condition.

A box tomb in fairly good condition. Note the stone delaminating on the right corner of the monument.

Chapter 4

MANAGEMENT AND MAINTENANCE OF THE CEMETERY

After documentation of the cemetery is complete and conservation has begun, it is time to turn attention to management and maintenance requirements. Each cemetery plan will depend upon its community's unique requirements, resources, and manpower. The creation of a local cemetery ordinance is a useful tool in planning for the long term management of the cemetery.

DEVELOPING A CEMETERY ORDINANCE

An ordinance helps to regulate the maintenance, funding, preservation, ownership, access and other issues related to both historic and modern cemeteries. Writing and adopting a local ordinance is time consuming, but worth the effort.

Identify a commission, a township board member, or a city council member that will support the ordinance. It will probably be necessary to educate local officials and commissioners regarding the conditions of historic cemeteries and the need for more specific regulations designed to preserve the integrity of these cultural resources. Once local officials recognize the need for regulation of historic cemeteries, work with these officials and the

city, village or township attorney to draft an ordinance. Provide a sample ordinance containing a list of issues to be addressed. The following are suggestions:

- Protection of the cemetery from vandalism and theft
- Preservation and conservation of the historic cemetery and its artifacts and planting
- Protection of the cemetery from the unlawful removal of human remains
- Lawful relocation of human remains from an actively used or abandoned cemetery
- Protection of the cemetery from the removal of funerary objects
- Development of land that contains a cemetery
- Legal accessibility of cemeteries located on private property
- Specific locations and needs of military veterans' grave markers
- Guidelines related to removal, replacement, and repair of objects associated with a cemetery
- Illegal possession and sale of gravestones and funerary accessories
- Sale of a cemetery
- Use of the Secretary of the Interior's *Standards and Guidelines.*
- Authority to acquire or manage the cemetery
- Authority to raise / appropriate money for conservation and maintenance
- Supervisory body that will oversee management and finances (e.g. city council)
- Rules and regulations of the cemetery
- Process to appeal rules and regulations
- Sale of lots including prices of lots and services
- Lot records required
- Registration of interments
- Funerals and interments (rules)
- Preparation and filing of plats
- Perpetual care fund (investment of assets, use of assets, administration of assets and transferring the fund)
- Memorials (monuments and markers: definitions, use, restrictions)
- Neglected or abandoned cemeteries

The above list, compiled from the Chicora Foundation, "Grave Concerns, A Preservation Manual for Historic Cemeteries in Arkansas," and The Association for Gravestone Studies (AGS), should serve as a guide in the creation of an ordinance, a strongly recommended addition to a list of long-term goals. A sample ordinance prepared by Theodore Chase for The Association for Gravestone Studies is available on the association's website.

PLANNING FOR MAINTENANCE

A burial ground that is properly maintained is pleasant to visit and discourages vandalism. After the cemetery landscape is documented and the initial cleanup has been done, it is time to plan for ongoing maintenance. Maintenance choices may depend upon the budget of the cemetery organization or community. Every cemetery is different and has individual needs.

Short and Long Term Maintenance Goals

Both short and long term maintenance goals should be developed. Much like the prioritization of tasks concerning the repair of monuments, the priorities of landscape preservation and conservation begin with safety and emergency stabilization issues. For example, the removal of tree limbs that are broken or diseased and are potentially hazardous should be addressed immediately. It is important that trained, insured, professionals address safety issues as early as is reasonable.

A maintenance schedule should be part of a cemetery's master plan or preservation maintenance plan. Goals will depend upon the cemetery's needs. Some examples are:

Short term goals:

- Safety and emergency stabilization
- Weeding
- Pruning
- Mowing
- Collection of trash

Long-term goals:

- Strategies for lawn care
- Resolving erosion problems
- The preservation or replacement of trees and smaller plants

SOIL AND TURF MANAGEMENT

Testing and Amending the Soil

2 Before investing any time or resources on the reestablishment of plants or introducing new plants into the cemetery, test the soil. Nutrients cannot be transmitted to the plants effectively if the soil itself inhibits the plants from absorbing the nutrients added during the fertilization process. A soil that has a pH level between the 6.0 to 7.0 range is recommended.

Test kits are available at local nurseries and landscape companies. More extensive testing can be done through a local agriculture extension service. It may suggest what micronutrients are required to bring the soil pH up to a desirable level. This modification can usually be accomplished over a period of about two years, depending on how much adjustment is required. Soil testing should be done in the cemetery every three or four years. Keep a record of any amendments to the soil in order to chart progress.

Any soil amendments made in the cemetery will eventually be wicked up into the markers. With this as a consideration, it is important that those applying amendments have the chemical formulations of each product checked by a knowledgeable professional prior to application to prevent potential damage to headstones and other features. Formulas that are acidic should be avoided, as they will damage marble and limestone. Formulas that contain salts should be avoided as well. Ideally, use a slow release, nonacid, organic fertilizer. Be very careful when applying any chemical to the cemetery. Always blow off or sweep off excess chemicals that may have come into contact with the markers.

Lime

The application of lime will help adjust the acidity level in the soil. It will also change the structure of the soil so that it will decompose organic matter more quickly, hasten bacterial action in the soil and enhance the translocation process of micronutrients from the soil to the plants. The application of lime is done only when soil test results indicate a need to adjust a soil's acid level. Lime should not be applied to soils in conjunction with animal manures and nitrogenous fertilizers, as the combination causes a rapid release of ammonia, which can burn plants.

Fertilizer

If the decision is made to fertilize, it is important to supply the turf with no more than one pound of nitrogen per one thousand square feet. It is always best to supply fertilizer in light, frequent applications as opposed to infrequent heavy applications. Generally speaking applications can be done on or around the first week of June, September, and November. It is important to follow manufacturer instructions when applying fertilizer and irrigation should be adjusted to complement the introduction of fertilizer. A slow release formula with a 3:1:1 ratio is suggested for most applications.

Although a strong stand of turf usually requires fertilizer to maintain its vitality, over-application to enhance growth will require more maintenance to keep the look of the cemetery acceptable to modern standards. Furthermore, because fertilizers contain acids and salts, the routine application of fertilizers is discouraged. A balance must be struck between the health and vitality of the turf and the important considerations of stone conservation.

Herbicides and Insecticides

The routine use of herbicides is discouraged. Their use should be restricted to eradicate noxious plants such as poison oak and poison ivy. Insecticides should be used only in the case of serious infestations. Indiscriminate application of any chemical in a historic cemetery should be avoided. The probability of damage to the markers is much greater than the benefit gleaned from the chemical application.

Soil Compaction

Soil compaction is the single largest killer of turf. Failure to maintain the subsurface portion of the turf disrupts the balance of the turf and leads to a steady decline. Often the decline is blamed on insect infestation, disease, improper watering, or poor fertilization practices. Aeration helps eliminate thatch. The unmanaged build-up of thatch will make the lawn suffer. Ideally the cemetery should be aerated twice a year; though once a year is often adequate. This can be done with three-quarter inch hollow core tines that penetrate no more than three inches deep. It is best done during periods of active turf growth such as spring, early summer, or fall and when the soil is moist to insure full tine penetration. Another benefit of aerating is that it can be done in conjunction with the over seeding of the turf or other renovation projects. A negative aspect of aeration is that openings in the turf provide opportunity for the invasion of weeds. It is important, then, to time the aeration to avoid optimum germination periods.

Aeration should not be done in areas where snapped markers are still lying in the ground. A core aeration machine can cause severe damage to stones left covered by only a couple inches of dirt. Aerate only after a complete survey and probing has been done to assure that no stones are damaged.

Over-Seeding

The regular introduction of grass seed to the cemetery is an important part of the maintenance plan for a strong stand of turf. For best results, over-seeding can be accomplished immediately after core aeration has been completed. A mix of seed should be used for optimum coverage. The mix should reflect the conditions of the area, such as shade or sun, and the soil conditions as well.

The following are recommended as good basic mixes. Specific needs should be identified and mixes made to fit those needs. A reputable landscape supply company, such as Lesco, can offer a variety of premixed-bagged seed. For additional information, a local agriculture extension agent can be of assistance, as could the greens keeper at the local golf course. Generally the seed is applied at a rate of 120 pounds per acre. Here are suggestions from the grounds manager at Fort Custer National Cemetery, Battle Creek, Michigan:

Full sun mix:

- Twenty percent Gnome Kentucky Bluegrass
- Twenty percent Micro Tall Fescue
- Twenty-five percent Titan II Tall Fescue
- Twenty-five percent Waldina Hard Fescue
- Ten percent Affinity E Perennial Ryegrass

Shady mix:

- Forty percent Red Fescue
- Thirty percent Perennial Rye
- Twenty percent Chewings Fescue
- Ten percent Kentucky Bluegrass

In general the type of seed mix chosen should include drought resistant, slow growing, low maintenance cultivars.

Watering

Watering of the lawns should be done where reasonable to maintain the normal growth and color of the stand of turf. If no water is available, be certain that applications of chemicals or seeds are done so that forecasted rain will have the desired effect. Most historic cemeteries do not have irrigation systems available, so the frequency of watering may be limited to natural rainfall. The cost of installing an irrigation system is often prohibitive. In addition it could be very damaging to the graves and markers, and is not historically accurate. If feasible, a water supply could be installed near the fence line or immediately outside of the fence line to accommodate maintenance needs. Locate the water tap near a roadway and use quick couplers that can be installed below grade. **Level 3**: An irrigation specialist can assist in the installation of these types of hook-ups.

Mowing

2 The lawns of historic burial grounds were not maintained using the same techniques and standards as the lawns in today's residential communities. In fact, cows and sheep were often the means by which the grass was "mowed." The turf was often longer than we are accustomed to seeing today, and to some extent, a return to the nineteenth-century standard may well be one of the best ways to preserve a historic burial ground. In some communities, however, the look that was accepted years ago would not be tolerated today. Using the older method can actually make maintenance harder because the removal of the longer thicker grass blades near to the bases of the stones is more difficult than keeping a shorter blade manicured.

How often the grass is mowed will depend on those involved in the project, the type of cultivar present, its general health, the weather and the availability of resources. Often, municipally owned graveyards are maintained by private contractors that simply cut the grass on a specified schedule. Without the proper instruction, supervision, and follow through, lawn maintenance will continue to be the most damaging activity to stones in the graveyard. Instruct those working in the historic cemetery that they will be working in a fragile environment with special requirements and care must be taken near monuments and historic plantings.

Without proper instruction and follow through, lawn maintenance damage like this will continue.

Generally speaking, no more than one third of the grass blade should be removed at any one cutting. Frequency of cutting is, to a great extent, dependent upon weather and fertilization conditions. For the most part, the following mowing schedule can be used to keep the cemetery looking manicured:

- From the beginning of the season to mid June, every five days
- From mid June to mid or late August, every ten days
- From late August to the end of the cutting season, every five days

There are points that can be discussed with those responsible for the maintenance of the cemetery lawn that will lessen the chance of damage to gravestones and historic plant material from mowing. Specific topographical and other unique features will warrant additional discussion with the lawn maintenance crew. At the very least be clear regarding the following points:

- The maintenance crew must be trained in the specific needs of the cemetery prior to actually cutting, with **an understanding that a historic cemetery is handled differently than a residential or commercial property.**
- **No riding mowers should be used in an historic cemetery.** They are too large for the closely spaced markers and in some circumstances too heavy and can leave ruts in the soil. Only walk-behind mowers are to be used in the cemetery.
- Grass should be cut to a height of 3" unless other unique considerations are discussed and agreed upon prior to cutting.
- All clumps of grass left by the mowers should be raked up and discarded off premises.
- All mowers used in the cemetery should **have and use discharge guards** to protect the gravestones and workers from thrown debris. It should be made clear to workers that **mowing equipment should never make contact with headstones.**
- Where possible, alternate the direction of mowing every other cut.
- **All mowers should be equipped with rubber bumpers on the decks**, any axle assembly, or other feature on the mower that might come in contact with a stone while mowing. This can be fabricated out of old inner tubes or tires and can be riveted on. Loose cell foam can also be used as a bumper.
- While mowing around stones the discharge chute should project away from the marker.
- Grass should be cut by the mower up to, and no closer than, 12 inches from every marker. The rest of the turf will be trimmed with a line trimmer (weed whips) using a line that measures no more than .09" in diameter. There should be a clear understanding as to the delicacy of the markers in the cemetery.
- Any damage should be reported immediately to the cemetery administrator.
- There should be a process for delaying maintenance in the event of a funeral or burial.

Drainage

Determining drainage problems will require a professional engineer or landscape architect. Near many cemeteries the surrounding area has been developed causing a change in the original topography of the cemetery. As a result, the newly created run off from the developed areas can cause drainage issues that must be addressed. Not only will standing water cause damage to the stones and their surroundings, but the standing water poses a health issue as well. Often the installation of a French drain (a trench filled with gravel and topped with sand) or some drainage tile will rectify the problem. Install the drainage outside

the fence line of the cemetery so that the run-off is not allowed to enter the cemetery. Prior to any excavation be certain that graves are not going to be affected by these actions. In the event that soil has to be imported and used to level or build up an area, be certain that no markers are being covered and lost due to the addition of soil. In many instances a municipal planner or engineer will be available to suggest methods or improvements that will assist in the drainage issues. Advice from an archeologist experienced with cemetery work may be appropriate as well.

Depressions

Depressions in the soil are usually the result of earth in the burial shaft settling, or the result of removal of trees or bushes. For slight depressions it is generally recommended that they be left alone. If the depression poses a safety or drainage hazard and the decision is made to fill it, it is important to decide whether or not it is that of an unmarked grave. Any alteration of the landscape should be documented and recorded with the cemetery survey data.

Trees

2 Planting the proper tree in the right location and then correctly maintaining it will determine whether it will be an asset or a liability. It is recommended that trees be fertilized annually with a slow release fertilizer with a ratio of 3:1:1. An inspection of the trees should be made periodically to make sure the root systems are not interfering with gravestones and that broken limbs are not safety hazards. An effort should be made to replace a tree that has sustained damage or is no longer viable. The ideal plan is to replace a tree with the exact species. Replacement of a memorial tree, for example, could be done using its genetic stock. However, some old species are susceptible to insects and disease. Also, it may not be economically feasible to replace certain species or not advisable because it maybe harmful to gravestones.

3 In most cases it is recommended that an arborist (see Yellow Pages of the phone book) or tree service that is knowledgeable about historic landscapes be consulted when replacement is considered. If a tree needs to be removed due to disease, damage, or conflict with gravestones, it is best to cut it as close to the ground as possible, then leave the stump to decay without assistance of chemicals. After the stump has decayed topsoil can be added and the area reseeded.

"The Massachusetts Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries" is an excellent resource for landscape maintenance. It would be appropriate for use in Michigan because Massachusetts plant hardiness zones are the same as

in southern Michigan, zones 5 and 6. The following are some of Massachusetts's recommendations for tree maintenance:

> A specific planting plan should be developed prior to planting additional trees. The selection of tree species is an important consideration in terms of appropriateness, maintenance requirements and protection of historic artifacts. Botanic diversity is a particularly important consideration for sites that have roots in the rural cemetery movement. Monocultures are generally not recommended because of experience with devastating diseases like Dutch Elm Disease, White Pine Blister Rust and Chestnut Blight. Acid rain has been monitored for many years and it is suspected to be affecting Sugar Maples, causing Maple decline. Traditionally, Maples have been considered to be long lived trees where narrow tree pits, road salt and drought have not been a problem. ("Massachusetts Preservation Guidelines for Municipally Owned Historic Burial Grounds and Cemeteries," p. 28-29)

Replacement trees should be limited to areas that do not interfere with grave markers, paths, drives, fences, walls, and buildings. Tree placement should take into consideration the specific characteristics in relation to the type of stone. For example, the roots of acidic trees, such as pine and oak, can be detrimental to marble, limestone, and sandstone, which contain calcium carbonate. Stones of the silica family, such as granite, are more resistant to acid. If a tree needs to be replaced in the cemetery, the Michigan Department of Natural Resources offers the following hardiness and size guidelines for tree selection:

RECOMMENDED MICHIGAN NATIVE TREES			
Common	**Genius Species**	**Hardiness Zone**	**Size Class**
Fir, Balsam	Abies Balsamea	3-5	large>40’
Maple, Red	Acer rubrum	3-9	large>40’
Maple, Sugar	Acer saccharum	3-7	large>40’
Birch, River	Betula nigra	4-9	large>40’
Birch, White	Betula papyrifera	2-4	large>40’
Hackberry	Celtis occidentalis	4-9	large>40’
Beech, American	Fagus grandifolia	4-9	large>40’
Cedar, Eastern Red	Juniperus virginiana	2-9	large>40’
Tuliptree	Liriodendron tulipfera	4-9	large>40’
Blackgum	Nyssa sylvatica	5-9	large>40’
Spruce, White	Picea glauca	2-6	large>40’
Pine, Red	Pinus resinosa	2-5	large>40’
Pine, White	Pinus strobes	3-8	large>40’
Cherry, Black	Prunus serotina	4-9	large>40’
Oak, Swamp White	Quercus biocolor	4-7	large>40’
Oak, Bur	Quercus macrocarpa	3-8	large>40’
Oak, Pin	Quercus paustris	5-8	large>40’
Oak, Red	Quercus rubra	5-8	large>40’
Oak, Shumard	Quercus shumardii	5-9	large>40’
Arborvitae	Thuja occidentalis	2-8	large>40
Basswood	Tilia Americana	4-7	large>40’
Ohio Buckeye	Aesculus glabra	4-6	medium 30-40’
Ironwood	Ostrya virginiana	3-9	medium 30-40’
Spruce, Black	Picea mariana	2-5	medium 30-40’
Maple, Striped	Acer pensylvanicum	3-7	small>30’
Serviceberry, Downy	Amelancier arborea	3-8	small>30’
Hornbeam, American	Carpinus caroliniana	4-8	small>30’
Redbud, Eastern	Cercis Canadensis	4-9	small>30’
Dogwood, Flowering	Cornus florida	5-6	small>30’
Dogwood, Grey	Cornus racemosa	4-8	small>30’
Hawthorn	Cratageus spp.	5-8	small>30’
Common Chokecherry	Prunus virginiana	3-8	small>30’
Nannyberry Viburnum	Viburnum lentago	2-8	small>30’

TREES NOT RECOMMENDED FOR PLANTING		
Common	**Genus Species**	**Comments**
Maple, Boxelder	Acer negundo	Weak wood, poor branch structure, prone to insect pests, invasive.
Maple, Norway	Acer plantanoides	Overplanted, invasive, susceptible to storm damage.
Maple, Norway Cultivars	Acer plantanoides cultivars	Overplanted, invasive, susceptible to storm damage.
Maple, Silver	Acer saccharinum	Weak wood, poor branch structure, very susceptible to storm damage, invasive roots.
Tree of Heaven	Ailanthus altissima	Weak wood, sucker growth
Birch, Paper	Betula papyifera	Prone to major insect pests, very susceptible to storm damage.
Birch, European White	Betula pendula	Prone to major insect pests, very susceptible to storm damage.
Chestnut, American	Castanea dentate	Prone to major disease and insect pests
Russian Olive	Elaeagnus angustifolia	Prone to major disease and insect pests, very invasive
Ash species	Fraxinus spp.	Prone to major disease and insect pests, especially Emerald Ash Borer
Ginkgo	Gingko biloba	Fruit from female trees have very unpleasant odor.
Honeylocust	Gleditsia tricanthos	Messy fruit, thorns may be harmful, thornless varieties are available.
Mulberry, White	Morus alba	Messy fruit, susceptible to storm damage, invasive roots.
Spruce, Colorado	Picea pungens	Out of range in Michigan, prone to disease
Spruce, Colorado Blue	Picea pungens var. glauca	Out of range in Michigan, prone to disease
Poplar, White	Populus, alba	Susceptible to storm damage, excessive sucker growth, invasive roots.
Poplar, Cottonwood	Populus deltoids	Susceptible to storm damage, excessive sucker growth, invasive roots.
Cherry, Black	Prunus serotina	Messy fruit, prone to disease and insect pests, very susceptible to storm damage.
Locust, Black	Robinia pseudoacacia	Prone to major disease and insect pests, sucker growth.
Willow, Weeping	Salix alba	Weak wood, poor branch structure, very susceptible to storm damage, invasive roots.

TREES NOT RECOMMENDED FOR PLANTING – CONTINUED		
Common	**Genus Species**	**Comments**
Willow Black	Salix, nigra	Weak wood, poor branch structure, very susceptible to storm damage, invasive roots.
Mountain ash, American	Sorbus americana	Major disease and insect pests
Mountain ash, European	Sorbus aucuparia	Major disease and insect pests
Elm, American	Ulmus americana	Prone to major disease and insect pests, especially Dutch Elm Disease, invasive roots.
Elm, Siberian	Ulmus pumila	Prone to major disease and insect pests, very susceptible to storm damage.
Elm, Slippery	Ulmus rubra	Prone to major disease and insect pests, especially Dutch Elm Disease.
Elm, Rock	Ulmus thomasii	Prone to major disease and insect pests.

Pruning

Trees and shrubs should be pruned on a regular basis to protect people and cemetery artifacts from falling branches. Too much shade may retain moisture in the ground, which affects grave markers, particularly marble and slate. Look for canopies that are too broad and susceptible to wind damage or trees that are shallow rooted and easily toppled. Consider thinning the crown of a tree as opposed to removing the tree. A five-year cycle of pruning is advised for normal maintenance. After inclement or windy weather the burial ground should be inspected for tree damage that would necessitate pruning or staking.

Plants

A supply of plants taken from the cemetery can be maintained by taking cuttings or propagating plants from seed. A small flower/plant bed might be started outside the cemetery for this purpose, assuring that a supply of the cemetery's historic species will be on hand. This could be done by volunteers, such as a local garden club or master gardener.

Some plants self-seed or put up new shoots through runners and create new plants known as volunteer growth. All volunteer growth should be removed at least once a year and a thorough inspection of trees and shrubs throughout the cemetery should be done on a yearly basis, to avoid damage caused by unchecked growth.

BUILDINGS, OTHER STRUCTURES, AND FEATURES

Many historic cemeteries contain structures such as mausoleums, chapels, and crypts. While it is beyond the scope of this work to address conservation of these buildings, they are an important part of the historic context of a cemetery and a plan for their conservation should be developed. Likewise, stone walls and concrete curbing fall into the same category. Professionals experienced with conservation of historical and architectural features should be consulted before any work is begun. Without reasonable, appropriate conservation measures these buildings and structures are endangered and begin to pose security and safety concerns. Failure to maintain historic structures not only detracts from the appearance of the cemetery but compromises the cemetery's historic fabric.

Pathways and Roads

2 The circulation pattern of roads and pathways in the cemetery should remain as originally laid out. Maintenance will depend upon how heavily the site is used. Repairing paved areas, cleaning paths and drives, removing hazards that might cause tripping, monitoring and repairing erosion problems, and snow removal are on-going activities. Brick and gravel paths and roadways require regular maintenance.

Vehicle entrances should be at least twelve to fourteen feet wide. Pedestrian entrances should be at least forty-eight inches wide. Paths should be a minimum of sixty inches wide and wheelchair access should be offered. (Strangstad, p. 20) The Americans with Disabilities Act is intended to eliminate, as much as reasonable, unnecessary barriers encountered by those with disabilities. There are exceptions to parts of this act, specific to historic settings. "Complying with barrier-free access requirements, in such a way that character-defining features, materials and finishes are preserved, for example, widening existing stone walks by adding new stone adjacent to it to achieve the desired width." (The Secretary of the Interior's *Rehabilitation Guidelines for the Treatment of Cultural Landscapes*, p. 86).

Signage

Another ancillary element that the cemetery plan needs to address is signage. In addition to historic signage there is often a need for contemporary signs. If they are well designed and appropriately placed they will enhance the visitor's experience by providing information, interpreting history, assisting in way finding, and indicating regulations that pertain to the site. Signage, though necessary, can be an unobtrusive component of the cemetery.

For a small cemetery, it is recommended that signs be limited to the cemetery entrance. Signs that provide pertinent information should be posted prominently, but should not

detract from the historic feeling of the cemetery. If it is necessary to include way finding or interpretive signage within the cemetery the number of signs should be limited and their color and design should blend with the surroundings. Avoid creating the impression of false history by using materials or styles that appear to be historic when they are not. Likewise, materials such as polished granite or marble should not be used as they can be confused with monuments.

Metal is the most durable and appropriate material for signage. Cast alloys of aluminum or brass will provide a visually pleasing sign that will be quite durable and require little maintenance. Although they are durable, avoid both sheet metal and plastic for aesthetic reasons. Though historically correct, wood tends not to weather well and may have to be replaced frequently. The mounting standards or posts can be as important as the sign, and care should be taken when choosing them. While it is appropriate to post signs on fencing it is not recommended that they be attached to trees. Before placing any signs, consider how they will affect the view shed and historic resources of the cemetery.

Signs that identify or name the cemetery are the ones most likely to be historic in nature. Often a historic cemetery will have an ornate cast iron sign as part of the entry gate. Where this type of sign exists it should receive the same care and maintenance as other decorative metalwork. Historic signs often provide little additional information beyond the cemetery's name, creating a need for other informational signage. Further information might include the cemetery's founding date and any other names for the cemetery, both historic and current, thus clearing up any confusion for those doing research pertaining to the site.

Informational Signs

To retain clarity of either instructions or information several different signs may be necessary. Informative signs should be posted near the entrance of the cemetery where the visitor can readily find them and should provide pertinent information such as the name and contact information of the agency maintaining the cemetery and its hours of operation.

Informational signs may also include:

- historical information
- founder's name
- the names of important persons interred
- state, national, or local register designation, if applicable
- information to contact cemetery authority for further rules and restrictions on funerals, headstones, plantings, etc.

If a restoration is in progress signage can keep the public informed. Such a sign might include the name of the group or agency in charge of the restoration project as well as information about where interested persons can contribute both financial and volunteer help. It should also identify a contact person with phone number, e-mail address, or a web site created for the project. A sign of this type can also serve to recognize those that have contributed to the restoration.

A cemetery may have a state historical marker that gives a brief summary of the history of the cemetery. Michigan law now requires that work on sites with state markers must meet the Secretary of the Interior's *Standards for Rehabilitation*, or the marker can be removed.

Signs that provide information on important burials, local settlement histories, or ethnic groups buried in the cemetery or that indicate unusual plantings or monuments can be erected by the local government, historical society or cemetery associations. If a group plans on this type of sign the history should be well researched and accurate. Where many markers are missing or stones are deteriorated, plaques may be used to list all known burials.

Signs such as these inform the public of the important historical information relative to the cemetery. They also demonstrate a community's commitment to the historic cemetery.

Regulatory Signs

Sometimes a cemetery association or a local government will post a regulatory sign near the entrance to inform the public of any special regulations pertaining to the cemetery. The public needs to be aware of restrictions on pets, jogging, or alcohol, or limitations on grave decorations or plantings. Where restrictions need to be posted, they should be done in as unobtrusive a manner as possible. It is off-putting to be met by a large list of "don'ts" upon entering the cemetery gates. Be advised that no rule can be created that is contrary to local, state, or federal regulation, so research the regulations as they relate to the site. Regulatory signs also advise the public of any restrictions, prohibitions, or permits required by the cemetery authority.

Regulatory signs may include:

- hours of operation
- rules / prohibitions, e.g., no dogs or alcoholic beverages
- caution regarding fragility of older stones
- caution not to move or tread on fallen stones
- policy regarding cleaning or "rubbing" of headstones, including any permits or permission required

Before any signs are ordered or installed, check with local authorities to see if any ordinances apply to the site, or if permits are required. While signage is essential for information and way finding, the over-use of signs detracts from a cemetery's appearance and raises the question of historical accuracy.

Lighting

Small cemeteries founded in the nineteenth century did not historically have lighting as an original feature. Modern security issues, however, sometimes dictate a need for some lighting. Maintaining historic context and balancing today's needs become an issue that should be addressed with thought and care.

Most experts recommend keeping lighting to a minimum and preferably confining it to outside the cemetery boundaries. It is suggested, however, that the lighting outside of the cemetery (possibly pre-existing) be enhanced if security needs exist. Improved street lighting or the addition of lighting on buildings surrounding the perimeter of the cemetery may offer the most reasonable approach.

Installing new lighting within the parameters of an historic cemetery is a challenge. The electrical lines needed for installation most likely do not exist within the boundaries of the cemetery. Overhead lines will most often be aesthetically unpleasing and burying lines is almost impossible given the nature of these sites. The heavy equipment necessary to install underground lines, the chances of disturbing a burial site, and the potential for damage to cemetery elements makes it a daunting and very expensive task.

While historic cemeteries do not often have lighting as a feature, any fixtures or poles that appear to be historic should remain. They require the same research and documentation as other features of the cemetery. All documentation should be included with cemetery survey data. Cemetery plans and goals should include proper conservation and maintenance of these historic features.

Other Features

Often, in order to optimize the use of a historic cemetery, a need arises for certain elements that never existed historically. Trash receptacles and, to a lesser extent, seating are modern additions that are of some necessity in the cemetery. Choice of materials and respectful placement is the key in incorporating these elements. Be aware that creating a false sense of history is unacceptable according to the Secretary of Interior's *Standards and Guidelines for Historic Preservation and Rehabilitation*. Using materials or designs that lead visitors to believe that these new elements were historically present is destructive to the historic integrity of a property. Trash receptacles should be placed discretely and unobtrusively in areas where they are required. Seating should be simple in design and, if needed, preferably placed outside the entrance to the cemetery. Avoid additional plantings that can be historically inaccurate and increase the cost of maintenance. Repair and conservation of pre-existing ancillary features is always suggested as they contribute to the historic character of the cemetery.

Chapter 5

THE CEMETERY AS
A CULTURAL ARTIFACT

MULTI-PURPOSE USE OF CEMETERIES

While a great number of historic cemeteries remain active with new sections platted and burials continuing, not all of the state's cemeteries are still in use. Though inactive, they are still important to a community as a cultural resource. A group formed to act as curator of a historic cemetery should be aware that in order for conservation efforts to continue, it is important to devise ways to attract, and interest, a diverse group of people. Finding new uses for historic cemeteries helps assure that they will be well maintained and cared for. In addition, multi-purpose use of a cemetery prevents the appearance of abandonment that can invite trouble. With good planning historic cemeteries can serve the living while commemorating the dead. A multi-dimensional approach to planning will help generate the interest and funds necessary to insure that goals set for the future conservation of the cemetery are achieved.

As an educational tool the cemetery offers the community many opportunities that, if utilized to their full potential, can benefit a cemetery preservation project in many ways. Charging a small fee for historic tours can be a means of providing much needed revenue for a project. History tours for both adults and children will build respect for and interest in local history as well as foster community pride and respect for the site. For school children

a field trip to the cemetery can spark an interest in preservation, art, folklore, or other studies. Genealogists often find information not easily accessible elsewhere. The cemetery can also serve as a laboratory and workshop for preservation projects. Imagination and planning will enable a community to fully utilize this important resource.

Tours are one way of utilizing the cemetery for educational purposes. Tecumseh, a small community in Lenawee County, Michigan, counts over three hundred Civil War soldiers buried in their Brookside Cemetery. Every spring, as part of Tecumseh's "Promenade the Past" annual festival, Robert Elliot, local historian and guide, conducts an extremely popular Civil War tour. He has done extensive historical research utilizing public records at the Archives of Michigan, personal letters, and other memorabilia to construct the lives of several soldiers. Local actors dressed in period costume stand alongside selected tombstones and recount the soldiers' histories in first-person narrative. Mr. Elliot who has been conducting these tours for ten years, says the emotional impact of the tour is impressive. Since he began the tours for school children, scouts, and others there have been no incidents of graffiti or vandalism in the cemetery. It is an excellent way to not only recount local history but to also tie that history to the broader story of our nation's past. The respect generated for the individuals involved in making the area's history leads to respect for the cemetery.

Brownie Troop 2487 visited Lodi Township Cemetery to learn about the cemetery and its history and to pick up trash and branches.

Involving local adult education, schools, scout troops, 4-H, and other organizations will insure a wide use of the cemetery. Two ideas include: a group meeting to read and record epitaphs, (even young children can participate in such an activity), or a group discussion on cultural attitudes towards death based on epitaphs and inscriptions.

Teachers may find the cemetery a useful learning tool. It can become an outdoor laboratory for the study of geology, chemistry, biology, and botany. Writing, literature, and history instructors can find ample opportunities for their students to use the cemetery to generate stories and research histories. For art instructors there is a wealth of sculpture and headstone carvings available for drawing, photographing, and studying. Geared either toward elementary or secondary education the following list of questions could be used in association with a visit to the cemetery. When combined with a prior history, culture, or art lesson, they will help focus the visit, generate an interest in, and provide a follow-up activity to the visit.

- Are any markers inscribed in foreign languages? What does this relate about the area's history?
- Are there indications of wars, epidemics or other catastrophic incidents recounted in the epitaphs or inscriptions? (Examples: Mentions of battles or military campaigns, a large number of people who died during the 1918-19 flu epidemic, or several family members that died on the same day.)
- What is the oldest grave marked?
- What is the newest grave marked?
- Are there any famous people buried in the cemetery? (local, state, or nationally important)
- What decorative carvings and epitaphs are noticed? Are there similar carvings on other monuments? Do similar motifs have similar dates? What does this indicate?
- What is the condition of the monument? The grounds? The fences etc.?
- What is the most common material used for monuments? (stone type)
- Was there anything surprising about the cemetery or the visit?
- Pick one monument and write a paragraph, or essay about the epitaph, carving/artwork, or the condition of the monument.

Workshops modeled on the Association for Gravestone Studies and the National Preservation Institute sponsored workshops can be planned. At times monument dealers, cemetery conservation groups, or preservation organizations like the Michigan Historic Preservation Network, conduct training sessions on proper gravestone cleaning and repair techniques.

The Michigan Historic Preservation Network, as well as other groups have given workshops on cemetery conservation. Here a representative from Cathedral Stone talks at a workshop given by the Michigan Historic Preservation Network in Rochester Hills, Michigan.

Grave Concerns, a Preservation Manual for Historic Cemeteries in Arkansas, offers a list of "Over 100 Things to do in a Cemetery." We reproduce it here in part, with a few original ideas, providing a list of activities that seem most suited to the Michigan climate, and the relatively small size of the cemeteries we have been discussing:

- Conduct walking tours highlighting selected burials in the cemetery such as Civil War soldiers or local founding fathers.
- Have students complete a living history of the cemetery. Write short biographies of those buried in the cemetery and have them available for walking tours and other activities.
- Conduct tours with interpreters dressed in period costumes recounting personal histories.
- Conduct a scavenger hunt where groups look for information that can be gleaned from inscriptions or artwork on monuments.
- Publish genealogical information.
- Plan demonstrations or conduct workshops on proper cleaning and/or maintenance techniques.
- Conduct a photographic workshop.
- Hold Memorial and Veterans Day services.

- Sponsor a "Make a Difference Day" clean up.
- Establish an adopt-a-plot or adopt-a-stone program to help with maintenance.
- Seek out students and others who must complete community service projects and use them for routine maintenance.
- List the cemetery on local and national historic registers.
- Create a slide show or power point program for use in presentations.
- Establish a web site about the cemetery.
- Design a pamphlet or self guided walking tour of the cemetery.
- Conduct a monument inscription workshop with instructions on reading the stones and understanding their meaning.
- Offer seminars on antique plant care and propagation.
- Establish a "Friends of the Cemetery" group or cemetery foundation.
- Other ideas can be found at www.angelfire.com.

As a landscape, the cemetery is a type of botanical garden where a variety of trees and other plant species may be found. In the spring wildflowers can be seen and in the fall a visitor may enjoy the rich palette of colored leaves. Some horticulture-related activities for individuals or organizations are:

- Have a shrub and tree tour.
- Lead a tour of garden enthusiasts to view and discuss historic plantings.
- If trees are mapped or easily identifiable, compare which species are native to Michigan and which are not.
- Have a spring flower tour. What flowers are symbolic?
- Identify Michigan wild flowers.
- Create a calendar or coloring book using historic cemetery plants.
- Hold a botanical watercolor or drawing class.
- Hold a workshop on care of the cemetery landscape.
- Offer limited sales of clippings and seeds from historic plants.
- Have an amateur or professional juried photograph contest and sale featuring photos taken in the cemetery. A percentage of the sales could go to the cemetery organization.
- Offer a workshop on propagating and growing antique plants.

These lists are only a beginning. Finding a way to integrate a historic cemetery into community life is limited only by the creativity of the planners.

GRAVESTONE RUBBING – DON'T

Cemeteries, with their irreplaceable headstones, are an important part of the cultural heritage of every area. Cemeteries contribute to our local and regional heritage, and should be respected and treated as carefully as any other historic artifact.

Gravestone rubbing is the process of reproducing the inscriptions on headstones onto paper by rubbing a wax stick, chalk or other art-markers over paper on the surface of the stone. While this may seem to be a harmless activity, many stones in historic cemeteries are permanently damaged by this practice. Persons unfamiliar with the requirements of historic cemeteries may assume that the various headstone materials are impervious to harm, however, stone can be easily damaged and must be treated with care. The following information regarding the damage to gravestones has been adapted from the Association for Gravestone Studies leaflet, "*Gravestone Rubbings for Beginners*" by Jessie Lie Farber.

Damage Caused by Rubbing

Gravestone rubbings are not recommended and are no longer considered an acceptable practice because of the harm and damage that can occur. Listed below are common concerns and damage caused by rubbing.

- Paper used to make the rubbing can tear, causing the rubbing material (often wax) to be transferred to the monument. Removing wax from the stone is extremely difficult without significant degradation of the stone.
- Rubbing over the edges of the letters and carving on a stone causes minute damage to those edges. Over time, this damage opens pores in the stone, allowing additional moisture into the stone, which can accelerate deterioration from the inside out.
- The harsh elements of nature to which stones are exposed not only deteriorate inscriptions and decorations, but also render the total facade susceptible to damage. Previous repairs, or existing deterioration due to spalling or sugaring of the surface, also make applying friction and pressure to the face of the stone an unsound practice.
- Some rubbing papers can leave a waxy residue on the stone, which hinders the stone's natural ability to breathe, and may discolor the stone and ruin the natural patina. The waxy residue can also interact with acid rain, accelerating deterioration of the crust of the stone. Using newspaper as a rubbing media, which is often advocated, can also adversely affect the stone because it contains acids and the ink may stain the stone.
- Adhesive tapes of any kind should not be used. They may leave a residue on a headstone that will adversely affect the stone.

- **The use of shaving cream to highlight inscriptions is not an acceptable practice and should not be allowed.** Shaving cream contains steric acid, a waxy solid, which causes the surface of stones to deteriorate more quickly. The damage to the surface of the stone is similar to that of acid rain, but is more severe. Marble and limestone are particularly vulnerable. Because it soaks into the stone quickly, it is very difficult to completely rinse off the surface. Residues include organic compounds, which attract harmful microscopic organisms such as moss and algae, further deteriorating the stone.

Photography as an Alternative to Rubbing

With the currently available photographic capabilities, rubbings are an unnecessary risk for fragile historic headstones. High-resolution photography of stones is a safe and effective alternative to rubbing. Photography can document and reproduce the same information. A digital camera can achieve remarkable results without chemicals or stress to the stones.

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Appendix A

FORMS

MICHIGAN GENERAL CEMETERY SURVEY FORM

Use continuation sheets where needed

Survey Date _____

Current Cemetery Name _____

Historic Cemetery Name _____

Address _____

Village/City _____ Township _____

County _____

Owner _____

Owner's address _____

Owner's phone number _____

Type of ownership

☐ private-profit ☐ private-nonprofit ☐ private-unspecified ☐ city ☐ township ☐ county
☐ state ☐ federal ☐ Native American ☐ other _____

Accessibility to public

☐ unrestricted ☐ restricted (private property) ☐ by car ☐ by foot

Description

Type of cemetery (check all that apply)
☐ community ☐ family ☐ military ☐ municipal ☐ national ☐ religious
☐ other, explain _____

Design/style/layout

☐ early burying ground/small historic cemetery ☐ Rural Cemetery
☐ Lawn Park ☐ Memorial Park

Condition

☐ currently in use ☐ abandoned ☐ maintained, but not in use

Overall evaluation of condition of grounds

☐ excellent ☐ good ☐ fair ☐ poor

Specific problems

☐ overgrown vines ☐ overgrown grass ☐ overgrown shrubs ☐ unpruned trees
☐ fences, walls in poor repair

Context

☐ urban ☐ rural ☐ residential ☐ commercial ☐ industrial

Approximate size of burial ground: _____x_____ft., _____acres

Boundaries

☐ fence (material) _____
☐ wall (material) _____
☐ gate (inscription) _____
☐ hedge (type) _____
☐ other _____
☐ none _____
Condition of boundaries _____

Topography
☐ flat ☐ rolling

Natural features: _____

Ethnic group(s) interred
☐ Caucasian ☐ Asian ☐ Native American ☐ African American ☐ Hispanic
☐ other, explain _____

Further information _____

Grave groupings (check all that apply)
☐ family ☐ fraternal order ☐ military ☐ religious ☐ ethnic heritage
☐ other, explain _____

Plot enclosures (check all that apply; indicate number of each if appropriate)
☐ curbing, material: _____
☐ hedge, type: _____
☐ wall, material: _____
☐ other (explain) _____

Gravestones
Approximate number of markers (fifty years or over in age) _____
Approximate number of markers (less than fifty years old) _____
Approximate number of burials _____
Evidence of unmarked burials _____

Number of markers with burial dates from ☐ 19th century ☐ 20th century

Age: earliest date_____ most recent date_____

Materials (check all that apply and place a **P** on the most prevalent material):
☐ fieldstone ☐ sandstone ☐ limestone ☐ marble ☐ granite ☐ wood
☐ concrete/cement ☐ iron (cast/wrought) ☐ white bronze/zinc
☐ other, explain _____

Note if other methods of marking graves exist, such as footstones, mounding, broken pottery, flowers, other types of decoration beyond markers:_____

_____

Orientation of markers (N-none/very few, S-some, M-most, A- all)

East/West_____ North/South_____

other (explain) _____

_____

Decorative carvings on the markers. Provide a list of common images:_____

_____

_____

Are there unusual markers? Describe_____

_____

_____

Names of stone carvers (specify name, town, company if available) _____

_____

Condition of markers (give approximate number)

☐ inscriptions illegible ☐ inscriptions legible ☐ no inscription ☐ sunken/tilted stones
☐ fragments/pieces on the ground ☐ broken but standing
☐ damaged surfaces/chipped/cracked

If other conditions or damage observed, please specify problem _____

_____

List any restoration efforts (examples: metal supports, enclosed in concrete etc.)

_____

_____

_____

List any hazards imperiling the cemetery's existence _____

_____

_____

List other structures (mausoleums, chapels, columbaria, etc.) and describe condition _____

_____

_____

_____

List artifacts (statues, urns, etc.) and describe condition _____

_____

_____

_____

Circulation system of paths and roadways_____

_____

_____

General overview of vegetation (List specific plants on **Plant Documentation Form**)_____

_____

_____

_____

Historical background

Year established (use circa if actual date not documented) _____

Ownership history _____

Has the cemetery been listed in an existing published/unpublished cemetery survey?

☐ No ☐ Yes: date, and where stored? _____

_____

List important individuals of local, state, or national importance buried here: _____

_____

_____

List any historical incidents: _____

_____

_____

List distinctive monuments, architectural features or sculptures and explain their historical significance: _____

_____

_____

_____

_____

Is this cemetery the successor to another located elsewhere? If so, explain_____

_____

Are the markers in their original locations or rearranged? _____

_____

_____

Additional information:_____

_____

_____

_____

Significance of this site to local, state, or national history:_____

_____

_____

_____

_____

Surveyor name _____

Surveyor address _____

_____

MICHIGAN INDIVIDUAL MONUMENT RECORD FORM

Cemetery or Graveyard Name _____

Municipal unit/county _____

Address or location _____

1. Monument number (from grid) _____
2. Monument type/shape
   ☐ head ☐ foot ☐ tomb ☐ family ☐ obelisk ☐ pedestal with urn ☐ block
   ☐ beveled ☐ flush ☐ marker/small tablet ☐ ledger stones ☐ box ☐ table
   ☐ rustic ☐ sculptural memorial ☐ columnar ☐ cross

   Tablet: ☐ rectangular ☐ semicircular ☐ with shoulders ☐ in base

   ☐ other (describe) _____

   _____
3. Material
   ☐ marble ☐ granite ☐ sandstone ☐ limestone ☐ fieldstone ☐ concrete
   ☐ white bronze (zinc) ☐ bronze ☐ iron ☐ other _____
4. Carver or manufacturer _____
5. Number of carved surfaces _____
6. Carving technique used: ☐ incised ☐ relief ☐ three dimensional
7. Decorative carving motif(s)
   ☐ urn and willow ☐ urn ☐ willow ☐ heart ☐ hands clasped ☐ hand pointing upward
   ☐ hand reaching down ☐ angel ☐ botanical ☐ lamb ☐ open book

   ☐ other (describe) _____
8. Number of people commemorated _____
9. Condition of marker
   ☐ sound ☐ chipped ☐ cracked ☐ crumbled ☐ eroded ☐ broken ☐ tilted ☐ sunken
   ☐ repaired ☐ in situ ☐ displaced ☐ encased in concrete ☐ overgrown (vines, weeds, brush)
10. Previous repairs
   ☐ cracks ☐ pins ☐ mortar ☐ adhesive ☐ girdling
11. Condition of inscription
   ☐ excellent ☐ clear but worn ☐ mostly decipherable ☐ mostly undecipherable
12. Dimensions

   main body: height _____ width _____ thickness _____

   base: height _____ width _____ thickness _____
13. Marker orientation
   ☐ N ☐ S ☐ E ☐ W ☐ NE ☐ SE ☐ NW ☐ SW
14. Master record number _____
15. Date of record _____
16. Name of recorder or group _____

17. Inscriptions

face _____

_____

_____

right _____

_____

_____

_____

rear _____

_____

_____

_____

left _____

_____

_____

_____

18. Photographs (one or more per side)

Additional information _____

_____

_____

_____

_____

Recent cleaning/repairs (date) _____

_____

_____

_____

_____

PLANT DOCUMENTATION FORM

Cemetery name _____ Reference number _____

Municipal unit/county _____

_____

_____

Date_____

Genus _____

Species_____

Common name _____

_____

Size _____

Color _____

PHOTO

Condition_____

_____

Location: master map grid number_____

Historical significance/context of plant _____

_____

_____

Does plant appear to be part of a planned landscape?

_____

Evaluation of integrity and significance_____

_____

_____

Recorder's name _____

SAMPLE PERMISSION FORM TO GAIN PERMISSION TO VISIT, CLEAN AND/OR RESTORE A CEMETERY
(adapted from www.savinggraves.org)

The undersigned land owner hereby grants permission to the volunteer named below and other persons acting in a volunteer supervision of said volunteer to attempt to restore _____ Cemetery in the county of_____, in the state of _____.

There is an understanding that such efforts may include (but are not limited to) removing all noxious and detrimental vegetation (including trimming trees, lawn mowing and weeding), removing accumulated debris from buried gravestones and markers, the excavation and repair of markers, and the straightening and resetting of gravestones.

Name and title (please print) _____

Signature of cemetery owner (or designee of municipality) _____

Date signed_____

Township of_____

Location of cemetery_____

Address of owner _____

Phone of cemetery owner_____

Special instructions to volunteer_____

_____

The volunteer named below agrees to perform the tasks set out herein to the best of his/her ability, promising to act in good faith to clean the above-named cemetery, to be responsible for the acts of any persons working under the volunteer's supervision, to be responsible for any damage sustained at the site and to exercise due and diligent care to prevent injury to the site or any persons.

The volunteer named below certifies that neither he/she nor any person operating under the volunteer's supervision shall remove from the above location any stone, monument, marker, artifact, ornamentation, enclosure, or other object without the express permission of the cemetery owner.

The volunteer named below further agrees that his/her efforts shall comply with the generally accepted cemetery conservation and preservation techniques as promulgated by organizations such as Saving Graves, The Association of Gravestone Studies, the National Park Service, and the National Trust for Historic Places.

Date signed_____

Signature of Volunteer _____

Printed name of Volunteer _____

Address of Volunteer_____

Telephone number of Volunteer_____

E-mail address of Volunteer_____

Appendix B

RESOURCES

ORGANIZATIONS

The following list includes local, state, and national resources related to cemetery preservation/ conservation.

American Institute for Conservation of Historic and Artistic Works
1717 K Street, Suite 200, Washington, D.C. 20006. (202)452-9545

Association for Preservation Technology
P.O. Box 8178, Fredericksburg, VA 22404. (800)338-1926

Center of Historical Cemeteries Preservation
P.O. Box 6296, Tallahassee, FL 32314. (850)877-9014
Promotes the study, documentation and preservation of historical burial sites in the southeastern United States and the Caribbean.

Chicora Foundation, Inc.
P.O. Box 8664. Columbia, SC 29202. (803)787-6910. www.chicora.org

Getty Conservation Institute
1200 Getty Center Drive, Suite 700, Los Angles, CA 90049. (310)440-7325

Michigan State Historic Preservation Office
Michigan Historical Center, 702 West Kalamazoo Street, Lansing, Michigan 48909-8240. (517)373-1630. www.michigan.gov/shpo.

National Endowment for the Humanities
1100 Pennsylvania Avenue NW, Washington, D.C. 20506. (202)682-5400.www.arts.endow.gov/
It offers assistance to nonprofit organizations seeking information on federal services.

National Institute for Conservation Heritage Preservation
1624 K Street NW, Suite 700, Washington, D.C. 20006. (888)388-6789.
www.heritagepreservation.org

National Park Service
1202 Eye St., NW, 2255 Washington, D.C. 20005. (202)513-7270. www.cr.nps.gov

National Register of Historic Places
National Park Service, U.S. Department of the Interior, P.O. Box 37127, Washington D.C. 20006. (202)343-9559.

National Trust for Historic Preservation
1785 Massachusetts Ave., N.W., Washington D.C. 20036. (202)673-4296

National Trust for Historic Preservation. Midwest office.
53 West Jackson Blvd., Suite 350, Chicago, IL 60604. (312)939-5547

National Preservation Institute
P.O. Box 1702, Alexandria, VA 22313-1702. (703)765-0100

Research Grant Guides
P.O. Box 1214, Loxahatchee, FL 33470. (561)795-6129. www.researchgrant.com

Save Outdoor Sculpture
1730 K Street NW Suite 566, Washington, D.C., 20006. (800)422-4612

The Association for Gravestone Studies
278 Main Street, Suite 207, Greenfield, MA 01301. (413)772-0836. www.gravestonestudies.org

The Council on Foundations
1828 L Street, NW, Washington, D.C. 20036. (202)466-6512. www.cof.org/home.htm

The Foundation Center
79 Fifth Avenue, New York, NY 10003. (212)691-1828. www.fdncenter.org/

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Crockett, James Underwood. *Trees.* New York: Time-Life Books, 1972.
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SOURCES FOR ANTIQUE PLANTS

Antique Heirloom Plants
333 Redemption Rock Trail, West Sterling, MA 01564. (978)422-8371
www.antiqueheirloomplants.com

Antique Rose Emporium
9300 Lueckmeyer Road, Brenham, TX 77833. (800)441-0002

Baker Creek Heirloom Seeds
2278 Baker Creek Road, Mansfield MO 65704. (417)924-8917
www.rareseeds.com

Heirloom Roses
24062 NE Riverside Drive, St. Paul, OR 97137, (503)538-1576
www.heirloomroses.com

Old House Gardens
536 Third Avenue, Ann Arbor, MI 48103
www.oldhousegardens.com
Antique bulbs and reproduction seed catalogs for sale.

Michigan State University Extension Service
Agricultural Hall, Room 108, Michigan State University, East Lansing, MI 48824-1039, (517)355-2300.

Perennial Pleasures Nursery
P.O. Box 147, East Hardwick, VT 05836. (802)472-5104
www.antiqueplants.com

Roses of Yesterday and Today
803 Brown's Valley Road, Watsonville, CA 95076. (831)728-1901

Schliefert Iris Gardens
9515 Hwy 50, Murdock, NE 68407. (402)234-4172

Seed Savers Exchange
3076 N. Winn Road, Decorah, IA. (319)382-5990

Seeds of Change
1 Sunset Way, Henderson, NV 89014. (888)762-7333

Select Seeds
180 Stickney Hill Road, Union, CT 06076. (800)684-0395

Thomas Jefferson Center for Historic Plants
Monticello, P.O. Box 316, Charlottesville, VA 22902. (800)243-1743
www.monticello.org

SUPPLIERS

Jerith Aluminum Fences

Ace Fence Company
11022 Ingeram, Livonia, Michigan 48150. 734-427-6166

Monuments

Arnet's Beckers Burrells Monuments
4495 Jackson Road, Ann Arbor, MI 48103. 734-665-3658

Epoxy

Akemi Plastics, Inc.
Eaton Rapids, MI

Akepox 22010 Epoxy

Architectural Stone
2033 Austin Road, Troy, MI 48083

D-2, Anti-microbials, Jahn Mortars and Grouts

Cathedral Stone Products
7266 Park Circle Drive, Hanover, MD 21076. 800-684-0901. www.jahnmortars.com

Vulpex Soap

Conservation Resources International
8000-H Forbes Place, Springfield, VA 22151. 800-634-6932. www.conservationresources

Rust Converter

Corrosion Control Industries
P.O. Box 4717, Johnson City, TN 37602. 877-661-7878

Tools and Supplies for Stone Working and Restoration

Granite City Tool
247 28th Ave. South, St. Cloud, MN 56387. www.granitecitytool.com

Akepox 2010 Epoxy

Granite House
2984 28th Street Southwest, Grandville, MI 49418. 616-531-0606

Lime and Portland Cement

Graymont Dolime Inc.
21880 West State Route 163, Genoa, OH 43430. 800-537-4489. http://graymont-oh.com

Mastico Epoxy

Hilgartner Natural Stone Company
101 West Cross Street, Baltimore, MD 21230. 410-752-4832. www.hilgartner.com

Historically Accurate Fence and Ironwork

King Architectural Metals
3131 Washington Blvd., Baltimore, MD 21230. 800-542-2379

SUPPLIERS

Turf Care Products

Lesco, 1077 James L. Hart Pkwy., Ypsilanti, MI 48197. 734-487-5559. www.lesco.com

Portland Cement, Lime, and Rust Converter

Liner Rolpanit Inc. North America
30 Glen Cameron Road, Suite 101, Ontario, Canada L3T 1N7. 905-707-7087.
www.linrol.com

Elite Fence Products, Inc.

Michigan Fence and Supply Company
44865 Utica Road, Utica, Michigan 48317. 810-739-5351

Epoxy and Stone Working Tools for the Cemetery

Miles Supply Company
143 Boynton Street, P.O. Box 237, Barre, VT 05641-0237. 802-476-3963

Master Halco Ornamental Iron Fencing

Monumental Iron Works
P.O. Box 365, Lahabra, California 90633. 888-643-3623. www.mafence.com

Stone Consolidants, Paint Strippers and other Chemical Agents used in Restoration Projects

Pro-So-Co, Inc.
755 Minnesota Avenue, P.O. Box 1578, Kansas City, KS 66117. 800-255-4255

Industrial Rust Cover

Rustoleum
11 Hawthorne Pkwy., Vernon Hills, IL 60061. 800-553-8444. www.rustoleum.com

Epoxy

Sika Corporation, 201 Polito Avenue, Lyndhurst, N.J. 07071. 201-933-8800

Historic Iron Work and Fences

Stewart Iron Works Company
P.O. Box 2612, 20 West 18th Street, Covington, KY 41012. 859-431-1985
http://stewartironworks.com

Akepox 2010 Epoxy

Terrazzo and Marble Supply
1290 Evergreen Road, Detroit, MI 48223. 313-273-1556

Tools for Stone Work

Trow and Holden
45 South Main Street, Barre, VT 05641. 800-451-4394. www.trowandholden.com

Source for Vulpex Soap

University Products
517 Main Street, P.O. box 101, Holyoke, MA 01041. 800-628-1912
www.universityproducts.com

WEB SITES	
Name of Organization	**Web Address**
AHGP Michigan Cemetery Transcription and Photo Project	www.usgennet.org/mi/state1
Alliance for Landscape Preservation	www.ahlp.org
American Fence- locates AFA contractors in a specific area	www.americanfenceassociation.com
American Forest Historic Tree Nursery	www.historictrees.org
American Institute for Conservation of Historic and Artistic Works	www.//aic.stanford.edu
Ancestry- genealogy	www.ancestry.com
Antique heirloom plants	www.antiqueheirloomplants.com
Arkansas Historic Preservation Program- cemetery preservation	www.arkansaspreservation.org
Association for Gravestone Studies	www.gravestonestudies.org
Association for Preservation Technology	www.apti.org
Baker Creek Heirloom Seeds	www.rareseeds.com
Ben Meadows- environmental supplies such as probes	www.benmeadows.com
Cemetery Junction Directory Cemetery records	www.daddezio.com www.geneasearch.com
Chicora Foundation- cemetery conservation/preservation	www.chicora.org
Cyndi's list- genealogy	www.cyndislist.com/mi.htm
Chamblee roses- includes heirlooms	www.chambleeroses.com
Feroze Exports- sandstone	www.ferozeexports.com/sandstonedefination.htm
Genealogy Links	www.genealogylinks.net
Genealogy today	www.genealogytoday.com
Heirloom Gardens- seeds and plants	www.heirloomnursery.com
Heirloom Plants & Seeds - links to numerous sources	www.av.qnet.com
Heirloom Roses	www.heirloomroses.com
Indiana Pioneer Cemeteries	www.rootsweb.com (link)
International Society of Arboriculture	www.treesaregood.com
Internet Resources for Nonprofits	www.ai.mit.edu/people/ellens/non/online.html
I Love Plants- links to garden and plant-related web sites	www.iloveplants.com
Legal help	www.usgennet.org www.legalanthropology.com
Michigan Legislature website Legal: chap.456-cemetery assns. And chap. 128 cemetery day in May	www.michiganlegislature.org

WEB SITES	
Mapping software	www.legacymark.com www.cemoffice.com
Michigan Historic Preservation Network	www.mhpn.org
Michigan State Historic Preservation (SHPO)	www.michigan.gov/shpo
Michigan State University Extension Service	www.msue.msu.edu
Monticello-Thomas Jefferson Center for Historic Plants	www.monticello.org
National Center for Preservation Training and Technology	www.ncppt.nps.gov
National Institute for Conservation Heritage Preservation	www.heritagepreservation.org
National Plant Database	www.plants.usda.gov
National Register for Historic Places	www.cr.nps.gov/nr
National Park Service, Heritage Preservation Services	www2.cr.nps.gov
Old House Gardens bulb catalog.	www.oldhousegardens.com
Oregon Historic Cemeteries Association	www.oregoncemeteries.org
Perennial Pleasures Nursery-heirloom plants and seeds	www.antiqueplants.com
Roses	www.avagara.com
Roses of Yesterday	www.rosesofyesterday.com
Research Grant Guides	www.researchgrant.com
Sad news-genealogy search, books, and library	www.sadnews.net
Saving Graves	www.savinggraves.com
Sculpture site-cemetery link	www.sculptor.org
Heritage Preservation-click on Save Outdoor Sculpture	www.heritagepreservation.org
Select Seeds	www.selectseeds.com
Stewart Iron Works-fabricators of fences, gates, and furnishings	www.stewartironworks.com
The Foundation Center-guide to grant seeking on the web/links	http://fdncenter.org
The Right Tree Handbook	www.mnpower.com/treebook/
U.S. Forest Service, Hazards Tree Page	www.na.fed.us/spfo/hazard/pubs.htm
U.S. General Services Administration-technical briefs	www.w3.gsa.gov
Washtenaw County cemeteries	www.rootsweb.com/~miwashte/
Wayne County cemeteries	www.rootsweb.com/~miwayne/wacemetery.htm
Wayne County cemetery records	www.interment.net/usmi/wayne.htm
Wayside Gardens-old roses	www.waysidegardens.com

Appendix C

GLOSSARY

The following glossary terms have been taken from the National Register bulletin *Guidelines for Evaluating and Registering Cemeteries and Burial Places; A Graveyard Preservation Primer;* The Secretary of the Interior's *Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Historic Landscapes; Grave Concerns: A Preservation Manual for Historic Cemeteries in Arkansas;* and *Landscapes of Memories: A Guide for Conserving Historic Cemeteries, Repairing Tombstones.*

Altar tomb
a solid, rectangular, raised tomb or grave marker resembling ceremonial altars of classical antiquity and Judeo-Christian ritual.

Artificial stone
a term used to describe various materials also known as *art marble, artificial marble, cast stone,* and *composite stone.* Some mixture of stone chips or fragments is generally embedded in a matrix of cement or plaster, and the surface may be ground, polished, molded, or otherwise treated to simulate stone.

Bedding
the manner or direction in which bedding planes (layers, stratification or direction in which a stone is formed) are laid when a stone is in use. Bedding is a condition that is typically seen in sedimentary stones such as sandstone and limestone. Stone monuments have bedding planes that are either horizontal (naturally bedded), vertical and parallel (face bedded), or perpendicular (edge-bedded) to the exposed surfaces. Most historic slab grave markers have a bedding that is vertical and parallel to the face; it is easiest to split a stone along the natural bedding planes and turn it upright to create a grave marker.

Bevel marker
a rectangular grave marker, set low to the ground, having straight sides and uppermost, inscribed surface raked at a low angle.

Blistering
Swelling and rupturing of a thin, uniform layer of stone are usually found on sandstone, but also on granite. It is generally caused by salts and/or moisture and can occur either across or parallel to bedding planes.

Block markers
made of granite and the type of marker most used today. Most are made of granite, and age can be determined by the amount of engraving found on the stones. The early twentieth century block markers began with few images, but as time proceeded lasers were used to create individual and elaborate designs of portraits of the deceased and activities that they held dear such as hunting, traveling and other worldly pursuits.

Bluestone
a trade term applied to hard, fine-grained, commonly feldspathic and micaceous sandstone or siltstone of dark greenish to bluish gray color that splits readily alone bedding planes to form thin slabs. Commonly used to pave surfaces for pedestrian traffic, this material may occasionally be seen in gravestones.

Boxtomb
a grave monument resembling a box, usually about three feet by six feet and two feet by three feet high, making an individual grave, or occasionally a family or other multiple burial. Such structures may be known locally as crypts; burial, however, is generally below ground with construction taking place following burial.

Brownstone
a trade term applied to ferruginous dark brown and reddish brown sandstone quarried and extensively used for building in the eastern United States during the middle and late nineteenth century. Most later use has been for renovation, repair, or additions to structures in which the stone was originally used. In gravestones, most commonly used as bases, although common in some areas, such as the Connecticut River Valley, for table stones as well.

Burial cache
a place of concealment for burial remains and objects.

Burial mound
a mass of earth, and sometimes stone or timber, erected to protect burial chambers for the dead.

Burial site
a place for disposal of burial remains, including various forms of encasement and platform burials that are not excavated in the ground or enclosed by mounded earth.

Burial vaults
unseen underground brick boxes the size of the deceased. The top, seen as a hump the length of the body, is sometimes covered by plaster or cement. The ends may encase a marker for the deceased. These are much like the modern day concrete burial vaults. The barrel vault was generally made for the wealthy. It is believed to be an English contribution.

Calcite
a mineral form of calcium carbonate. It is the principal constituent of most limestone.

Carin
a mound of stones marking a burial place.

Cemetery
an area set aside for burial of the dead; in Latin American culture known as *campo santo*, or holy field.

Cenotaph
a monument, usually of imposing scale, erected to commemorate one whose burial remains are at the separate location; literally *empty tomb*.

Character-defining feature
a prominent or distinctive aspect, quality, or characteristic of a cultural landscape that contributes significantly to its physical character. Land use patterns, vegetation, furnishings, decorative details and materials may be such features.

Chest marker
a solid, rectangular, raised grave marker resembling a chest or box-like sarcophagus. (1.)

Cinerary urn
a receptacle for cremation remains, or ashes, in the shape of a vase.

Columbarium
a vault or structure for storage of cinerary urns.

Columns
pedestal monuments, once a sign of victory by the Romans (Column of Trajan), are used in cemeteries as a symbol of mortality. Columns were seen as more versatile than an urn or an individual likeness. The base could be used to house the body of the deceased. Most columns found in American cemeteries were erected between 1870 and 1900.

Component landscape
a discrete portion of the landscape, which can be further, subdivided into individual features. The landscape unit may contribute to the significance of a National Register property, such as a farmstead in a rural historic district. In some cases, the landscape unit may be individually eligible for the National Register of Historic Places, such as a rose garden in a large urban park.

Crematorium
a furnace for incineration of the dead; also crematory.

Crumbing
the effects of weather or trapped moisture in a stone. Can appear to be grains of sand eroding from the stone.

Crypt
an enclosure for a casket in a mausoleum or underground chamber, as beneath a church.

Cultural landscape
a geographic area (including both cultural and natural resources and the wildlife or domestic animals therein), associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values. There are four general types of cultural landscapes, not mutually exclusive: historic sites, historic designed landscapes, historic vernacular landscapes, and ethnographic landscapes.

Delamination
separation of layers of stone along bedding planes.

Displaced
original placement is important if the cemetery chooses to seek listing in the National Register of Historic Places. If the stones have been moved, it is no longer a marker. The displaced stone becomes a memorial since it no longer serves the original purpose. There are different reasons that stones may be rearranged. If the row alignment seems a bit too perfect or if the stones are arranged in an odd pattern, such as a circle, most likely all of the stones in a site have been moved.

Dolomite
rock consisting mainly of magnesium carbonate and calcium carbonate; limestone or marble with much magnesium carbonate in it.

Dolomite limestone
limestone that contains more than ten percent but less than eighty percent of the mineral dolomite.

Efflorescence
film or encrustation on masonry of soluble salts, generally white and most commonly consisting of calcium sulfate that may deposit on the surface of stone, brick, or mortar if moisture moves through the masonry. Often caused by free alkalis leached from mortar or adjacent concrete.

Epitaph
an inscription on a grave marker identifying and/or commemorating the dead.

Erosion/sugar decay
a fine white, gritty substance that is produced on marble markers. The erosion is usually due to weathering or pollution.

Exedra
a permanent open air masonry bench with a high back, usually semicircular in plan, patterned after the porches or alcoves of classical antiquity where philosophical discussions were held; in cemeteries, used as an element of landscape design and at a type of tomb monument.

Exfoliation
the peeling or scaling of stone surfaces caused by chemical or physical weathering.

Face
the visible surface of stone masonry after setting. In gravestones, commonly the carved surface of table stones and slabs.

Family cemetery
a small private burial place for members of the immediate or extended family; typically found in rural areas, and often, but not always, near a residence; different from a family plot, which is an area reserved for family members within a larger cemetery.

Feature
the smallest element(s) of a landscape that contributes to the significance and that can be the subject of a treatment intervention. Examples include a woodlot, hedge, lawn, specimen plant, alee, house, meadow or open field, fence, wall, earthwork, pond or pool, bollard, orchard, or agricultural terrace.

Fillett
a concave filling-in (e.g., with mortar) of a reentrant angle where two surfaces meet.

Flaking
a term commonly used regarding gravestones to indicate minor delamination of surfaces or otherwise unsound stone, which easily peels off in small sheets or layers.

Flat markers
often made of metal and placed flush with or embedded in the ground. This style of marker is generally found in twentieth century cemeteries. This style became popular with perpetual care sites, for they allow mowing with ease.

Flush marker
a flat, rectangular grave marker set flush with the lawn or surface of the ground.

Footstone
a marker used in the seventeenth and eighteenth century when both a stone at the head and a stone at the foot marked the grave. Footstones are smaller and more simply inscribed than their headstones. If they bear any carving, it is usually only the name or initials of the deceased, perhaps the death date, and sometimes a simple decorative design.

French Drain
a trench filled with gravel, and topped with sand used for eliminating excess water from low points and other areas with water-saturated soil.

Gneiss
coarse-grained metamorphic rock with discontinuous foliation. When used for building stone, generally classed as trade granite. Most gneiss is dark and composed mainly of quartz, feldspar, mica, and ferromagnesian minerals (iron-magnesium silicates).

Granite
defined geologically as igneous rock with crystals or grains of visible size and consisting mainly of quartz and the sodium or potassium feldspars. In building stone and gravestones, crystalline silicate rock with visible grains. The commercial term includes gneiss and igneous rocks that are not granite in the strictest sense.

Grave
a place or receptacle for burial.

Grave marker
a sign or marker of a burial place, variously inscribed and decorated in commemoration of the dead.

Grave shelter
a rectangular, roofed structure usually of wood, covering a gravesite, enclosed by boards or slats or supported by poles; in tribal custom used to contain burial offerings and shelter the spirit of the dead; also grave house.

Graveyard
an area set aside for burial of the dead; a common burying ground of a church or community.

Headstone
an upright stone marker placed at the head of the deceased; usually inscribed with demographic information, epitaphs, or both; sometimes decorated with a carved motif.

Igneous rocks
those formed by change of the molten material called magma to the solid state. The igneous rocks are one of three generic classes of rocks (igneous, sedimentary, and metamorphic). Various igneous rocks, generally termed granite if coarse grained, are used for building stone and gravestones.

Incised carving
engraving that is ornamentation made by cutting into the stone.

In place (in situ)
the original location of a gravestone.

Integrity
the authenticity of a property's historic identity, evinced by the survival of physical characteristics that existed during the property's historic or prehistoric period. The seven qualities of integrity as defined by the National Register Program are location, setting, feeling, association, design, workmanship, and materials.

Interment
a burial; the act of committing the dead to a grave.

Laminated stone
stone consisting of thin sheets; stone built up in layers, such as slate.

Ledger
a large rectangular grave marker usually of stone, set parallel with the ground to cover the grave opening or grave surface.

Limestone
rock of sedimentary origin composed principally of calcite or dolomite or both. Limestone varies greatly in texture and porosity. It is usually white, gray or buff in color. Under normal conditions it weathers to a light silver gray or white depending on the stone variety, but is usually darker in color than the bright white of marble. It is commonly used in gravestones and tomb structures.

Lych gate
traditionally, a roofed gateway to a church graveyard under which a funeral casket was placed before burial; also lich gate; commonly, an ornamental cemetery gateway.

Macadam
named after John L. Macadam (1756-1836), Scottish engineer who invented the process of using broken stones for roads.

Marble
geologically a metamorphic rock made up largely of calcite or dolomite. It is formed as a result of the recrystallization of limestone under the intense pressure of geologic processes. As used commercially, the term includes many dense limestone and some rock dolomites. Numerous minerals may be present in minor to significant amounts in marble, and their presence and distribution account for much of the distinctive appearance that many marbles possess. The color of marble ranges from the brilliant white of calcite to black, blue-gray, red, yellow and green, depending on the mineral composition. It is the predominant stone for gravestones in the nineteenth century.

Mausoleum
a monumental building or structure for burial of the dead above ground; a "community" mausoleum is one that accommodates a great number of burials.

Memorial
an object whose purpose it is to commemorate a person or an event.

Metal corrosion
deterioration of a metal through a chemical or electrochemical reaction between the metal and oxygen (oxidation) or other substances (acids, salts, water, different metals in contact, and so on). Corrosion is indicated by formation of the corrosion products (such as, rust on ferrous metals) or by loss of metal (pitting and so on).

Metamorphic rock
rock altered in appearance, density, and crystalline structure, and in some cases mineral composition, by high temperature or high pressure or both. Slate is derived from shale, quartzite from quartz, sandstone and true marble from limestone.

Mica
a group of silicate minerals characterized by nearly perfect basal cleavage (cleavage is the quality of a crystallized substance or rock of splitting along definite planes) causing them to split readily into extremely thin plates. They reflect light, causing a shiny or sparkly appearance. The micas are prominent constituents of metamorphic and igneous rocks. In gravestones, they are often apparent in brownstones.

Military cemetery
a burial ground established for war casualties, veterans, and eligible dependents. Those established by the federal government include national cemeteries, post cemeteries, soldiers' lots, Confederate and Union plots, and American cemeteries in foreign countries. Many states also have established cemeteries for them.

Monolith
a large, vertical stone grave marker having no base or cap.

Monument
a structure or substantial grave marker erected as a memorial at a place of burial.

Mortuary
a place for preparation of the dead prior to burial or cremation.

National cemetery
one of 130 burial grounds established by the Congress of the United States since 1862 for interment of armed forces servicemen and women whose last service ended honorably. Presently, the Department of Veterans Affairs maintains 114, the National Park Service (Department of the Interior) administers 14, and the Department of the Army has responsibility for two. The national cemetery in Michigan is Fort Custer National Cemetery in Augusta.

Obelisk
a four-sided, tapering shaft having a pyramidal point; a grave marker type popularized by romantic taste for classical imagery in the nineteenth century.

Peristyle
a colonnade surrounding the exterior of a building, such as a mausoleum, or a range of columns supporting an entablature (a beam) that stands free to define an outdoor alcove or open space.

Potter's field
a place for the burial of indigent or anonymous persons. The term comes from a Biblical reference: Matthew 27:7.

Receiving tomb
a vault where the dead may be held until a final burial place is prepared; also receiving vault.

Relief carving
ornamentation projecting forward from a surface usually shallow or, occasionally in gravestones, deep carving.

Rising damp
moisture carried upward through porous stone by capillary action. Soluble salts in the ground beneath a gravestone may be introduced into a stone through this process. If the salts crystallize within the pores of the stone, the action may cause the surface to break off, known as spalling; if the salts are carried to the surface of the stone and then crystallize on it, efflorescence is formed.

Rostrum
a permanent open-air masonry stage used for memorial services in cemeteries of the modern period, patterned after the platform for public orators used in ancient Rome.

"Rural cemetery"
a burial place characterized by spacious landscaped grounds and romantic commemorative monuments established in a gardenlike setting in the first half of the nineteenth century. Mount Auburn Cemetery (1831) near Boston was the first cemetery developed in this tradition.

Sandstone
sedimentary rock composed of sand-sized grains naturally cemented by mineral material. In most sandstone used for building and gravestones, quartz grains predominate. Sandstone is typically buff, gray, brown, red, purple or pink in color; the latter four colors are commonly called brownstone. Some sources of sandstone in the Midwest and Canada were: Medina varieties in southern Ontario (red-brown, gray or mottled); Ohio sandstone from the Berea beds south of Cleveland (light gray or buff); Ohio Briar Hill sandstone (variegated rusty color); and Michigan Lake Superior sandstone (red).

Sarcophagus
a stone coffin or monumental chamber for a casket.

Scaling
advanced loss of stone, which may vary in depth.

Schist
a metamorphic rock with continuous foliation. It splits along foliation and is occasionally used for gravestones.

Screen memorial
a vertically set grave marker consisting of a tablet with wing elements resting on a continuous base.

Sedimentary rock
formed from materials deposited as sediments, in the sea, in fresh water, or on the land. The materials are transported to their site of deposition by such forces as running water, wind, or moving ice. They may deposit as fragments or by precipitation from solution. Limestone and sandstone are the sedimentary rocks most used for building and gravestones.

Sepulcher
a burial vault or crypt.

Shale
rock of clay origin, easily split into layers. It is occasionally used for gravestones.

Shelter house
a pavilion or roofed structure, frequently open at the sides, containing seats or benches for the convenience of those seeking a place to rest; erected in rustic and classical styles to beautify a cemetery landscape.

Slant marker
a rectangular grave marker having straight sides and inscribed surface raked at an acute angle.

Slate
a hard, brittle metamorphic rock consisting of clay minerals and characterized by good cleavage (cleavage is the quality of a crystallized substance or rock of splitting along definite planes) that is unrelated to the bedding in the earlier shale or clay from which it formed. It was a popular gravestone material of the eighteenth century, particularly in coastal areas. Many of the best-preserved examples of gravestone art are found in slate, an extremely stable stone.

Soapstone
massive soft rock that contains a high proportion of talc. It is occasionally used in gravestones.

Soiled/stained/discolored
A natural or man made condition that alters the original color or finish of the surface of the stones.

Soundness
the quality of a stone exhibits no sign of damage.

Spall
occurs when part of the stone flakes or splits away through frost action or pressure. As a noun, a chip or flake of stone.

Stele
an upright stone or commemorative slab commonly inscribed or embellished on one of the broader vertical surfaces; a grave marker type revived from classical antiquity.

Surface crusts
hard crusts that develop through movement of moisture towards the surface and outer edges of stone and deposition of dissolved material in those areas. Dark- colored crusts on sandstone result from a chemical reaction of the stone to airborne pollutants and often indicates disintegration of the stone behind the crust.

Table marker or stone
a rectangular grave covering consisting of a horizontal stone slab raised on legs, which sometimes are highly elaborate; also “table stone.”

Tablet stone
a stone grave marker consisting of a single piece of stone usually not more than three inches thick and set vertically in the ground; to be distinguished from a table stone or vault.

Tomb
a burial place for the dead.

Tomb recess
a niche or hollow in a wall that shelters a tomb.

Tympanum
a semicircular (or occasionally triangular) decorated face at the top of a tablet stone.

Vault
a burial chamber, commonly underground.

Appendix D

INFORMATION FOUND ON
MONUMENTS AND MARKERS

ORGANIZATION ABBREVIATIONS USED ON MONUMENTS AND MARKERS

Gravestone abbreviations are often a source of frustration to those surveying cemeteries. The following list compiled by Michael Joseph Mitchell, member of the Association for Gravestone Studies is one of the more complete lists available. The abbreviations on stones encountered in the cemetery should be viewed in their local, regional, and state context and their historical context, as there may be other interpretations of abbreviations.

AAONMS	Ancient Arabic Order of Nobles of the Mystic Shrine (Masonic)
AASR	Ancient and Accepted Scottish Rite (Masonic)
ABA	American Benefit Association
AF&AM	Ancient Free and Accepted Masons
ALOH	American Legion of Honor
AMD	Allied Masonic Degree
AMORC	Ancient and Mystical Order Rosae Crucis (Rosicrucians)
AMOS	Ancient Mystic Order of Samaratins (see IOOF)
AOF	Ancient Order of Foresters
AOH	Ancient Order of Hibernians
AOKMC	Ancient Order of Knights of Mystic Chain
AOUW	Ancient Order of United Workmen
APA	American Protective Association
AOM	Ancient Order of Mysteries (Masonic)
AUSA	Association of the United States Army
AUV	Association of Union Veterans
B of RTM	Brotherhood of Rail Road Track Men
BARE	Benefit Association of Railway Employees
BAY	Brotherhood of American Yeomen
BK of M	Black Knights of Molders
BKA	Benevolent Knights Association
BLE	Brotherhood of Locomotive Engineers
BLF&E	Brotherhood of Locomotive Firemen and Engineers
BPOE	Benevolent and Protective Order of Elks
BPOEW	Benevolent and Protective Order of Elks of the World
BRT	Brotherhood of Railway Trainmen
BSA	Boy Scouts of America
C of C	Children of the Confederacy
CAR	Children of the American Revolution
CBKA	Commandery Benevolent Knights Association
CBL	Catholic Benevolent Legion
CCTAS	Crusaders Catholic Total Abstinence Society
CDof A	Catholic Daughters of America

Abbreviation	Interpretation
CKof A	Catholic Knights of America
CMBA	Catholic Mutual Benefit Association
COOF	Catholic Order of Foresters
CSA	Confederate States Army
CSN	Confederate States Navy
CTAS	Catholic Total Abstinence Society
DAR	Daughters of the American Revolution
D.O.A./DA	Daughters of America
DAC	Daughters of the American Colonists
DAV	Disabled American Veterans
DOKK	Dramatic Order Knights of Khorassan (Knights of Pythias)
DoL	Daughters of Liberty
DOLLUS	Dames of the Loyal Legion of the United States
DON	Daughters of the Nile (Masonic)
DUV / DUVCW	Daughters of Union Veterans of the Civil War
EAA	Experimental Aircraft Association
EAU	Equitable Aid Union
EBA	Emerald Beneficial Association
FAA	Free and Accepted Americans
FCL	Fraternity, Charity, Loyalty, seen on some Union and Masonic stones
FMF	Fleet Marine Force
FOAST	Fraternal Order of Alaska State Troopers
FOE	Fraternal Order of Eagles
FOF	Fraternal Order of Firefighters
FOP	Fraternal Order of Police
GAR	Grand Army of the Republic
GSA	Girl Scouts of America
GALSTPTR	German American Legion of St. Peter
GLAUM	Grand Lodge Ancient Order of Mysteries-Masonic Order
GLDS	Grand Lodge Daughters of Scotia
GUOOF	Grand United Order of Odd Fellows
IBBH	International Brotherhood of Blacksmiths and Helpers
ICBU	Irish Catholic Benevolent Union
IOA	International Order of Alhambra
IODE	Independent Order, Daughters of the Empire
IOF	Independent Order of Foresters
IOGT	International Order of Good Templars
IOH	Improved Order of Heptasophs
IOI	Independent Order of Immaculates

Abbreviation	Interpretation
IOJD	Independent Order of Job's Daughters
IOKP	Independent Order of Knights of Pythias
IOOF	Independent Order of Odd Fellows
IOOF-PM	Independent Order of Odd Fellows Past Master
IOR	Independent Order of Rechabites
IORG	International Order of Rainbow Girls (Masonic)
IORM	Improved Order of Redmen
IOStL	Independent Order of St. Luke
IOV	International Order of Vikings
ISDA	Italian Sons and Daughters of America
ISH	Independent Sons of Honor
IUOM	Independent United Order of Mechanics
IWW	Industrial Workers of the World
JAOUW	Junior Order-Ancient Order of United Workmen
J.O.A.M.	Junior Order of American Mechanics
J.O.U.A.M.	Junior Order of United American Mechanics
K.of C.	Knights of Columbus
K.of P.	Knights of Pythias
K of FM / KFM	Knights of Father Matthew
K of H	Knights of Honor
K of L	Knights of Loyola
K of SJ	Knights of St. John
K of STP	Knights of St. Patrick
K of STW	Knights of St. Wenceslas
K of T / KT	Knights of Tabor
K of TM	Knights of the Macabees
KG	Knights of St. George
K.M. / KM	Knights of Malta (Masonic)
KM	Knights Militant (KKK)
K.T. / KT	Knights Templar (Masonic)
KGC	Knights of the Golden Chain
KGC	Knights of the Golden Circle
KGE	Knights of the Golden Eagle
KGL	Knight Grand Legion
KHC	Knights of the Holy Cross
KKK	Knights of the Ku-Klux-Klan
KLH	Knights and Ladies of Honor
KMC	Knights of the Mystic Chain
KOL	Knights of Labor

Abbreviation	Interpretation
KPC	Knights of Peter Claver
KSF	Knights of Sherwood Forest
KSL	Knights of St. Lawrence
KOTM	Knights of the Macabees
KSTG	Knights of St. George
KSTI	Knights of St. Ignatius
KSTJ	Knights of St. Joseph
KSTM	Knights of St. Martin
KSTP	Knights of St. Peter
KSTP	Knights of St. Paul
KSTT	Knights of St. Thomas
LAOH	Ladies Ancient Order of Hibernians
LGAR	Ladies of the Grand Army of the Republic
LKof A	Loyal Knights of America
LOL	Loyal Order Orange Lodge (The Orange Order) (Orange Men)
L.O.M.	Loyal Order of Moose
LOOM	Loyal Order of the MOOSE
LOVUS	Legion of Valor of the United States
MAW	Marine Air Wing
MBS	Mutual Benefit Society
MCL	Marine Corps League
M.W.A.	Modern Woodmen of America
MOPH	Military Order of the Purple Heart
MOS&B	Military Order of the Stars and Bars
MOVPER	Mystic Order of Veiled Prophets of the Mystic Realm (Grotto)
MOLLUS	Military Order of the Loyal Legion of the United States
NL	Navy League
NU	National Union
N.O.W.	Neighbors of Woodcraft
NCOA	Non-Commissioned Officers Association (Military Society)
NEOP	New England Order of Protection
NOK	New Order Knights (KKK)
NSDAR	National Society Daughters of the American Revolution
NSSUP	National Society Sons of Utah Pioneers
O of A	Order of Amaranth (Masonic)
O of UF	Order of United Friends
OCF	Order of Chosen Friends
OCR	Order of Confederate Rose
OES	Order of the Eastern Star

Abbreviation	Interpretation
OGC	Order of the Golden Crodd
OSC	Order of Scottish Clans (St. Andrews Societies)
ODHS	Des Schwestern Verbandes (Sisters of the Federation)
OUAM	Order of United American Mechanics
PFof A	Patriotic Friends of America
PH	The Order of Patrons of Husbandry (The Grange)
PM	Patriarchs Militant (Independent Order of Odd Fellows)
PBA	Police Benevolent Association
POW	Prisoner of War
RA	Royal Academy
RA	Royal Arcanum
RK	Roman Knights
R.A.M.	Royal Arch Masons
R.N.A.	Royal Neighbors of America
ROJ	Royal Order of Jesters (Masonic)
RMOKHSJ	Religious and Military Order of Knights of the Holy Sepulcher of Jerusalem
RO-AUM	Rosicrucian Order (Masonic)
RSGF	Royal Society of Good Fellows
RSM	Royal and Select Masons
RSTV	Rite of St.Vita
RSTV	Rite of St.Vaciara
RTT	Royal Templars of Temperance
S of E	Sons of England
S of St.G	Sons of St. George
SR	Scottish Rite (Masonic)
ST	Sons of Temperance
SV	Sons of Veterans of the United States of America
S.A.L.	Sons of the American Legion
SAR	Sisters of the American Revolution
SAR	Sons of the American Revolution
SBL	Society B. Lafayette
SCV	Sons of Confederate Veterans
SUV/SUVCW	Sons of Union Veterans of the Civil War
S.A.W.V.	Spanish American War Veteran
SBCL	Saint Bonifazius Catholic Union
SMAA	Scandinavian Mutual Aid Association
SNA-AUM	Shrine of North America (Masonic)
S.S.M.A.	Soldiers and Sailors Memorial Association
TCL	Tall Cedars of Lebanon (Masonic)

Abbreviation	Interpretation
TH	Temple of Honor and Temperance-Independent Order of Odd Fellows
TPLF	Temple of Honor and Temperance
TROA	The Retired Officers Association
UR	The Uniform Ranks designation
UCV	United Confederate Veterans
UDC	United Daughters of the Confederacy
UFL	Union Fraternal League
U.S.A.	United States Army
U.S.N.	United States Navy
U.S.A.F.	United States Air Force
U.S.C.G.	United States Coast Guard
U.S.M.C.	United States Marine Corps
UAOD	United Ancient Order of Druids
UOPF	United Order of Pilgrim Fathers
VFW	Veterans of Foreign Wars
W.C.	Woodmen Circle
W.O.W.	Woodmen of the World
W.O.W.	Women of Woodcraft
WKSC	White Knights of the Southern Cross (KKK)
YMCA	Young Men's Christian Association
YWCA	Young Women's Christian Association
MILITARY MARKERS	
BTN	Battalion
DIV	Division
ART	Artillery
INF	Infantry
CAV	Cavalry
CO	Company
PVT	Private
CPL	Corporal
SGT	Sergeant
WO	Warrant Officer
LT JG	Lieutenant Junior Grade
LT	Lieutenant
COM	Commander
CAPT	Captain
COL	Colonel
MAJ	Major
ADM	Admiral
GEN	General

COMMON LATIN PHRASES USED ON MARKERS

Yet another confusing part of reading tombstone inscriptions is the phrases that were often carved into the stone as an addition to the epitaph or simply as the epitaph. These phrases were carved in Latin and it was not uncommon for phrases such as those listed below to be inscribed on Catholic stones and Protestant stones in the twentieth century. The list, taken from the book *Iconography of Death* by Debi Hacker, will assist you in understanding the meaning of the inscription on the stones.

AB INITIO, AB FINEM	"From beginning to end"
AMOR DEI	"The love of God"
AVE MARIA, GRATIA PLENA	"Hail Mary, Full of Grace"
DEO VINDICE	"Latin for "God will Vindicate"
ECCE AGNUS DEI	"Behold, the Lamb of God"
FECIT	"Maker," meaning the stonecutter
FUGIT HORA	"Time Flies"
HIC DORMIT	"Here Rests..."
HIC IACET SEPULTUS	"Here lies buried..." also seen as initial H.I.S.
HIC PAUSAT	"Here Rests..."
HIC REQUIESCIT	"Here Rests..."
HIC SEPULTUS	"Here (lies) buried..." also seen as initials H.S.
HIC SITUS EST	"Here lies..."
IN MEMORIUM	"In memory of..."
LIBER VITAE	"The Book of Life." The Book of Life was believed to be a record of the elect, to be opened at the end of the world.
MANUS DEI	"Hand of God"
MEMENTO MORI	"Remember that you must die"
PAX	"Peace"
REQUIESCIT IN ISTO TUMOLO	"In this grave rests..."
REQUIESCIT IN PACE	"He/She rests in peace." Also seen as initials R.I.P.
SIC ITUR AD ASTRA	"Thus is accomplished the journey to the stars"
SIC TRANSIT GLORIA MUNDI	"So passes the glory of the world"
SPIRITUS SANCTUS	"The Holy Spirit"
SPUS SCUS	an abbreviation for the Latin phrase "Spiritus Sanctus"
VERUM DEI MANET IN AFTERNUM	"The word of God Endureth forever." Often inscribed on the open pages of the Bible on a tombstone. Also seen as initials V.D.M.A.
VOX CLAMANTIS IN DESERTO	"The voice (of one) crying in the wilderness"

SYMBOLS AND THEIR MEANINGS

Debi Hacker's book, *The Iconography of Death*, is the source of the following list of commonly used symbols.

Carving	Suggested Meaning
Acorn	Symbol of fertility and life, power of spiritual growth
Anchor	Hope; may represent sailing, seafaring or service in the Navy
Angels	Rebirth, protection, divine love, angels lead souls to heaven, praying angel looking up represents intercession
Apple	The fruit of salvation, does not represent the fruit eaten in the Garden of Eden
Arches	Roman symbol of the heavens; passage from this world into the next; triumph in death; journey to heaven
Arrow	When held by a cherub represents a spiritual weapon, dedicated to the service of God; represents death; could represent hunting or military if used with other weapons
Banner	Victory; God's love; triumph, rejoicing
Beehive	Symbol of a pious and unified community
Bed	A visual denial of death, as in "She is not dead, but sleepeth"
Bird	The soul; bird in flight represents the soul's flight to heaven
Book	Wisdom, knowledge, education; the Book of Life or record of the elect, which will be open at the end of the world
Bouquet	Life cut short, grief
Burning Flame	The soul; eternal life in the hereafter
Butterfly	Resurrection
Calla Lily	Marriage, fidelity
Cannon	Military service or profession
Celtic Cross	Union of heaven and earth
Chain	Links of the chain represents earthly existence; if one link is broken it represents the end of earthly existence; chain with three links represents the International Order of Odd Fellows
Chalice	Symbol of Christian faith
Cherub	Represents a heaven bound soul; spiritual resurrection; usually on children's stones
Clouds	Symbol of heaven, heavenly reward, or unseen God
Column	Broken column represents life cut short; column with facades represents heaven
Crown	Christian fortitude; victory over sin and death; promise of eternal life
Cypress	Devotion to God; immortality; eternal life; mourning
Dog	As man's best friend it represents watchfulness and fidelity
Door	Entry to Heaven
Dove	Purity of the soul; peace; in flight, represents the soul going to heaven, the Holy Ghost

Carving	Suggested Meaning
Eagle	The Christian soul strengthened by grace; may also represent nationalism, military profession, or Civil War veteran; Masonic symbol
Eye	All-knowing and ever-present God; Masonic symbol; Holy Trinity
Female Figure	Grief, sorrow
Fern	Humility, solitude and sincerity
Finger Pointing Downward	Deceased has been chosen by God
Finger pointing upward	Indicates that the soul has gone to heaven
Fleur-de-Lis	Trinity; the Virgin Mary; the three segments indicate faith, wisdom, and valor
Flowers	Goodness of life, abundant life; lushness of heavenly paradise
Garland	Victory in death
Gate	Death; heaven; reward of the faithful
Grapes	The grape is the symbol of the blood of Christ; spiritual resurrection
Hand	The hand of God
Hands Clasped	Farewell; hope of a meeting in heaven; union of marriage
Harp	Joy; worship; music of heaven; Irish descent; musical ability of deceased
Heart	Love; devotion; soul triumphant; courage
Hourglass	Symbol of mortality and the swift passing of earthly time
Ivy	Symbol of faithfulness and eternal life; death; friendship
Lamb	Symbol of Christ; innocence (found most often on a child's grave); on adult grave it represents a devout Christian; guidance from God
Lamp	Eternity; devotion to God; guidance and enlightenment from God; wisdom; piety; divine inspiration
Lily of the Valley	Devotion to God; purity, devotion; humility
Log	Divine harvest; end of life; Woodsman of the World symbol; part of the "rustic movement"
Masonic Compass	Freemasons
Moon	Eternity; sign of the second coming
Morning Glory	Shortness of a young life
Oak	Strength of faith and virtue; endurance of the Christian against adversity; Christ; Christian faith; valor
Obelisk	Eternal life; regeneration; when draped, represents mourning
Olive	Peace; marriage; fertility; family; crown or wreath of olives represents a spiritual victory
Open gates	The spirit entering heaven
Palm	Symbol of victory; reward of the righteous; a righteous man,
Peacock	Immortality through resurrection
Pine Cone	Ancient symbol for regeneration and fertility; immortality
Poppies	Rest; peace; mortality
Rainbow	God's throne; heaven; symbol of pardon and of the reconciliation given to the human race by God

Carving	Suggested Meaning
Rope	Binding together, as in a fraternal organization
Rose	Devotion to God; red rose represents martyrdom; white rose represents purity; paradise; the Virgin Mary; motherhood; rosebud represents a life cut short; love; grief
Scallop Shell	Birth; new life; baptism
Scythe	Death; end of life, divine harvest; man's mortality
Severed Branch	Death; end of life cycle
Sheaf of Wheat	Divine harvest; bounty of life; fruitful life; end of a fruitful life
Star	Divine guidance, Christ; heaven
Sun Shining	Christ; heavenly light; heaven
Swords	Military profession
Sword, broken	Life cut short
Swords, crossed	Represents ranking military person
Swords, points down	Death during military service
Sword held by angel	Justice and mercy; judgment
Thistle	Scottish descent; Scotland; earthly sorrow and sin
Tree	Tree of Knowledge; symbol of life or death, depending on whether the tree is healthy or cut down
Tree stump	Part of the "rustic" movement; symbol of Woodsman of the World; death is inevitable, end of life
Triangle	Holy Trinity
Trumpet	Praise of God; Judgment Day
Urn	Mortality; grief; draped urn represents mourning
Violet	Humility, a flower of spring represents youth; short life
Weeping Willow	Mourning; sorrow; Christian faith, spreading of the Gospel;
Wings	Symbol of divine mission; angels, archangels, seraphim and cherubim have wings
Winged Face/Head	The soul in flight, joyful resurrection
Winged Hourglass	Mortality, mans fleeting earthly existence
Wreath	Victory in death

Appendix E

PRESERVATION GUIDELINES

STANDARDS FOR PRESERVATION & REHABILITATION

The following standards for the preservation and rehabilitation of historic landscapes have been taken from the Secretary of the Interior's *Standards for the Treatment of Historic Properties and the Guidelines for the Treatment of Cultural Properties*. We include these standards in order to give some guidance in what is acceptable preservation practice. For an unabridged version of the secretary of the interior's guidelines, see the National Park Service web site or address in the resources section of the appendix.

Preservation Standards

1. A property will be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken.

2. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration necessitates repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color, and texture.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

REHABILITATION STANDARDS

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.
3. Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
4. Changes to a property that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterizes the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will be undertaken in such s manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

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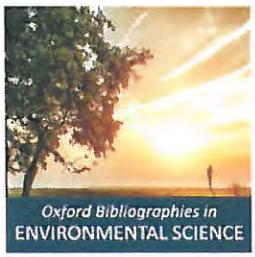
Cemetery ironwork (cleaning and repair, fence companies, fence styles, drawings, paint removal)
Cleaning headstones
Lawn maintenance
Measuring monuments (drawing)
Reading inscriptions on headstones

http://www.jahnmortars.com
Mortar mixes (no author)

In 1997 Gregg King joined the Canton Township Parks Division and within two years he found himself in charge of maintenance and preservation efforts at the township's three historic cemeteries. Looking for local contractors to aid in his work, Mr. King soon realized that there were almost as many opinions and methods as there were contractors. Realizing a need for a local, comprehensive and historically accurate source of historic cemetery conservation methods, he began the task of exhaustively researching, and synthesizing available information. This manual is the result of Gregg's years of investigation and research obtaining information from organizations such as the Association for Gravestone Studies and the National Preservation Institute. It is written in collaboration with Kosky Glynn & Saborio LLC, Historic Preservation Consultants, and with the enthusiastic support and financial aid of Canton Township and the Michigan State Historic Preservation Office. For local governments, cemetery and civic organizations, and laypersons involved in cemetery care and conservation it is an easy to follow and user-friendly guide and source book which guides the reader through the process, from documentation to cleaning and repair as well as landscape considerations. For Michigan it is an aid in preserving its small historic cemeteries using in part the Secretary of the Interior's *Guidelines for Historic Preservation*. For Gregg King it is an offering to those who find themselves considering a cemetery conservation project in hopes that it will assist them in their journey.

Potential dangers of glyphosate weed killers



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BY DEVRA DAVIS (HTTP://BLOG.OUP.COM/AUTHORS/DEVRA-DAVIS/) MARCH 19TH 2016

What do Norway, Denmark, Sweden, Sri Lanka, El Salvador, Brazil, and India have in common? They have banned the use of Roundup (http://news.nationalgeographic.com/2015/04/150422-glyphosate-roundup-herbicide-weeds/)—the most heavily applied herbicide in the United States. Why have these nations acted against what is the most heavily used herbicide in the world today? This is because of growing reports of serious illness to farmworkers and their families. Thanks to a little known provision in US law governing pesticides (http://www.epa.gov/ingredients-used-pesticide-products/types-pesticide-ingredients) (the overarching category defined by the EPA for pesticides, herbicides, fungicides, and rodenticides), industry experts sit side by side with government officials in determining what is and is not toxic. In these other nations, far less cozy arrangements exist and reports of tragic illness have spurred direct and immediate actions.

To understand what inspired these disparate nations to restrict a pesticide widely dispersed in garages, schoolyards, golf courses, and farmland around America today, it's important to consider the close tie between glyphosate (the main ingredient in Roundup) and the production (http://www.monsanto.com/products/pages/monsanto-agricultural-seeds.aspx) of corn, cotton, soybeans, alfalfa, canola, sorghum, sugar beets, and wheat. Seeds for these major US commercial crops have been genetically engineered to resist the toxic effect Roundup has on weeds. Physicians report (https://www.organicconsumers.org/old_articles/documents/INGLES-Report-from-the-1st-National-Meeting-Of-Physicians-In-The-Crop-Sprayed-Towns.pdf) that rates of serious birth defects in one of Argentina's poorest regions, Chaco, quadrupled the decade after glyphosate was introduced, while that of chronic kidney disease is soaring in young men and women in Central America, India, and other heavily sprayed regions.

This past June, a group of experts advising the World Health Organization (WHO) known as the International Agency for Research on Cancer (IARC) unanimously determined that glyphosate is probably a human carcinogen (http://jech.bmj.com/content/early/2016/03/03/jech-2015-207005.extract) ("Group 2A" in the IARC Monographs on the Evaluation of Carcinogenic Risks to Humans (http://monographs.iarc.fr/ENG/Classification/)). Other agents identified as Group 2A include jet fuel, engine exhausts, a number of pesticides, and tars—all of which are subject to stringent controls today. More recently, nearly 100 scientists joined in rejecting the European Food Safety Agency assurance that Roundup was not toxic.

Herbicide by wuzefe. CC0 Public Domain via Pixabay (https://pixabay.com/en/herbicide-avignon-in-rice-field-587589/).

Underlying the WHO evaluations over the past four decades is one simple fact: Every agent known to cause cancer in humans also causes it in animals when adequately studied. Whenever experimental studies indicate a compound causes cancer in animals, it should be regarded as if it causes cancer in humans.

If glyphosate were a drug, it would never have been allowed to market.

Drugs are put into medical practice only after experiments establish that a novel agent might alleviate disease in animals. Monsanto began selling glyphosate in Roundup in 1973. It didn't complete animal tests until 1981. When those tests produced a rare form of kidney cancer, industry sponsored scientists effectively discredited them.

In the case of glyphosate and cancer, one important animal study stands out. That study used a type of mouse bred to never get the disease. Four animals exposed to glyphosate developed the same very rare cancer in a single study. Not a single case of cancer was expected. The chances of that happening are close to one in a billion. Of course, people are not rodents. But the human genome project has shown that we differ from the mouse by less than one percent of all our genetic material. If studies with mice guide the pharmaceutical industry, how can we deny their relevance to toxic chemicals?

With tobacco, asbestos, vinyl chloride, hormone replacement therapy, diagnostic radiation, some metals, exhaust gases, chlorinated solvents, and a host of other agents, we got it backwards. Reports of their detrimental impacts surfaced decades before steps were finally taken to discourage their widespread use.

We are flying blind when it comes to understanding the risks of glyphosate—along with malathion and diazonon and other pesticides—because we have assumed them to be innocent until proven guilty. To the contrary, pesticides should not be accorded the rights of the accused in a criminal trial. By their very nature pesticides are designed to kill things and indeed there are times, as with epidemics such as equine-encephalitis, that we need to employ them for that purpose.

Studies of people with high exposures to glyphosate or other pesticides, including farmers, pesticide applicators, crop duster pilots, and manufacturers, have found high rates of blood and lymphatic system cancers, cancers of the lip, stomach, lung, brain, and prostate, as well as melanoma and other skin cancers. But what about the rest of us who may be exposed as golfers, lawn applicators, home gardeners, school children, ball players, and the like? We must rely on animal experiments, coupled with studies of those with high exposures, to predict risk in order to prevent harm.

What are we to do now? While industry spokespersons assure us that these other governments are just uninformed and ill-advised, their growing numbers alone should give us pause. There's been a disturbing pattern in US law of late that places us all at risk. Recent interpretations of the *Daubert* (http://www.americanbar.org/newsletter/publications/gp_solo_magazine_home/gp_solo_magazine_index/walsh.html) standard of evidence increasingly mean that only *after* harm has been demonstrated to have taken place can steps be taken to reduce exposures to a suspect agent. This ignores and undermines the fundamental goal of public health: Preventing harm by reducing risk.

With glyphosate and other toxic agents we cannot and should not wait for additional proof that low levels of exposure affect our health, before taking steps to reduce our exposures. We must rely on animal experiments coupled with studies of those with high exposures in efforts to reduce the burden of cancer and other diseases. To do otherwise treats ourselves and our children as lab rats in an experiment without any controls.

Featured image credit: Crop by PublicDomainPictures. CC0 Public Domain via Pixabay (https://pixabay.com/en/agriculture-chemical-crop-equipment-89168/).

***Devra Davis**, PhD, MPH is an award-winning writer and President of Environmental Health Trust. She is a Visiting Professor of Medicine at the Hadassah Medical Center and Ondokuz Mayis University Medical Center. She is also a member of the Founding Editorial Board of Oxford Bibliographies in Environmental Science (http://www.oxfordbibliographies.com/obo/page/environmental-science/).*

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[…] animal extraordinaire. The key issue is that we are, in the words of Dr Devra Davis, 'flying blind when it comes to understanding the risks of glyphosate'. Much of the science is out of date and a far more comprehensive approach to assessing the […]

IMNAHA 24TH MARCH 2016

The glyphosate "issue" is the hidden 90 percent of the GMO iceberg. Glyphosate is the Achilles heel of the industrialized food industry and they know it. That is why the industry has done everything they can to keep public focus ON labeling and OFF the fact that glyphosate is widely used (as a dessicant) on many NON GMO crops like oats, barley. and sugar cane. Once it is widely recognized that your morning bowl of NON GMO Cherrios, your favorite beer or candy bar all contain glyphosate, the REAL battle will be joined. In the meantime the consumer's only protection is to buy organic, locally sourced (if possible) food.

Martin Weatherall 25TH MARCH 2016

Here is some more information about the dangers of Roundup:

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NATIONAL GEOGRAPHIC

http://news.nationalgeographic.com/2015/04/150422-glyphosate-roundup-herbicide-weeds.html

What Do We Really Know About Roundup Weed Killer?

It's probably in your garage and on your lawn. And it's used on nearly every acre of corn and soy. But what risks does it pose?

By **Elizabeth Grossman**, National Geographic

PUBLISHED APRIL 23, 2015

A farmer in central Illinois sprays his cornfield with glyphosate. Seeds have been genetically engineered to tolerate the chemical so farmers can apply it to entire fields without destroying crops. As a result, its use has skyrocketed but some experts say research is needed exploring what happens to it in the environment and how much people are exposed.
PHOTOGRAPH BY SETH PERLMAN, AP

The world's most widely-used herbicide has been getting a lot of attention lately.

Last month, an international agency declared glyphosate, the primary ingredient in the popular product Roundup, a "probable human carcinogen." The weed killer also has made recent headlines for its widespread use on genetically modified seeds and research that links it to antibiotics resistance and hormone disruption. Several national governments are planning to restrict its use, and some school districts are talking about banning it.

So what do we know about glyphosate? Five key questions and answers:

How Is Glyphosate Used?

Introduced commercially by Monsanto in 1974, glyphosate kills weeds by blocking proteins essential to plant growth. It is now used in more than 160 countries, with more than 1.4 billion pounds applied per year.

Glyphosate, often sold under the brand name Roundup, is probably in your garage or shed because it's ranked as the second most widely used U.S. lawn and garden weed killer. These products have been promoted as easy-to-use and effective on poison ivy, kudzu, dandelions, and other weeds.

But the primary use is by agriculture. Nearly all the corn, soy, and cotton now grown in the United States is treated with glyphosate.

Its use skyrocketed after seeds were genetically engineered to tolerate the chemical. Because these seeds produce plants that are not killed by glyphosate, farmers can apply the weed killer to entire fields without worrying about destroying crops. Between 1987 and 2012, annual U.S. farm use grew from less than 11 million pounds to nearly 300 million pounds.

"By far the vast use is on [genetically engineered] crops – corn, soy and cotton – that took off in the early to mid-nineties," says Robert Gilliom, chief of surface water assessment for the US Geological Survey's National Water Quality Assessment Program.

In addition, some five million acres in California were treated with glyphosate in 2012 to grow almonds, peaches, onions, cantaloupe, cherries, sweet corn, citrus, grapes, and other edible crops.

Glyphosate, marketed by Monsanto as Roundup, is the second most popular weed killer for residential yards and gardens.
PHOTOGRAPH BY J. BLUE, BLOOMBERG/GETTY

What Happens to Glyphosate in the Environment?

Despite its widespread use, USGS hydrologist Paul Capel said there is "a dearth of information" on what happens to it once it is used.

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Glyphosate is not included in the U.S. government's testing of food for pesticide residues or the monitoring of chemicals in human blood and tissues. As a result, there is no information on how much people are exposed to from using it in their yards, living near farms or eating foods from treated fields.

A recent USGS study sampled waterways in 38 states and found glyphosate in the majority of rivers, streams, ditches, and wastewater treatment plant outfalls tested. Not much was found in groundwater because it binds tightly to soil.

Glyphosate also was found in about 70 percent of rainfall samples. It "attaches pretty firmly to soil particles" that are swept off farm fields then stay in "the atmosphere for a relatively long time until they dissolve off into water," Capel says.

What About Exposure Through Food?

Before genetically engineered crops, glyphosate residues in food were considered unlikely, says Charles Benbrook, research professor at Washington State University's Center for Sustaining Agriculture and Natural Resources. But since about 2005, pre-harvest use of glyphosate "results in very high residues," he says. Traces were found in 90 percent of 300 soybean samples.

So what is the likelihood of exposure? The people most likely to be exposed are working on or living near farms where glyphosate is used, says University of California, Irvine professor Bruce Blumberg.

What Is known About Effects on Human Health?

The U.S. Environmental Protection Agency had determined that the science "does not provide evidence to show that glyphosate causes cancer." But now the EPA says it will analyze new findings by the UN's International Agency for Research on Cancer, which declared in March that glyphosate probably raises the risk of cancer in people exposed.

The UN agency based its decision on human, animal, and cell studies, says National Cancer Institute scientist emeritus, Aaron Blair who chaired the IARC review committee. The studies found glyphosate in farmworkers' blood and urine, chromosomal damage in cells, increased risks of non-Hodgkin lymphoma in some people exposed, and tumor formation in some animal studies.

The big unanswered question is the potential health effect of low levels over extended periods of time.

Monsanto called the IARC conclusion "inconsistent with decades of ongoing comprehensive safety assessments." The American Soybean Association and National Corn Growers Association also denounced the finding. CropLife America, a trade association representing pesticide manufacturers, says, "It's important to remember that glyphosate acts on an enzyme that exists only in plants and not mammals, contributing to the low risk to human health."

One study suggests that glyphosate may affect pathogens such as *Salmonella* in ways that can contribute to antibiotic resistance. Other recent research suggests it can interfere with hormones.

Yet the really big unanswered question is the potential health effect of low levels over extended periods of time.

So Where Does This Leave Us?

The EPA is reviewing its approved uses of glyphosate and expects to release a preliminary assessment of the human health risk later this year. This is expected to include new restrictions.

Meanwhile, Sri Lanka, alarmed by suspected links to human kidney disease, has banned it. Brazil is considering a similar move. Mexico and the Netherlands have imposed new restrictions, and Canada has just begun a process to consider new rules.

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W.H.O. Report Links Ingredient in Roundup to Cancer

By REUTERS
MARCH 20, 2015

The world's most widely-used weed killer can "probably" cause cancer, the World Health Organization said on Friday.

The organization's cancer arm, the International Agency for Research on Cancer, said glyphosate, the active ingredient in the Monsanto herbicide Roundup, was "classified as probably carcinogenic to humans." It also said there was "limited evidence" that glyphosate was carcinogenic in humans for non-Hodgkin lymphoma.

Monsanto, the world's largest seed company, said scientific data did not support the conclusions and called on the group to hold a meeting to explain the findings.

"We don't know how IARC could reach a conclusion that is such a dramatic departure from the conclusion reached by all regulatory agencies around the globe," Philip Miller, Monsanto's vice-president for global regulatory affairs, said in a statement.

The U.S. government says glyphosate is considered safe. It is mainly used on crops like corn and soybeans that are genetically modified to survive it.

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CITY COUNCIL MEETING MINUTES

October 11, 2016

CALL TO ORDER:

The Jackson City Council met in regular session in the City Hall and was called to order at 6:32 p.m. by Mayor Bill Jors.

PLEDGE OF ALLEGIANCE AND INVOCATION:

The Council joined in the Pledge of Allegiance. Invocation was given by Freddie Dancy, 2nd Ward City Councilmember.

ROLL CALL:

Present: Mayor Bill Jors, Councilmembers Arlene Robinson, Freddie Dancy, Daniel P. Greer, Craig Pappin, Andrew R. Frounfelker, and Derek J. Dobies.

Also present: City Manager Patrick Burtch, City Attorney Bethany Vujnov, City Treasurer/Clerk Andrew J. Wrozek, Jr., City Assessor Jason Yoakam, Director of Police and Fire Matthew Heins, Deputy Fire Chief Dave Wooden, and City Engineer Jon Dowling.

ADOPTION OF AGENDA:

Motion was made by Councilmember Greer to add an action item under New Business regarding the Safer Grant 13E, seconded by Councilmember Pappin. Votes - Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

Moved by Councilmember Dobies to add agenda item 13F regarding discussion of Non Discrimination within the City for potential action, seconded by Councilmember Dancy. Votes – Yeas: Councilmember Dobies and Dancy. Nays: Mayor Jors, Councilmembers Robinson, Greer, Pappin, and Frounfelker. Motion fails.

Motion was made to adopt the agenda as presented by Councilmember Greer, seconded by Councilmember Pappin. Votes - Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

CITIZEN COMMENTS:

Public comment time was opened. Comments were heard and the meeting resumed.

PRESENTATIONS/PROCLAMATIONS. None.

PETITIONS & COMMUNICATION. None.

EXECUTIVE SESSION to discuss a written legal opinion and collective bargaining:

Motion was made by Councilmember Greer, seconded by Councilmember Dancy to suspend Open Session and go into Executive Session. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin and Frounfelker, and Dobies (7). Nays: none.

RETURN TO OPEN SESSION:

Motion was made by Councilmember Frounfelker, seconded by Councilmember Greer to return to Open Session. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin and Frounfelker. (6). Nays: none. Absent from vote: Councilmember Dobies.

CONSENT CALENDAR:

A. Minutes of the Regular Meeting of September 20, 2016:
Approve the minutes of the regular City Council meeting of September 20, 2016.

B. Human Relations Commission Appointment:
Mayor's recommendation to appoint Hassan Ahmad to the Human Relations Commission filling a current vacancy beginning immediately and ending December 31, 2018, in accordance with the Human Relations Commission recommendation.

C. Region 2 Planning Commission:
Mayor's recommendation to reappoint Laura Schlecte to the Region 2 Planning Commission for a three year term, beginning December 1, 2016, and ending November 30, 2019.

D. Building Board Code of Examiners and Appeals Appointment:
Mayor's recommendation to replace City Manager Patrick Burtch with Mark Fish, Neighborhood and Economic Operations, Inspection Division to serve on the Building Code Board of Examiners and Appeals.

E. City Summary of Revenue and Expenditures:
Receive the City of Jackson's summary of revenue and expenditures for two (2) months ended, August 31, 2016.

F. CDBG and HOME Financial Statements through August 31, 2016:
Receive the Community Development Block Grant (CDBG) and HOME Financial Summaries through August 31, 2016.

G. Jackson YMCA Turkey Trot:
Approve the request from the Jackson YMCA Turkey Trot to conduct their 12th annual Jackson YMCA Turkey Trot on November 24, 2016 from 6:30 a.m. until 11:00 a.m. starting at 127 W. Wesley. (Contingent upon receipt of proper insurance coverage.)

Motion was made by Councilmember Greer, seconded by Councilmember Robinson to approve the Consent Calendar. Votes - Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, and Frounfelker. (6). Nays: none. Absent from vote: Councilmember Dobies. Motion carried.

PUBLIC HEARINGS:

Motion was made by Councilmember Robinson, seconded by Councilmember Dancy to open the public hearing. Roll call votes: all yes. Motion carried.

A. Public Hearing to Rezone 707 Madison Street and 1216 Clinton Street:
Public hearing on the request to rezone from R-4 (High Density Apartment and Office) to C-4 (General Commercial).

1. Ordinance amending Chapter 28, Section 28-32, City Code, to rezone 707 Madison Street and 1216 Clinton Street from R-4 (High Density Apartment and Office) to C-4 (General Commercial). (City Planning Commission recommended approval.)

   Sam Thomas, Architectural Designer for Brian Grove, Inc. was available for questions. Resident at 702 Center St. asked a question regarding payment of demolition. Motion was made by Councilmember Frounfelker, seconded by Robinson to close the public hearing and to continue in open session. Roll call votes: all yes. Motion carried.

OTHER BUSINESS:

A. **Ordinance – Revisions to Section 13-9, Chapter 13 – Historic Preservation (Second/Final Reading).**
Recommendation: Final adoption of Ordinance No. 2016-27, amending Section 13-9, Chapter 13, City Code, in an effort expedite the appeal process by revising language adopted from the Local Historic Districts Act to safeguard the heritage of the City of Jackson.

Motion was made by Councilmember Greer, seconded by Councilmember Robinson to approve final adoption. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

B. **Change Order 1 (Deduct) to the 2016 Sewer Rehabilitation Contract with Insituform Technologies USA, LLC.**
Recommendation: Approve Final Balancing Change Order 1 (Deduct) to the Contract with Insituform Technologies USA, LLC for the 2016 Sewer Rehabilitation contract in the decreased amount of $21,393.38 to balance contract quantities for various items that are complete to match quantities placed in the field, to add items that were necessary to complete the work in the field, and authorize the City Manager and City Engineer to execute the appropriate document.

Motion was made by Councilmember Greer, seconded by Councilmember Frounfelker to approve. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

C. **City Assessor Position and Employment Agreement.**
Recommendation: Consider an Employment Agreement for the position of City Assessor as discussed at the September 27, 2016, City Council meeting.

Motion was made by Councilmember Greer, seconded by Councilmember Frounfelker to approve employment agreement for the Assesor. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

NEW BUSINESS:

A. **Resolution for Halloween.**
Recommendation: Approve a resolution establishing Halloween hours between 6:00 p.m. and 8:00 p.m. on Monday, October 31, 2016, encouraging all children to "trick or treat" during that time period.

Motion was made by Councilmember Frounfelker, seconded by Councilmember Robinson to approve. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

B. Resolution for Byrne JAG Grant Budget Amendment and Purchase Authorization.

Recommendation: Resolution amending the 2016/17 budget to reflect the receipt of the Byrne Justice Assistance Grant (JAG) in the amount of $35,801.00, authorization to proceed with the purchase of a police K9 and associated equipment, and authorize the Mayor to execute the appropriate document(s).

Motion was made by Councilmember Frounfelker, seconded by Councilmember Robinson to approve. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

C. Central Fire Station Roof Project.

Recommendation: Accept the bid submitted by McDonald Roofing in the amount of $134,932.00, and commence replacement of the remaining section of roof at the Central Fire Station, and authorize the Mayor and City Treasurer/Clerk to execute the appropriate document(s).

Motion was made by Councilmember Greer, seconded by Councilmember Frounfelker to accept the bid submitted by McDonald. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

D. Three (3) Year Professional Services Agreement to Conduct and Maintain the City of Jackson Cross Connection Control Program.

Recommendation: Approve a Professional Services Agreement with HydroCorp, Troy, for continuation of the City's Cross Connection Control Program at a cost of $133,128.00 over the three (3) year term of this agreement, and authorize the Mayor to sign the Agreement and the City Attorney to make minor modifications and take all actions necessary to finalize the agreement.

Motion was made by Councilmember Greer, seconded by Councilmember Frounfelker to approve a Professional Services Agreement. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Dancy, Greer, Pappin, Frounfelker, and Dobies (7). Nays: none. Motion carried.

E. SAFER Grant.

Motion was made by Councilmember Greer, seconded by Councilmember Pappin to authorize the City Manager to accept SAFER Grant if the City and the Fire Fighters Union reach an agreement on these following issues which may impact the City's future economic condition: 1. Wages. 2. Length of service and cap for full service pensions. 3. Annuity withdraws from the pension system at retirement. Final average compensation for pension calculations. 5. Health Insurance. 6. Employment of SAFER Grant funded Employees. Any agreement on these issues must be through the duration of the full successor agreement. Votes – Yeas: Mayor Jors, Councilmembers Robinson, Greer, Pappin, and Frounfelker, and Dobies (6). Nays: Councilmember Dancy (1). Motion carried.

CITY COUNCILMEMBERS' COMMENTS.

MANAGER'S COMMENTS.

ADJOURNMENT:

No further business being presented, motion was made to adjourn by Councilmember Dancy, seconded by Councilmember Greer. Motion carried. Mayor Jors closed the meeting at 9:45 p.m.

CITY OF
JACKSON
Founded 1829

Office of the Mayor

161 W. Michigan Ave. • Jackson, MI 49201
Phone: (517) 788-4028 • Facsimile: (866) 384-1772

MEMO TO: City Councilmembers

FROM: William C. Jors, Mayor

DATE: October 25, 2016

SUBJECT: Downtown Development Authority

RECOMMENDATION:

Approval of the Mayor's recommendation to appoint Karen Bunnell to the Downtown Development Authority filling a current vacancy, beginning immediately and ending March 31, 2018.

In accordance with City Code Section 2-401 providing for creation of Authority pursuant to Act 197 of the Public Acts of 1975, adopted 3/22/77 and City Commission resolution adopted 11/26/91. Members are appointed by the Mayor subject to Council confirmation, for four year terms. The Mayor serves during term of office. The Board shall consist of 13 members, with at least seven having an interest in downtown district property, and at least one member a resident of the downtown district, including the Midtown Association president.

It is my recommendation therefore to appoint Karen Bunnell to the Downtown Development Authority filling a current vacancy, beginning immediately and ending March 31, 2018.

WCJ:skh

APP-CC

CITY OF JACKSON
Founded 1829

Office of the Mayor

161 W. Michigan Ave. • Jackson, MI 49201
Phone: (517) 788-4028 • Facsimile: (866) 384-1772

CITY OF JACKSON BOARD/COMMISSION APPLICATION

NAME: Karen Bunnell

ADDRESS: 223 W Washington Ave Apt E ZIP: 49201

HOME PHONE: 517-917-7832 OTHER PHONE: 517-936-2015

E-MAIL ADDRESS: karen@barkerweber.com

OCCUPATION: Insurance - Group Benefits Admin & Account Exec.

COMMUNITY INVOLVEMENT

Jackson Young Professionals Daughters of the American Revolution
Energizing Education Art, Beer & Wine Festival

Are you registered voter? Yes Ward? 5

Which Board or Commission(s) are you interested in?

1. Downtown Development 2. _____ 3. _____

List additional information you feel may be pertinent to the board or commission

Feel free to attach any information. (Resume, press clippings)

APPLICATION WILL BE KEPT ON FILE FOR ONE YEAR.

Signature of Applicant

6-27-16
Date

223 W Washington AVE, APT E, Jackson, MI 49201 • 517.917.7832 • karen@barkerweber.com

Karen T. Bunnell

Personal Statement

Since moving back to Jackson, I have dedicated my time and energy serving my community, whether through my job at Barker Weber Insurance Agency, the Social Events Committee for Jackson Young Professionals and different organizations and events throughout the year. Growing up, I couldn't wait to get out of Jackson and now I don't want to leave. I love all of the things that are happening in here and being a part of what is making it a great place to live is amazing.

Skills

- Proficient in multiple social media platforms
- Knowledgeable of Adobe Creative Suite software and Microsoft Office
- Marketing
- Medicare and under 65 health insurance
- Event planning
- Public speaking

Employment History

Group Benefits Administrator & Account Executive	Barker Weber Insurance Agency, Jackson, MI	December 2013 - present
Review Specialist	Inovalon, Lansing, MI	2011-2013
Relations Consultant	Lucki Multimedia, Fayetteville, NC	2010

Education

Bachelor of Arts in Communication	Spring Arbor University, Spring Arbor, Mich.	May 2010

Awards

- Jackson Magazine 30 and Under Class of 2015

Community Involvement

- Art, Beer and Wine Festival – 2015 and 2016
- How Bazaar – 2015
- Jackson Young Professionals – member since 2015
- Jackson Young Professionals – Social Events Committee since 2015
- Energizing Education – mentor at Cascades Elementary School – 2015-2016
- Daughters of the American Revolution (DAR), Sarah Treat Prudden Chapter – member since 2015, Corresponding Secretary June 2016 – present

JOAN CAMPAU

joan.campau@gmail.com 811 Oakridge, Jackson, MI 49203 (517) 740-0884

October 8, 2016

Office of the Mayor
161 W. Michigan Avenue
Fourteenth Floor
Jackson, MI 49201

To Whom It May Concern:

I am writing to submit my resignation from the Ella Sharp Park Board of Trustees, as I no longer reside in Jackson. I was grateful for the opportunity to sit on the board and wish you continued success.

Please don't hesitate to contact me if further information or action is required.

Cordially,

Joan Campau

RECEI
OCT 1 3
BY:

October 14, 2016

The Honorable Mayor and City Councilmembers
City of Jackson
161 W. Michigan Avenue
Jackson, MI 49201

Dear Mayor Jors and City Councilmembers,

It is with regret that I find that I need to resign my position as Administrative Hearings Bureau officer effective August 15, 2016. It has been my pleasure to serve the citizens of Jackson.

Sincerely,

Charles H. Aymond

Charles H. Aymond
6075 Browns Lake Road
Jackson, MI 49203

CITY OF JACKSON
Founded 1829

City Manager's Office

161 W. Michigan Ave. - Jackson, MI 49201
Phone: (517) 788-4035 • Facsimile: (517) 768-5820

MEMO TO: Mayor and City Councilmembers

FROM: Patrick H. Burtch, City Manager PHB

DATE: October 25, 2016

SUBJECT: CDBG and HOME Financial Summaries through September 30, 2016

Recommendation:

Accept and place on file the CDBG and HOME Financial Summaries through September 30, 2016.

Attached is a memo from Jennifer Morris, Director of Neighborhood and Economic Operations, regarding the September 2016 CDBG and HOME financial summaries which denotes personnel costs, assistance to one eligible homeowner for rehabilitation, assistance to one eligible homeowner for emergency hazard repair, and nine awarded demolition contracts.

I recommend Council receive the attached CDBG and HOME Financial Summaries through September 30, 2016 and place on file. Your consideration and concurrence is appreciated.

PHB

DEPARTMENTAL REPORT

MEMO TO: Patrick Burtch, City Manager

FROM: Jennifer Morris, Director of Neighborhood and Economic Operations

DATE: October 25, 2016

RECOMMENDATION: To accept and place on file the CDBG and HOME Financial Summaries through September 30, 2016

SUMMARY

Attached please find the Financial Summaries for the CDBG and HOME funds for the three-months ending September 30, 2016. Monthly expenses include personnel costs, assistance to one eligible homeowner for rehabilitation, assistance to one eligible homeowner for emergency hazard repair, and nine awarded demolition contracts.

My recommendation is to accept and place on file the CDBG and HOME Financial Summaries through September 30, 2016.

ATTACHMENTS

City of Jackson
Community Development Block Grant
Monthly Financial Summary
For the Three Months Ended September 30, 2016

		Budgeted	Expended Prior Year	Actual Month-to-Date	Actual Year-to-Date	Total Funds Expended-to-Date	Balance	Percent Spent
	Public Services							
1	King Center Summer Program							
	FY 2015/2016	35,000	31,242	-	3,390	34,632	368	98.9%
	Administration							
2	Administration & Planning							
	FY 2015/2016	66,500	29,201	4,835	21,935	51,136	15,364	76.9%
	FY 2016/2017	97,500	-	-	-	-	97,500	0.0%
	Code Enforcement							
3	City Code Enforcement - Inspection							
	FY 2014/2015	131,500	107,466	8,457	24,034	131,500	0	100.0%
	FY 2015/2016	46,000	-	8,698	9,621	9,621	36,379	20.9%
	FY 2016/2017	144,000	-	-	-	-	144,000	0.0%
4	City Code Enforcement - Rehabilitation							
	FY 2015/2016	89,000	1,518	8,748	15,911	17,429	71,571	19.6%
	FY 2016/2017	86,750	-	-	-	-	86,750	0.0%
5	City Attorney Office							
	FY 2013/2014	20,000	8,970	2,369	5,464	14,434	5,566	72.2%
	Housing Rehabilitation Projects							
6	Homeowner Rehabilitation							
	FY 2013/2014	221,358	177,607	43,751	43,751	221,358	(0)	100.0%
	FY 2014/2015	77,284	-	36,145	36,145	36,145	41,139	46.8%
	FY 2015/2016	98,886	-	-	-	-	98,886	0.0%
	FY 2016/2017	75,000	-	-	-	-	75,000	0.0%
7	City Emergency Hazard Repair Program							
	FY 2015/2016	150,000	35,025	8,967	6,876	41,901	108,099	27.9%
	FY 2016/2017	77,316	-	-	-	-	77,316	0.0%

		Budgeted	Expended Prior Year	Actual Month-to-Date	Actual Year-to-Date	Total Funds Expended-to-Date	Balance	Percent Spent
8	Downtown-Investor Rehabiliation							
	FY 2015/2016	305,212	-	-	-	-	305,212	0.0%
	FY 2016/2017	300,000	-	-	-	-	300,000	0.0%
9	John George Home	35,000	25,895	-	-	25,895	9,105	74.0%
10	City Rehab Administration (Denied Loans)							
	FY 2014/2015	8,000	4,375	59	133	4,508	3,492	56.4%
	FY 2015/2016	3,000	-	-	-	-	3,000	0.0%
	FY 2016/2017	3,000	-	-	-	-	3,000	0.0%
	Street Projects							
11	Edward & Winthrop							
	FY 2015/2016	97,890	4,287	-	93,603	97,890	-	100.0%
	FY 2016/2017	198,110	-	-	-	-	198,110	0.0%
12	Mechanic: Morrell to Washington							
	FY 2016/2017	111,900	-	-	-	-	111,900	0.0%
13	Special Assessments (FY 2015/2016)	25,000	6,338	-	2,386	8,724	16,277	34.9%
	Other Projects							
14	Park Improvements							
	FY 2014/2015	524,985	514,967	-	-	514,967	10,018	98.1%
	FY 2015/2016	80,000	-	-	-	-	80,000	0.0%
	FY 2016/2017	20,000	-	-	-	-	20,000	0.0%
	Public Improvements							
15	Demolition - Neighborhood Economic Stabilization							
	FY 2013/2014	155,000	154,144	12,246	856	155,000	0	100.0%
	FY 2014/2015	185,000	185,000	1,667	(0)	185,000	0	100.0%
	FY 2015/2016	320,000	43,253	100,313	95,258	138,511	181,489	43.3%
	FY 2016/2017	136,125	-	-	-	-	136,125	0.0%

City of Jackson
HOME
Monthly Financial Summary
For the Three Months Ended September 30, 2016

	Budgeted	Total Prior Year Funds Expended	Actual Month-to-Date	Actual Year-to-Date	Total Funds Expended-to-Date	Balance	Percent Spent
1 Rehabilitation Assistance Program							
FY 2015/2016	187,129	145,486	-	-	145,486	41,643	77.7%
FY 2016/2017	188,340	-	-	-	-	188,340	0.0%
2 HOME Administration							
FY 2016/2017	25,000	-	-	-	-	25,000	0.0%
3 CAA - CHDO Operting Expenses							
FY 2013/2014	12,500	-	-	-	-	12,500	0.0%
FY 2015/2016	7,527	-	-	-	-	7,527	0.0%
4 CAA - CHDO Acq/Rehab/Resale							
FY 2016/2017	37,650	-	-	37,650	37,650	-	100.0%

CITY OF JACKSON
Founded 1829

City Manager's Office

161 W. Michigan Ave. - Jackson, MI 49201
Phone: (517) 788-4035 • Facsimile: (517) 768-5820

MEMO TO: Mayor and City Council Members

FROM: Patrick H. Burtch, City Manager

DATE: October 25, 2016

SUBJECT: Special Event Application for the Annual Jackson Christmas Parade.

Recommendation:

Approve a request from the Downtown Jackson Christmas Parade to conduct their 26th annual Jackson Christmas Parade event on November 18, 2016 from 6 p.m. to 9 p.m. in downtown Jackson.

Attached are memos from Nathan Mack, regarding the Special Event Application for the event Annual Jackson Christmas Parade.

I recommend approval of the special event application for the event Annual Jackson Christmas Parade. Your consideration and concurrence is appreciated.

PHB

DEPARTMENTAL REPORT

MEMO TO: Patrick Burtch, City Manager

FROM: Nathan Mack, Executive Director, DDA

DATE: October 25, 2016

RECOMMENDATION: Approve a request from the Downtown Jackson Christmas Parade to conduct their 26th annual Jackson Christmas Parade event on November 18, 2016 at 6 p.m. to 9 p.m. in downtown Jackson.

SUMMARY: Annual Christmas Parade complete with marching bands, floats, hundreds of walkers, Santa and Mrs. Claus through downtown Jackson along Michigan Avenue.

DEPARTMENTAL APPROVAL SUMMARY

Approvals noted below by each department indicate they have been made aware of the request and the capacity of their department has been met. Conditions of their approval and special considerations are noted.

Department	Approval	Denial	Economic Impact
Police	x		$100
Fire	x		$0
Engineering	x		$0
Public Works	x		$1,400
Recreation	x		$0
DDA	x		$0
			$1,500

CONDITIONS & CONSIDERATIONS

- Police escort and barricades for street closures.

INSURANCE STATUS

Cover under City of Jackson insurance policy.

ATTACHMENTS: Special Event Application: Annual Jackson Christmas Parade.

CITY OF JACKSON SPECIAL EVENT APPLICATION
Downtown Development Authority
161 W. Michigan Avenue ~ Jackson, MI 49201 ~ (517) 768-6410

Date Received By DDA Office: _____ Time: _____ By: _____

Please complete this application in accordance with the City of Jackson Special Events Policy, and return it to the Office of the Downtown Development Authority at least 60 calendar days before the first day of the event.

Event Name: Annual Jackson Christmas Parade
Sponsoring Organization's Legal Name: Downtown Jackson Christmas Parade
Organization Address: One Energy Plaza Jackson MI 49201
Tax I.D. Number: N/A
Event Organizer: Edward Hatfield Title: Committee Chairman
Phone (work): 517.788.1420
Phone (during event): 517.262.4422
Agent's Address: One Energy Plaza, Jackson MI 49201
Agent's E-Mail Address: Edward.HatfieldJR@cmsenergy.com
Organization Address: One Energy Plaza, Jackson MI 49201
Please give a brief description of the proposed special event: Annual Christmas Parade complete with marching bands, Floats, hundreds of walkers, Santa + Mrs Claus through downtown Jackson along Michigan Avenue

Event Day(s) and Date(s): Friday November 18th, 2016
Set-Up Date & Time: 11.18.16 4:45 pm Tear-Down Date & Time: 11.18.16 8:00pm
Event Location: See attached map

ANNUAL EVENT: Is this event expected to occur next year? (circle one) ***YES*** ***NO***
How many years has this event occurred? 25 years

MAP: If your event will use streets or sidewalks (for a parade, run, etc.) or will use multiple locations, please attach a complete map showing:

(a) The assembly and dispersal locations and the route plan;
(b) Any streets or parking lots that you are requesting to be blocked off;
(c) The location of vendors, if any;
(d) An emergency vehicle access lane; and
(e) The location of restrooms and trash receptacles.

A final map, if different, must be provided seven (7) days before the event.

STREET CLOSURES: Start Date/Time: Friday November 18th 4:45 pm

Through Date/Time: Friday November 18th 2016 8:00 pm

RESERVED PARKING: Are you requesting reserved parking? (circle one) ***YES*** ***NO***
If yes, list the number of street spaces, City lots or locations where parking is requested:

VENDORS: Food Concessions? ***YES*** ***NO*** Other Vendors: ***YES*** ***NO***

EVENT SPONSORS: Do you have an event sponsor? If yes, please name:

Not/app

DO YOU PLAN TO HAVE ALCOHOL SOLD/SERVED AT THIS EVENT? ***YES*** ***NO***
If yes, please attach liquor license and liquor liability insurance.

If yes, what time? _____ until _____

ENTERTAINMENT: Are there any entertainment features related to this event? ***YES*** ***NO***
If yes, provide an attachment listing all bands/performers, type of entertainment, and performance schedule. All noise generated by entertainment must be in compliance with the City Noise Ordinance. .

ATTENDANCE: What is the expected (estimated) attendance for this event? 20,000 +

AMUSEMENT: Do you plan to have any amusement or carnival rides? ***YES*** ***NO***
If yes, you are required to obtain a permit through the City Clerk's Office.

RESTROOMS: Are you planning to provide portable rest rooms at the event? ***YES*** ***NO***
If yes, how many? _____

As an event organizer, you must consider the availability of restroom facilities during this event. Consideration should be made regarding the type of event, the length of time it will be held, the number of people, etc. You must determine the rest room facilities in the immediate area of the event venue and then identify the potential need for portable facilities. Remember to identify accessible facilities for ADA requirements as well.

ELECTRICAL POWER: Will the Event require electrical power? *YES* *NO*
If yes, please explain the electrical requirements.

_____

_____

_____.

OTHER REQUESTS: (i.e., Police Department assistance, Fire Department, Neighborhood and Economic Operations Department, Parks and Recreation, water, street closures, electrical, etc.) Please note that additional requests may incur additional charges.

Police Escort of Santa Float from 409 S. Cooper to Michigan Ave. Follow Santa Float along parade route and escort Float back to 409 S. Cooper after the afterglow

INSURANCE: All sponsors of special events must carry liability insurance as set forth in the Special Events policy. A copy of either a Hold Harmless Agreement or a certificate of insurance AND endorsement naming the City of Jackson and the DDA as additional insureds for a liability policy must be provided at least two (2) weeks prior to scheduled Council approval.

CERTIFICATION AND SIGNATURE: I understand and agree on behalf of the sponsoring organization that:

1. I am the person with authority to act on behalf of the sponsoring organization.

2. I have submitted all required documents in support of the Special Events application, including insurance documents where applicable.

3. A $25 Special Event Application fee must be submitted along with this Special event Application.

4. Only the activities listed on the application will be permitted at the event. If additional activities are added, I will immediately contact the City of Jackson. I understand that the approval of my application may be withdrawn or additional requirements made.

5. All food vendors must be approved by the Jackson County Health Department, and each food or other vendor must provide the City of Jackson with a Certificate of Insurance which names the City of Jackson and the Downtown Development Authority as additional named insured parties on the policy.

6. Fire Department permit and approval is required for events including display fireworks. XCU Fireworks Liability insurance is required for all fireworks displays.

7. The approval of this special event may include additional requirements, limitations, or fees, based on the City's review of this application.

8. If I or my organization fail(s) to clean up and repair damages to the Event Area, my organization maybe billed for City services, and that failure to clean up and repair damage will be considered for future applications.

9. As the duly authorized agent of the sponsoring organization, I am applying for approval of this Special Event, affirm the above understandings, and agree that my sponsoring organization will comply with the terms of the written confirmation of approval, and all other City requirements, ordinances and other laws, which apply to this Special Event.

10. By signing this Special Event Application, I declare I am 21 years of age or older.

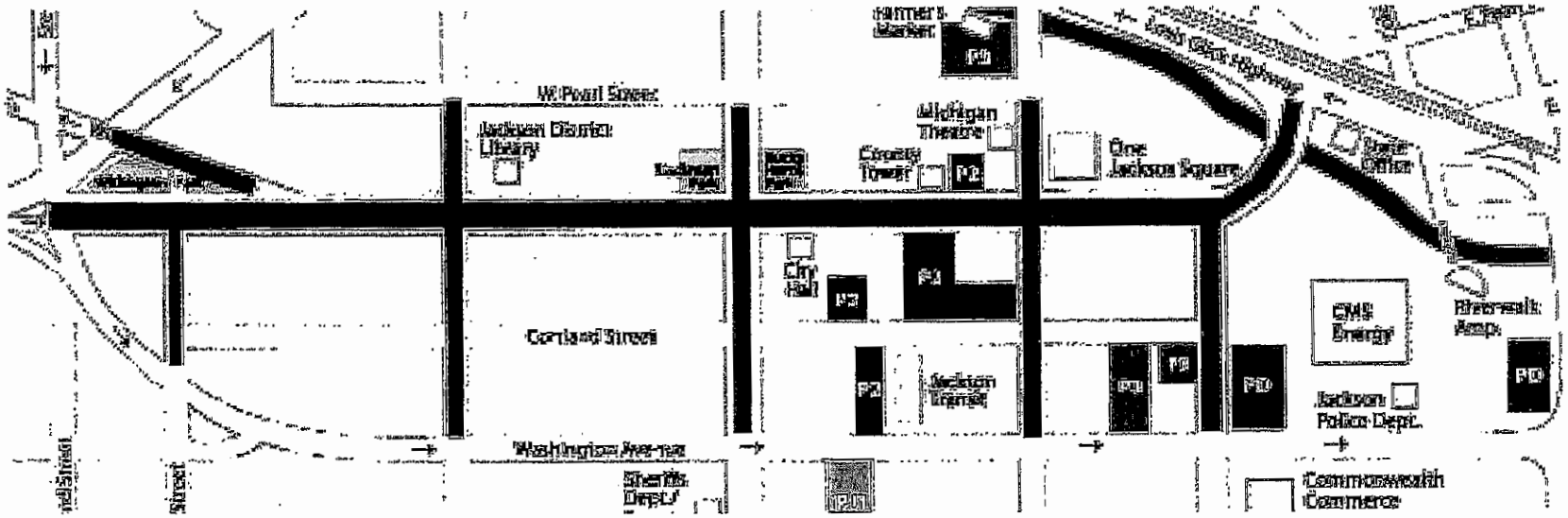
11. If required to provide liability insurance, I will add the City of Jackson and the Downtown Development Authority as additional insureds on the sponsoring organization's liability policy.

12. On behalf of the sponsoring organization, I agree that the sponsoring organization will defend, indemnify, and hold harmless the City of Jackson, its officers, employees and agents from and against any claim, demand, suit, loss, cost or expense, or any damage, which may be asserted, claimed or recovered against or from the City of Jackson its officer, employees and agents, by reason of any damage to property, bodily injury, or death, sustained by any person whomsoever, and which damage, injury or death arises out of or is incident to or in any way connected with or related to the special event.

10·07·2016
Date

Edward Hatfield Jr
Signature of Sponsoring Organization's Agent

RETURN THIS APPLICATION at least sixty (60) days before the first day of the event to: DOWNTOWN DEVELOPMENT AUTHORITY
161 W. MICHIGAN AVENUE, 5th Floor
JACKSON, MI 49201



Parade Street Closures

Christmas Parades November 18th 2016 4:45-8 p.m.
Michigan Ave (Steward Ave to Louis Glick Hwy)
First St (Washington Ave to Wildwood Ave)
Wildwood Ave (Michigan Ave to Louis Glick Hwy)
Cortland St (First St to Francis St)
Blackstone St (Washington Ave to Pearl St)
Hayes St (Michigan Ave to Pearl St) - **NOT REFLECTED ON MAP**
Jackson St (Washington Ave to Pearl St)
Mechanic St (Washington Ave to Pearl St)
Francis St (Washington Ave to Michigan Ave)

2016 Downtown Jackson Christmas Parade

Friday, November 18th

October 7th, 2016

Nathan Mack
Jackson Downtown Development Authority
161 W. Michigan Avenue
Jackson, MI 49201

Dear Nathan:

Please issue a check from the Christmas Parade fund for $25 to the proper entity to accompany our Annual Christmas Parade application.

As always, we thank you for partnering with the committee as our fiduciary agency. We look forward to working with you and your staff again this year.

Please feel free to contact me if you need any further information regarding this check request.

Siucerely,

Edward Hatfield, Jr

Edward Hatfield, Jr.
Jackson Downtown Christmas Parade Chair
O: 517-788-1420 C: 517-262-4422

CITY OF JACKSON
Founded 1829

City Manager's Office

161 W. Michigan Ave. - Jackson, MI 49201
Phone: (517) 788-4035 • Facsimile: (517) 768-5820

MEMO TO: Mayor and City Council Members

FROM: Patrick H. Burtch, City Manager

DATE: October 25, 2016

SUBJECT: Special Event Application for "Discover Downtown Again" Day (DDA Day).

Recommendation:

Approve a request from the City of Jackson Downtown Development Authority to conduct their 8th annual "Discover Downtown Again" Day event on November 19, 2016 from 10 a.m. to 2:30 p.m. in Horace Blackman Park.

Attached are memos from Nathan Mack, regarding the Special Event Application for the event "Discover Downtown Again" Day.

I recommend approval of the special event application for the event "Discover Downtown Again" Day. Your consideration and concurrence is appreciated.

PHB

DEPARTMENTAL REPORT

MEMO TO: Patrick Burtch, City Manager

FROM: Nathan Mack, Executive Director, DDA

DATE: October 25, 2016

RECOMMENDATION: Approve a request from the City of Jackson Downtown Development Authority to conduct their 8th annual "Discover Downtown Again" Day (DDA Day) event on November 19, 2016 at 10 a.m. to 2:30 p.m. at Horace Blackman Park.

SUMMARY: This event kicks off the holiday season with reindeer in the park, letters to Santa and local merchant promotions.

DEPARTMENTAL APPROVAL SUMMARY

Approvals noted below by each department indicate they have been made aware of the request and the capacity of their department has been met. Conditions of their approval and special considerations are noted.

Department	Approval	Denial	Economic Impact
Police	x		$0
Fire	x		$0
Engineering	x		$0
Public Works	x		$0
Recreation	x		$0
DDA	x		$0
			$0

CONDITIONS & CONSIDERATIONS

- None.

INSURANCE STATUS

Cover under City of Jackson insurance policy.

ATTACHMENTS: Special Event Application: "Discover Downtown Again" Day (DDA Day).

CITY OF JACKSON SPECIAL EVENT APPLICATION

Downtown Development Authority
161 W. Michigan Avenue ~ Jackson, MI 49201 ~ (517) 768-6410

Date Received By DDA Office: _____ Time: _____ By: _____

Please complete this application in accordance with the City of Jackson Special Events Policy, and return it to the Office of the Downtown Development Authority at least 60 calendar days before the first day of the event.

Event Name: "Discover Downtown Again" Day (DDA Day)

Sponsoring Organization's Legal Name: Downtown Development Authority

Organization Address: 161 W. Michigan Ave. Jackson, MI 49201

Tax I.D. Number: _____

Event Organizer: Kaiti McDonough Title: Assistant

Phone (work): 517-788-4355

Phone (during event): _____

Agent's Address: 161 W. Michigan Ave. Jackson, MI 49201

Agent's E-Mail Address: kmcdonough@cityofjackson.org

Organization Address: 161 W. Michigan Ave. Jackson, MI 49201

Please give a brief description of the proposed special event: An event to kick off the holiday season with reindeer in the park, letters to Santa and local merchant promotions.

Event Day(s) and Date(s): Saturday, November 19, 2016

Set-Up Date & Time: 10am Tear-Down Date & Time: 2:30pm

Event Location: Horace Blackman Park

ANNUAL EVENT: Is this event expected to occur next year? (circle one) ***YES*** ***NO***
How many years has this event occurred? 8 years _____

MAP: If your event will use streets or sidewalks (for a parade, run, etc.) or will use multiple locations, please attach a complete map showing:

(a) The assembly and dispersal locations and the route plan;
(b) Any streets or parking lots that you are requesting to be blocked off;
(c) The location of vendors, if any;
(d) An emergency vehicle access lane; and
(e) The location of restrooms and trash receptacles.

A final map, if different, must be provided seven (7) days before the event.

STREET CLOSURES: Start Date/Time:

Through Date/Time: None _____

RESERVED PARKING: Are you requesting reserved parking? (circle one) ***YES*** ***NO***
If yes, list the number of street spaces, City lots or locations where parking is requested:

_____

VENDORS: Food Concessions? ***YES*** ***NO*** Other Vendors: ***YES*** ***NO***

EVENT SPONSORS: Do you have an event sponsor? If yes, please name:

_____

DO YOU PLAN TO HAVE ALCOHOL SOLD/SERVED AT THIS EVENT? ***YES*** ***NO***
If yes, please attach liquor license and liquor liability insurance.

If yes, what time? _____ until _____

ENTERTAINMENT: Are there any entertainment features related to this event? ***YES*** ***NO***
If yes, provide an attachment listing all bands/performers, type of entertainment, and performance schedule. All noise generated by entertainment must be in compliance with the City Noise Ordinance. .

ATTENDANCE: What is the expected (estimated) attendance for this event? 200 _____

AMUSEMENT: Do you plan to have any amusement or carnival rides? ***YES*** ***NO***
If yes, you are required to obtain a permit through the City Clerk's Office.

RESTROOMS: Are you planning to provide portable rest rooms at the event? ***YES*** ***NO***
If yes, how many? _____

As an event organizer, you must consider the availability of restroom facilities during this event. Consideration should be made regarding the type of event, the length of time it will be held, the number of people, etc. You must determine the rest room facilities in the immediate area of the event venue and then identify the potential need for portable facilities. Remember to identify accessible facilities for ADA requirements as well.

ELECTRICAL POWER: Will the Event require electrical power? ***YES*** ***NO***
If yes, please explain the electrical requirements.

_____
_____
_____.

OTHER REQUESTS: (i.e., Police Department assistance, Fire Department, Neighborhood and Economic Operations Department, Parks and Recreation, water, street closures, electrical, etc.) Please note that additional requests may incur additional charges.
DDA is covered under the City of Jackson insurance policy. _____
_____
_____

INSURANCE: All sponsors of special events must carry liability insurance as set forth in the Special Events policy. A copy of either a Hold Harmless Agreement or a certificate of insurance AND endorsement naming the City of Jackson and the DDA as additional insureds for a liability policy must be provided at least two (2) weeks prior to scheduled Council approval**.**

CERTIFICATION AND SIGNATURE: I understand and agree on behalf of the sponsoring organization that:

1. I am the person with authority to act on behalf of the sponsoring organization.

2. I have submitted all required documents in support of the Special Events application, including insurance documents where applicable.

3. A $25 Special Event Application fee must be submitted along with this Special event Application.

4. Only the activities listed on the application will be permitted at the event. If additional activities are added, I will immediately contact the City of Jackson. I understand that the approval of my application may be withdrawn or additional requirements made.

5. All food vendors must be approved by the Jackson County Health Department, and each food or other vendor must provide the City of Jackson with a Certificate of Insurance which names the City of Jackson and the Downtown Development Authority as additional named insured parties on the policy.

6. Fire Department permit and approval is required for events including display fireworks. XCU Fireworks Liability insurance is required for all fireworks displays.

7. The approval of this special event may include additional requirements, limitations, or fees, based on the City's review of this application.

8. If I or my organization fail(s) to clean up and repair damages to the Event Area, my organization maybe billed for City services, and that failure to clean up and repair damage will be considered for future applications.

9. As the duly authorized agent of the sponsoring organization, I am applying for approval of this Special Event, affirm the above understandings, and agree that my sponsoring organization will comply with the terms of the written confirmation of approval, and all other City requirements, ordinances and other laws, which apply to this Special Event.

10. By signing this Special Event Application, I declare I am 21 years of age or older.

11. If required to provide liability insurance, I will add the City of Jackson and the Downtown Development Authority as additional insureds on the sponsoring organization's liability policy.

12. On behalf of the sponsoring organization, I agree that the sponsoring organization will defend, indemnify, and hold harmless the City of Jackson, its officers, employees and agents from and against any claim, demand, suit, loss, cost or expense, or any damage, which may be asserted, claimed or recovered against or from the City of Jackson its officer, employees and agents, by reason of any damage to property, bodily injury, or death, sustained by any person whomsoever, and which damage, injury or death arises out of or is incident to or in any way connected with or related to the special event.

10/06/2016 _____ *Kaiti McDonough* _____

Date Signature of Sponsoring Organization's Agent

RETURN THIS APPLICATION at least sixty (60) days before the first day of the event to: DOWNTOWN DEVELOPMENT AUTHORITY
161 W. MICHIGAN AVENUE, 5th Floor
JACKSON, MI 49201

CITY OF JACKSON
Founded 1829

City Treasurer/City Clerk
161 W. Michigan Ave. - Jackson, MI 49201
Treasurer: (517) 788-4043 • Clerk: (517) 788-4025

MEMO TO: Mayor and City Councilmembers

FROM: Andrew J. Wrozek, Jr., City Treasurer/Clerk

DATE: October 25, 2016

SUBJECT: Confirmation of Special Assessment Roll No. 3384

Recommendation:

RECESS AS A CITY COUNCIL AND CONVENE AS A BOARD OF REVIEW:

A. Public Hearing on Special Assessment Roll No. 3384 for street repaving Wisner Street from Argyle Street to Boardman Road.

   1. Resolution confirming Roll No. 3384

ADJOURN AS A BOARD OF REVIEW AND RECONVENE AS CITY COUNCIL

The required notice was published in the Jackson Citizen Patriot and a notification letter was sent to each property owner.

Attached is the resolution.

I recommend adoption of the resolution after its public hearing is held. Your consideration and concurrence is appreciated.

RESOLUTION
STREET CONSTRUCTION

BY THE BOARD OF REVIEW:

WHEREAS, the Assessor, in accordance with the direction of the City Council, did prepare special assessments concerning street repaving on Wisner Street from Argyle Street to Boardman Road which assessments were by him placed on Assessment Roll No. 3384 in the amount of $377,445.39 and reported to the City Council at its meeting held on the 25th day of October, 2016; and

WHEREAS, notice has been duly given that the City Council and Assessor would sit as a Board of Review in the Council Chambers in the City of Jackson on Tuesday, the 25th day of October, 2016, at 6:30 p.m. to hear any and all objections and suggestions by interested parties to said special assessments as contained in said roll; and

WHEREAS, the matter of said review having come on to be heard and the City Council and Assessor sitting as a Board of Review having heard all suggestions and objections made thereto and having fully considered the same;

NOW, THEREFORE, BE IT RESOLVED, that each and all of the special assessments as contained in said roll are hereby confirmed and made valid liens against the property and valid claims against the owners thereof, and the City Clerk is hereby directed to make certificates of this determination and attach the same to said roll and to turn said roll over to the City Treasurer for collection; and

BE IT FURTHER RESOLVED that each and all of the special assessments contained in Roll No. 3384 shall be divided into ten (10) equal installments, the first of which shall be payable by July 1, 2017 without interest charge; and the remaining installments, plus a 2.10% annual interest charge on each installment, shall be due annually on May 31st of each subsequent year until each of the special assessments has been paid in full; provided, however, that in the event the City issues bonds in anticipation of special assessments, the unpaid balance of said special assessments shall, in accordance with Section 22-9 of the Jackson City Code of Ordinances, bear a rate of interest which shall be one percent (1%) above the average interest cost of said special assessment bonds.

BE IT FURTHER RESOLVED that the unpaid balance of any special assessment, including pro rata interest charges, may be paid in full at any time and that each and any special assessment may be paid without interest if payment in full is made prior to July 1, 2017.

* * * * *

State of Michigan)
County of Jackson) ss
City of Jackson)

I, Andrew J. Wrozek, Jr., City Clerk in and for the City of Jackson, County and State aforesaid, do hereby certify that the foregoing is a true and complete copy of a resolution adopted by the Jackson City Council sitting as a Board of Review on the 25th day of October, 2016.

IN WITNESS WHEREOF, I have hereto affixed my signature and the Seal of the City of Jackson, Michigan, on this 25th day of October, 2016.

_____
Andrew J. Wrozek, Jr., City Clerk

_____
William C. Jors, Mayor

CITY OF
JACKSON
Founded 1829

City Assessor's Office

161 W. Michigan Ave. • Jackson, MI 49201
Phone: (517) 788-4033 • Facsimile: (866) 902-7891

August 22, 2016

Andrew J. Wrozek Jr., City Treasurer/Clerk
161 W. Michigan Avenue
Jackson, MI 49201

Randy:

Please place the following special assessment roll(s) on the agenda for a public hearing for Tuesday, October 25, 2016:

ROLL NUMBER	ROLL PURPOSE	AMOUNT ASSESSED	INSTALLMENTS
3384	Reconstruct Wisner St Argyle to Boardman	$ 377,445.39	10

The above special assessment roll(s) will be confirmed by the City Council on said Tuesday, October 25, 2016.

Sincerely,

Theresa Yeiter

Theresa Yeiter
Appraiser

Copy: City Manager's Office, Engineering, Public Works Department, Water Department, Wastewater Treatment Plant, File

S:\WORD_DOCU\YOAKAM\SpAssessments_SpecialAssessmenDocuments\LettersForAttyClerkTres\CLRK-TRES_dbl_duty_ROLLStreet_v1.docx

Sp. District Heading	Parcel # Owner	Principal Admin Fee	Interest Penalty	Addtl Penlty Cert Fee	Total Installment	Prin Bal Payoff Int	Total Payoff
3384	2-2438.2000	0.00	0.00		0.00	7,074.75	7,074.75
RPV WISNER, ARGYL	HBW PROPERTIES LLC 54 JACONNET ST #100 NEWTON HIGHLANDS MA 02461	0.00				0.00	

COM AT INTERS OF S LN OF MONROE ST & E LN OF WISNER ST TH S 265.2 FT TO POB TH S 88 DEG 15' 25" E 220.5 FT TH S 1 DEG 14' 45" W 100 FT TH N 88 DEG 15' 25" W 220.5 FT TO E LN OF WISNER ST TH N ALG SD E LN 100 FT TO BEG SE 1/4 SEC 28 T2S R1W

3384	2-2439.B000	0.00	0.00		0.00	4,229.28	4,229.28
RPV WISNER, ARGYL	EYDEL PROPERTIES III LLC 2501 COOLIDGE RD #501 EAST LANSING MI 48823	0.00				0.00	

2468.2C
BEG AT A PT ON E LN OF WISNER ST 680 FT N OF N LN OF ARGYLE ST TH NLY ALG E LN OF WISNER ST 59.78 FT TH S 88 DEG 15' 25" E 701.57 FT TH S 1 DEG 10' W 50.73 FT TH WLY 701.56 FT TO POB SE 1/4 SEC 28 T2S R1W

3384	2-2439.K000	0.00	0.00		0.00	14,149.51	14,149.51
RPV WISNER, ARGYL	FIFTH THIRD BANK 38 FOUNAIN SQ PLAZA-MD 10ATA1 CINCINNATI OH 45263	0.00				0.00	

THAT PART OF SE 1/4 OF SEC 28 T2S R1W DESC AS COM AT SE COR SEC 28 TH N 88 DEG 59' W ALG S LN SD SEC 33 FT TO W R/W LN OF WEST AVE TH N 1 DEG 10' E ALG SD W R/W LN 40 FT TO N R/W LN OF ARGYLE ST TH N 88 DEG 5' W 1059.42 ALG SD N R/W LN TO POB OF THIS DESC TH N 1 DEG 14' E 200 FT TH N 88 DEG 59' W 193.18 FT TO E R/W LN OF WISNER ST TH S 1 DEG 14' W 200 FT ALG SD E R/W LN TO INTERS OF E LN OF WISNER ST WITH N LN OF ARGYLE ST TH S 88 DEG 59' E 193.18 FT ALG N R/W LN OF ARGYLE ST TO POB SE 1/4 SEC 28 T2S R1W

3384	2-243900000	0.00	0.00		0.00	33,958.82	33,958.82
RPV WISNER, ARGYL	WOOD JACKSON CENTER LLC 321 HENRY STREET LEXINGTON KY 40508	0.00				0.00	

2468.2
COM AT INTERS OF N LN OF ARGYLE ST WITH W LN OF WEST AVE TH NLY ALG W LN OF WEST AVE 250 FT TO POB TH N 88 DEG 59' 45" W 550 FT TH N 1 DEG 10' E 430 FT TH WLY TO A PT ON E LN OF WISNER ST (SD PT IS 680 FT N OF INTERS OF N LN OF ARGYLE ST & E LN OF WISNER ST) TH SLY ALG E LN OF WISNER ST 480 FT TH S 88 DEG 59' 45" E 193 FT TH S 1 DEG 1' W 200 FT TO N LN OF ARGYLE ST TH ELY ALG N LN OF ARGYLE ST 509.42 FT TH N 1 DEG 10' E 215 FT TH S 88 DEG 59' 45" E 550 FT TO W LN OF WEST AVE TH NLY ALG W LN OF WEST AVE 35 FT TO POB SE 1/4 SEC 28 T2S R1W

3384	2-246700000	0.00	0.00		0.00	47,027.11	47,027.11
RPV WISNER, ARGYL	HD DEVELOPMENT OF MARYLAND INC P O BOX 105842 ATLANTA GA 30348	0.00				0.00	

2468.8, 2468.9
BEG AT THE NW COR OF WISNER ST AND MONROE ST (VACATED) TH S 259.07 FT, TH W 330 FT, TH N 19.65 FT, TH W 355.96 FT, TH N 281.1 FT, TH E 21.83 FT, TH N 453.67 FT, TH N 76 DEG 32'30" E 488.54 FT TO W LN OF WISNER ST, TH SOUTHERLY 517.61 FT ALONG W LN OF WISNER ST, TH S 139.38 FT TO POB. SE1/4 OF SEC 28 T2S, R1W

Sp. District Heading	Parcel # Owner	Principal Admin Fee	Interest Penalty	Addtl Penlty Cert Fee	Total Installment	Prin Bal Payoff Int	Total Payoff
3384	2-2468.10A0	0.00	0.00		0.00	15,479.73	15,479.73
RPV WISNER, ARGYL	SOUTH CENTRAL STATE 958 W MONROE ST JACKSON MI 49202	0.00				0.00	

BEG AT INTERS OF N LN OF MONROE ST & E LN OF WISNER ST TH E ALG N LN OF MONROE ST 220 FT TH N 1 DEG 44' 05" E 298 FT TH N 88 DEG 15' 55" W 237.92 FT TO E LN OF WISNER ST TH SLY ALG ELY LN OF WISNER ST TO POB SE 1/4 SEC 28 T2S R1W

3384	2-2469.2000	0.00	0.00		0.00	59,904.10	59,904.10
RPV WISNER, ARGYL	RAMCO JACKSON CROSSING SPE LLC 31500 NORTHWESTERN HWY #300 FARMINGTON HILLS MI 48334	0.00				0.00	

A PART OF E 1/2 OF SEC 28 T2S R1W BLACKMAN TWP AND THE CITY OF JACKSON DESC AS: COM AT E 1/4 COR OF SEC 28 TH S 89 DEG 04' 43" W 504.80 FT ALG E/W 1/4 LN AND S LN OF RECORDED PLAT OF "SMITH'S CITY FARMS" (LIBER 10 OF PLATS PG 26 JACKSON CO RECORDS) & TO WLY R/W OF WEST AVE FOR POB TH S 28 DEG 29' 43" E 451.55 FT ALG WLY R/W OF WEST AVE TH S 73 DEG 34' 26" W 157.37 FT TH S 15 DEG 47' 20" E 119.37 FT TH S 75 DEG 49' 36" W 309.87 FT TH S 14 DEG 09' 00" E 43.74 FT TH S 75 DEG 51' 00" W 28.00 FT TH S 14 DEG 09' 00" E 12.00 FT TH S 75 DEG 51' 00" W 335.05 FT TH S 14 DEG 09' 00" E 297.80 FT TH S 30 DEG 51' 01" W 86.91 FT TH S 00 DEG 12' 13" E 53.53 FT TH S 00 DEG 49' 48" E 250.32 FT TH S 89 DEG 47' 47" W 31.55 FT TH N 00 DEG 12' 58" W 297.96 FT TH S 89 DEG 47' 47" W 237.87 FT TO E R/W LN OF WISNER ST TH 368.24 FT ALG E R/W LN OF WISNER ST & ARC OF A 756.80 FT RADIUS CURVE TO THE LEFT THE CENTRAL ANGLE OF 27 DEG 52' 43" & A CHORD BEARING N 20 DEG 19' 50" W 364.62 FT TH S 75 DEG 40' 36" W 44.84 FT TO C/L OF WISNER ST TH ALG C/L OF WISNER ST THE FOLLOWING 3 COURSES 76.22 FT ALG THE ARC OF A 716.80 FT RADIUS CURVE TO THE LEFT THE CENTRAL ANGLE OF 06 DEG 05' 34" & A CHORD BEARING N 44 DEG 53' 31" W 76.19 FT TH N 47 DEG 56' 19" W 177.53 FT; TH 321.84 FT ALG THE ARC OF A 573.69 FT RADIUS CURVE TO THE LEFT THE CENTRAL ANGLE OF 32 DEG 08' 30" & A CHORD BEARING N 64 DEG 00' 46" W 317.63 FT TH N 00 DEG 36' 37" W 219.10 FT TH N 63 DEG 15' 48" W 33.01 FT TH N 26 DEG 44' 12" E 333.99 FT TH S 63 DEG 15' 48" E 78.06 FT TH N 89 DEG 04' 43" E 145.26 FT TH N 00 DEG 15' 17" W 549.01 FT TO THE S R/W LN OF BOARDMAN RD TH 196.76 FT ALG S R/W LN OF BOARDMAN RD & ARC OF A 683.78 FT RADIUS CURVE TO THE RIGHT THE CENTRAL ANGLE OF 16 DEG 29' 13" & A CHORD BEARING S 75 DEG 28' 11" E 196.08 FT TH S 67 DEG 13' 35" E 188.54 FT TH S 22 DEG 46' 22" W 225.02 FT TH S 67 DEG 13' 38" E 342.08 FT TH N 26 DEG 45' 40" E 225.56 FT TO S R/W LN OF BOARDMAN RD TH S 67 DEG 13' 35" E 123.71 FT ALG S R/W LN OF BOARDMAN RD TH 229.24 FT ALG THE ARC OF A 606.69 FT RADIUS CURVE TO THE LEFT THE CENTRAL ANGLE OF 21 DEG 38' 56" & A CHORD BEARING S 78 DEG 03' 03" E 227.87 FT TO INTERS OF S R/W LN OF BOARDMAN RD WITH WLY R/W LN OF WEST AVE TH S 28 DEG 29' 43" E 199.36 FT ALG WLY R/W LN OF WEST AVE & TO POB CONTAINING 1,490,399 SQUARE FT OR 34.2149 ACRES, M/L, EX ALL THAT LAND LYING IN BLACKMAN TWP., ALSO EX A PC OF LAND 88 FT BY 160 FT OCCUPIED BY SHERWIN WILLIAMS CO.

3384	2-2469.2A00	0.00	0.00		0.00	6,225.78	6,225.78
RPV WISNER, ARGYL	RAMCO JACKSON CROSSING SPE LLC 31500 NORTHWESTERN HWY #300 FARMINGTON HILLS MI 48334	0.00				0.00	

2469.4A
COM AT NE COR OF MASONRY STORE BUILDING NOW OCCUPIED BY SHERWIN WILLIAMS COMPANY TH SWLY ALG SD BUILDING'S N WALL AND CONTINUING IN A STRAIGHT LN TO INTERS OF ELY LN OF WISNER ST FOR POB OF THIS DESC TH SELY ALG ELY LN OF WISNER ST 88 FT TH NELY PARA TO SD BUILDING'S S WALL 160 FT TH NWLY PARA TO WISNER ST 88 FT TH SWLY 160 FT TO POB NE 1/4 SE 1/4 SEC 28 T2S R1W

Sp. District Heading	Parcel # Owner	Principal Admin Fee	Interest Penalty	Addtl Penlty Cert Fee	Total Installment	Prin Bal Payoff Int	Total Payoff
3384	2-2469.5000	0.00	0.00		0.00	66,958.30	66,958.30
RPV WISNER, ARGYL	SERITAGE SRC FINANCE LLC 3333 BEVERLY RD PROP TAX (BC-169A) HOFFMAN ESTATES IL 60179	0.00				0.00	

COM AT NW COR OF SE 1/4 OF SEC 28 T2S R1W TH N 88 DEG 53' 30" E 820.90 FT ALG E/W 1/4 LN OF SEC 28 TH S 26 DEG 45' 30" W 310.98 FT TH S 0 DEG 47' E 219.10 FT TO C/L OF WISNER ST TH NWLY 20.35 FT ON THE ARC OF A 537.686 FT RADIUS CURVE TO THE LEFT THE CHORD OF WHICH BEARS N 81 DEG 16' 58" W 20.35 FT TH N 82 DEG 17' 56" W 407.81 FT TH NWLY 214.04 FT ON THE ARC OF A 250.79 FT RADIUS CURVE TO THE RIGHT THE CHORD OF WHICH BEARS N 57 DEG 50' 55" W 207.61 FT TO A PT TH S 88 DEG 53' 30" W 79.51 FT TH N 0 DEG 47' W 314.23 FT ALG N/S 1/4 LN OF SD SEC 28 TO POB
EX COM AT THE E 1/4 COR OF SECT 28; TH S 89 DEG 04' 43" W 1773.41 FT ALONG THE E-W 1/4 LN AND THE S LN OF THE RECORDED PLAT OF "SMITHS CITY FARMS" AS RECORDED IN LIBER 10 OF PLATS, PAGE 26, JACKSON COUNTY RECORDS AND FOR A POB; TH CONTINUING ALONG THE E-W 1/4 LN S 89 DEG 04' 43" W 49.68 FT; TH S 26 DEG 55' 43" W 310.93 FT; TH N 63 DEG 15' 48" W 33.01 FT; THE N 26 DEG 44' 12" E 333.99 FT; TH S 63 DEG 15' 48" E 78.06 FT TO THE E-W 1/4 LN AND POB. ALSO EX THAT PORTION USED AS WISNER ST NW 1/4 S 1/4 SEC 28 T2S R1W

3384	2-2469.6000	0.00	0.00		0.00	50,153.19	50,153.19
RPV WISNER, ARGYL	GKC MICH THEATRES INC P O BOX 391 COLUMBUS GA 31902	0.00				0.00	

2469.7
COM AT S 1/4 POST SEC 28 T2S R1W TH N ON 1/4 LN 1,573.21 FT TH 75 DEG 45' E 379.6 FT TO BEG TH N 14 DEG 10' 26" W 250 FT TH N 77 DEG 16' 14" E 228 FT TH N 15 DEG 41' 40" W 200.71 FT TO SWLY LN OF WISNER ST TH SELY ALG SWLY CURVING LN OF WISNER ST TO A PT N 75 DEG 45'E 748.6 FT FROM BEG TH WLY TO BEG NW 1/4 SE 1/4 SEC 28 T2S R1W

3384	2-247300000	0.00	0.00		0.00	19,644.47	19,644.47
RPV WISNER, ARGYL	SERITAGE SRC FINANCE LLC 3333 BEVERLY RD PROP TAX (BC-169A) HOFFMAN ESTATES IL 60179	0.00				0.00	

COM AT SW COR OF NE 1/4 OF SEC 28 T2S R1W TH N 88 DEG 53' 30" E 1016.08 FT ALG E/W 1/4 LN OF SEC 28 TH N 0 DEG 26' 30" W 543.71 FT TO S LN OF BOARDMAN RD TH WLY 273.27 FT ON ARC OF 673.78 FT RADIUS CURVE TO LEFT ALG SLY LN OF BOARDMAN RD THE CHORD OF WHICH BEARS S 84 DEG 21' 51" W 271.47 FT TH S 70 DEG 50' 10" W 789.10 FT ALG SLY LN OF BOARDMAN RD TO N/S 1/4 LN OF SD SEC 28 TH S 0 DEG 47' E 277.67 FT ALG N/S 1/4 LN OF SEC 28 TO POB EX COM AT THE E 1/4 COR OF SECT 28; TH S 89 DEG 04' 43" W 1773.41 FT ALONG THE E-W 1/4 LN AND THE S LN OF THE RECORDED PLAT OF "SMITHS CITY FARMS" AS RECORDED IN LIBER 10 OF PLATS, PAGE 26, JACKSON COUNTY RECORDS AND FOR A POB; TH CONTINUING ALONG THE E-W 1/4 LN S 89 DEG 04' 43" W 49.68 FT; TH S 26 DEG 55' 43" W 310.93 FT; TH N 63 DEG 15' 48" W 33.01 FT; THE N 26 DEG 44' 12" E 333.99 FT; TH S 63 DEG 15' 48" E 78.06 FT TO THE E-W 1/4 LN AND POB. ALSO EX WLY 80 FT FOR WISNER ST SW 1/4 NE 1/4 SEC 28 T2S R1W

3384	2-247900000	0.00	0.00		0.00	13,658.99	13,658.99
RPV WISNER, ARGYL	BARNES DEVELOPMENT CO LLC 1000 ENTERPRISE DR ALLEN PARK MI 48101	0.00				0.00	

2468, 2438, 2477
BEG AT INTERS OF S LN OF MONROE ST AND E LN OF WISNER ST TH S 1 DEG 14' 45" W ALG E LN OF WISNER ST 272.2 FT TH S 88 DEG 15' 25" E 220.5 FT, TH N 01 DEG 14' 45" E 272.36 FT TO S LN OF MONROE ST, TH N 88 DEG 17' 55" W 220.5 FT TO BEG SE 1/4 SEC 28 T2S R1W

Sp. District Heading	Parcel # Owner	Principal Admin Fee	Interest Penalty	Addtl Penlty Cert Fee	Total Installment	Prin Bal Payoff Int	Total Payoff
3384	2-248000000	0.00	0.00		0.00	11,602.62	11,602.62
RPV WISNER, ARGYL	HILLSDALE COUNTY NATIONAL BANK ONE SOUTH HOWELL ST HILLSDALE MI 49242	0.00				0.00	

2469
COM AT CENTER OF SECT 28 TH S 0 DEG 47' E 177.92 FT, TH 413.55 FT ALONG A CURVE TO THE LEFT RADIUS 291.38 FT CENTRAL ANGLE 81 DEG 19'04" CORD BEARING S 41 DEG 32'25"E 379.7 FT TH S 82 DEG 12' E 49.43 FT TO POB. TH S 82 DEG 12' E 179.99 FT TH S 15 DEG 38'10"E 200.38 FT TH S 75 DEG 45' W 228.0 FT TH N 45 DEG 53' 21" W 46.25 FT TH N 45 DEG 06'39" E 35.64 FT TH N 0 DEG 47' W 215.76 FT TO POB SE 1/4 SEC 28 T2S R1W

3384	2-248100000	0.00	0.00		0.00	27,378.74	27,378.74
RPV WISNER, ARGYL	RAMCO JACKSON WEST ASSOC LTD P O BOX 4900 DEPT 365 SCOTTSDALE AZ 85261	0.00				0.00	

2469
COM AT S 1/4 POST SEC 28 T2S R1W TH N ON 1/4 LN 1,573.21 FT TO BEG TH N 75 DEG 45' E 379.60 FT TH N 14 DEG 10' 26" W 250 FT TH N 77 DEG 16' 14" E 228 FT TH N 15 DEG 41' 40" W 200.71 FT TO SWLY LN OF WISNER ST TH NWLY ALG SWLY CURVING LN OF WISNER ST TO A PT N 88 DEG 53' 30" E OF A PT ON N/S 1/4 LN 2,336.1 FT N OF S 1/4 POST TH S 88 DEG 53' 30" W TO N/S 1/4 LN TH S 762.89 FT ALG NS 1/4 LN TO BEG NW 1/4 SE 1/4 SEC 28 T2S R1W

Total Parcels: 14		0.00 0.00	0.00		0.00	377,445.39 0.00	377,445.39

CITY OF JACKSON
Founded 1829

City Manager's Office

161 W. Michigan Ave. - Jackson, MI 49201
Phone: (517) 788-4035 • Facsimile: (517) 768-5820

MEMO TO: Mayor and City Councilmembers

FROM: Jackson City Planning Commission

DATE: October 25, 2016

SUBJECT: Ordinance amending various sections of Chapter 28 of the City's Code of Ordinances

---

Recommendation:

Hold a public hearing, introduce the Ordinance, and recommend for second reading and final adoption the amendments to various sections of Chapter 28 of the City's Code of Ordinance in concurrence with the unanimous recommendation from the Jackson City Planning Commission on September 7, 2016.

Attached is the memo and draft Ordinance from Jennifer Morris, Director of Neighborhood and Economic Operations. The Planning Commission unanimously recommended approval of the attached amendments as a means of addressing a variety of ordinance inconsistencies/errors.

The Planning Commission recommends that the above mentioned Ordinance be forwarded to second reading and final adoption. Your consideration and concurrence is appreciated.

PHB

DEPARTMENTAL REPORT

MEMO TO: Patrick Burtch, City Manager

FROM: Jennifer Morris, Director of Neighborhood and Economic Operations

DATE: October 25, 2016

RECOMMENDATION: Hold the public hearing, introduce the Ordinance in first reading, and forward to second reading the amendments to various sections throughout Chapter 28 of the Code of Ordinances

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SUMMARY

As we continue to delve into the various sections of the Zoning Ordinance resulting from a variety of recent development reviews, additional inconsistencies have been identified. Therefore, the Planning Commission is recommending the following amendments:

1. Section 28-5 (Definitions) to add alternate energy source facilities to the definition of accessory structure and add a definition of watercourse

2. Section 28-71 (Permitted and Conditional Uses) prohibit recycling collection centers within the residential zoning districts, permit only permanent and interior resale operations, permit nonresidential accessory structures in industrial districts and residential accessory structures in all residential districts

3. Section 28-73 – Section 28-75 (Lot Area, Width, Yard, Building Height Requirements) establish a minimum setback from a watercourse

4. Section 28-90 (Natural Feature Setbacks) establishes a process and criteria for deviating from the setback requirements

5. Section 28-109 (Lighting Standards) clarify the maximum height of parking lot light fixture requirements

6. Section 28-110 (Environmental Protection Standards) clarify the standards for outdoor storage and waste disposal facilities

7. Section 28-111 (Temporary Uses and Structures) clarify the informational requirements necessary to review all season uses and address any inconsistencies between this section and chapter 5 and 16 which both reference the Clerk's office

8. Section 28-115 (Building Design Standards) clarify the rationale for the prohibited materials and better define the fenestration requirements

9. Section 28-120 (Accessory Structures) clarify the locations within which a detached accessory structure can be located and the quantity permitted, add ground mounted utility screening requirements, and add a reference to the swimming pool fencing requirements in the building code

10. Section 28-125 (Standards for Fences, Walls, and Landscape Berms) modify the type of fencing permitted

11. Section 28-130 (Nonconforming Lots, Buildings, Structures, and Uses of Building, Structures, and Land) eliminate inconsistencies in terminology

12. Section 28-135 (Site Plan review Procedures and Requirements) modify the minimum contour intervals

13. Section 28-160 (Planned Building Group Shopping Centers) reduce the building setback from 100 feet to 25 feet

14. Section 28-183 (Procedure for Change) eliminate the second public hearing at the City Council

15. Section 28-242 (Appointment and Membership) reduce the ZBA membership from 7 to 5

16. Section 28-253 (Signs Subject to Permit or Other Approval) permit ground signs in the single family residential districts through the conditional use approval process, provide more clarity regarding mural parameters, and permit wall signs above the second floor through the conditional land use process

POSITION

Based upon the above noted rationale for the proposed text amendments (Chapter 28, Sections 28-5, 28-71, 28-73-75, 28-90, 28-109, 28-110-111, 28-115, 28-120, 28-125, 28-130, 28-135, 28-160, 28-183, 28-242, and 28-253), the Planning Commission, via a unanimous vote on September 7, 2016, recommends that the Council hold the public hearing, introduce the amendments in first reading, and forward to second reading.

ATTACHMENTS

ORDINANCE 2016.__

An Ordinance amending Chapter 28 of the Code of Ordinances, City of Jackson, Michigan to make minor revisions to Article I, Section 28-5 (Definitions), Article III, Section 28-71 (Permitted and Conditional Uses), Section 28-73 – 28-75 (Lot Area, Width, Yard, Building Height Requirements), Section 28-90 (Natural Feature Setbacks), Article IV, Section 28-109 (Lighting Standards), Section 28-111 (Temporary Uses and Structures), Section 28-115 (Building Design standards), Section 28-120 (Accessory Structures), Section 28-125 (Standards for Fences, walls and Landscape Berms), Article V, Section 28-130 (Nonconforming Lots, Building, Structures, and Use of Buildings, Structures and Land), Section 28-135 (Site Plan Review Procedures and Requirements), Section 28-160 (Planned Building Group Shopping Center), Article VI, Section 28-183 (Procedures for Change), Article VIII, Section 28-242 (Appointment and Membership), Article IX, Section 28-253 (Signs Subject to Permit of Other Approval).

THE PEOPLE OF THE CITY OF JACKSON ORDAIN:

Section 1. Purpose.

To make minor revisions are summarized as follows:

1. Section 28-5 (Definitions) to add alternate energy source facilities to the definition of accessory structure and add a definition of watercourse

2. Section 28-71 (Permitted and Conditional Uses) prohibit recycling collection centers within the residential zoning districts, permit only permanent and interior resale operations, permit nonresidential accessory structures in industrial districts and residential accessory structures in all residential districts

3. Section 28-73 – Section 28-75 (Lot Area, Width, Yard, Building Height Requirements) establish a minimum setback from a watercourse

4. Section 28-90 (Natural Feature Setbacks) establishes a process and criteria for deviating from the setback requirements

5. Section 28-109 (Lighting Standards) clarify the maximum height of parking lot light fixture requirements

6. Section 28-110 (Environmental Protection Standards) clarify the standards for outdoor storage and waste disposal facilities

7. Section 28-111 (Temporary Uses and Structures) clarify the informational requirements necessary to review all season uses and address any inconsistencies between this section and chapter 5 and 16 which both reference the Clerk's office

8. Section 28-115 (Building Design Standards) clarify the rationale for the prohibited materials and better define the fenestration requirements

9. Section 28-120 (Accessory Structures) clarify the locations within which a detached accessory structure can be located and the quantity permitted, add ground mounted utility screening requirements, and add a reference to the swimming pool fencing requirements in the building code

10. Section 28-125 (Standards for Fences, Walls, and Landscape Berms) modify the type of fencing permitted

11. Section 28-130 (Nonconforming Lots, Buildings, Structures, and Uses of Building, Structures, and Land) eliminate inconsistencies in terminology

12. Section 28-135 (Site Plan review Procedures and Requirements) modify the minimum contour intervals

13. Section 28-160 (Planned Building Group Shopping Centers) reduce the building setback from 100 feet to 25 feet

14. Section 28-183 (Procedure for Change) eliminate the second public hearing at the City Council

15. Section 28-242 (Appointment and Membership) reduce the ZBA membership from 7 to 5

16. Section 28-253 (Signs Subject to Permit or Other Approval) permit ground signs in the single family residential districts through the conditional use approval process, provide more clarity regarding mural parameters, and permit wall signs above the second floor through the conditional land use process

Section 2. That Article I of Chapter 28 of the Code of Ordinances, City of Jackson, Michigan be amended to read as follows:

ARTICLE I. IN GENERAL

Sec. 28-5. Definitions.

Unless context indicates otherwise, the following words and phrases used in this chapter have these meanings:

Accessory use or structure means a use or structure customarily incidental and subordinate to the principal use or building and located on the same lot with such principal use or building, including alternative energy source structures such as solar fields, wind turbines, and back-up generators.

Watercourse shall mean any waterway including a river, stream, lake, pond or any body of surface water having definite banks, a bed and visible evidence of a continued flor or continued occurrence of water.

Section 3. That Article III of Chapter 28 of the Code of Ordinances, City of Jackson, Michigan be amended to read as follows:

ARTICLE III. ZONING DISTRICT REGULATIONS

Sec. 28-71. Permitted and conditional uses.

The following uses are permitted (P), or conditional (C) within the zoning districts. Conditional uses require approval by the planning commission according to the procedures of section 28-147.

	Zoning Districts											
	R-1	R-2	R-3	R-4	R-5	R-6	C-1	C-2	C-3	C-4	I-1	I-2
(129) Recycling collection centers	~~C~~	~~C~~	~~C~~	~~C~~	~~C~~	~~C~~	C	C	C	C	C	C
(133) Resale shops, used clothing and furniture (permanent and fully contained within a structure)							P	P	P	P		
(133a) Resale shops for used furniture (permanent and fully contained within a structure)									P	P		
(162) Accessory nonresidential uses and structures not otherwise prohibited, customarily accessory and incidental to any use by right							C	C	C	~~P~~C	C	C
(163) Any residential accessory use or structure clearly incidental and customary to the operation of	P	P	P	P	P	P	P/C*					

the uses by right (such as a garage) when located on the same property												

* Permitted for residential uses and conditional for nonresidential uses

Sec. 28-73. Lot area, width, yard, building height requirements – Residential districts.

	Zoning Districts											
	R-1	R-2	R-3	R-4	R-5	R-6	C-1	C-2	C-3	C-4	I-1	I-2
High water mark of a watercourse (minimum)	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.

Sec. 28-74. Lot area, width, yard, building height requirements – Commercial districts.

	Zoning Districts											
	R-1	R-2	R-3	R-4	R-5	R-6	C-1	C-2	C-3	C-4	I-1	I-2
Yard (minimum)												
High water mark of a water-course	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.

Sec. 28-75. Lot area, width, yard, building height requirements – Industrial districts.

	Zoning Districts											
	R-1	R-2	R-3	R-4	R-5	R-6	C-1	C-2	C-3	C-4	I-1	I-2
Yard (minimum)												
High water mark of a water-course	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.	15 ft.

Sec. 28-90. Required setback from the high water mark of a watercourse.

(a) Within an established high water mark setback there shall be no: construction; deposit of any material, including structures; removal of any soils, minerals and/or vegetation; dredging, filling or land balancing; constructing or undertaking seasonal or permanent operations, except as authorized in this section.

(b) The setback shall only contain vegetation unless located within the C-3 zoning district within which a boardwalk/sidewalk may be constructed on public and/or private property as a means of maintaining public access/visibility to the waterfront.

(c) Additionally, under certain conditions defined below a high water mark setback conditional use permit may be authorized by the Planning Commission to allow limited construction, activity, use or operations within said setback. All such conditional use permit requests will be evaluated based upon no less than the following general criteria:

(1) The relative extent of the public and private need for the proposed activity.
(2) The availability of feasible and prudent alternative locations and methods to accomplish the expected benefits from the activity.
(3) The extent and permanence of the beneficial or detrimental effects which the proposed activity may have on the public and private use to which the area is suited, including the benefits the natural feature and/or natural feature setback provides.
(4) The probable impact of each proposal in relation to the cumulative effect created by other existing and anticipated activities in the watershed.
(5) The probable impact on recognized historic, cultural, scenic, ecological, or recreational values, and on fish, wildlife and the public health.
(6) The size and quantity of the natural feature setback being considered.
(7) The amount and quantity of the remaining natural feature setback.
(8) Proximity of the proposed construction and/or operation in relation to the natural feature, taking into consideration the degree of slope, general topography in the area, soil type and the nature of the natural feature to be protected.
(9) Economic value, both public and private, of the proposed construction and/or operation, and economic value, both public and private, if the proposed construction and/or operation were not permitted.
(10) The necessity for the proposed construction and/or operation.

ARTICLE IV. SITE AND BUILDING DESIGN STANDARDS

Sec. 28-109. Lighting standards.

(f) Lighting intensity and uniformity standards.

(2) Footnotes to the table.

d. The maximum height of parking lot light fixtures, from grade, shall be as follows~~cannot be~~:

1. ~~More than~~ Up to fifteen (15) feet in a residential district;

2. Up to ~~More than~~ eighteen (18) feet in a commercial or industrial district when WITHIN~~within~~ one hundred fifty (150) feet of a residential district;

3. Up to ~~More than~~ twenty (20) feet in a commercial district when NO LESS THAN ~~not within~~ one hundred fifty (150) feet of a residential district; or

4. Up to ~~More than~~ twenty-five (25) feet in an industrial district when NO LESS THAN ~~not within~~ one hundred fifty (150) feet of a residential district.

Sec. 28-110. Environmental protection standards.

(d) *Standards for limiting the external effect of uses.* All uses must comply with the following standards which limit their effect on the surrounding area:

(3) Outdoor storage and waste disposal.

a. All outdoor storage and waste disposal facilities must be enclosed by an opaque fence or wall adequate to conceal such facilities from adjacent properties and adjoining rights-of-way and constructed in accordance with the standards established for them in section 28-125 (standards for fences, walls, and landscape berms).~~of this chapter~~

(e) *Hazardous materials (includes automobile wrecking/salvage yards and junkyards).*

(3) Outdoor aboveground storage. Secondary containment structures must be designed to protect containers from the effects of storms, wind, fire and vandalism. Structures that are covered and protected from rain and precipitation must provide secondary containment for ten (1) percent of the volume of all containers or the volume of the largest container, whichever is greatest. Structures that are not protected from rain and precipitation must provide secondary storage capacity to hold one hundred fifty (150) percent of the stored substances unless the zoning administrator (or designee) or planning commission approves a less quantity. Whether open or covered, the aboveground storage area shall also be fully screened from view at all abutting parcel perimeters.

Sec. 28-111. Temporary uses and structures.

(c) *Seasonal uses.*

(1) Sidewalk cafes. A sidewalk café ~~as defined in chapter 16 of this Code~~ is permitted provided the following standards are met:

a. All uses must comply with the following standards which limit their effect on the surrounding area:

i. The tables, chairs and other appurtenances must be associated with the building containing the restaurant or business, owned or leased, by the person operating the sidewalk café.

ii. The tables, chairs and other appurtenances must be placed in a way that a clear pathway of at least five (5) feet (eight (8) feet on Michigan Avenue) in width – free of street trees, street furniture, signs, and other obstructions – is maintained along the section of the sidewalk closest to the building.

iii. The tables, chairs, and other appurtenances shall not be permanently anchored to the sidewalk in any manner.

iv. Ingress and egress from the building or driveway shall not be blocked or obstructed by any such appurtenances.

v. All temporary fencing shall comply with the provisions of this chapter.

b. Plot site plan (PSP). A PSP comply with the requirements of subsection 28-135(e) of this chapter must be submitted for the review and approval of the zoning administrator (or designee)

c. Other city standards. The café must comply with all~~the standards contained in chapter 16 of this code, as well as other~~ pertinent municipal regulations~~, as determined by the city clerk (or designee)~~.

Sec. 28-115. Building design standards.

(c) *Exterior wall design standards.*

Footnotes to the Table of Acceptable [Exterior/Wall] Materials.

i. Must be clapboard, cedar shingles or similar materials approved by the chief building official and~~,~~ zoning administrator (or designee) upon the review of building façade elevations submitted by the applicant. Any grade of ~~P~~plywood, oriented strand board (OSB), T-111 siding, and similar materials are strictly prohibited on any portion of a structure because they are not finished building materials and do not under any circumstances weather like the other reference exterior/wall materials.

(d) *Roof design standards for principal structures.*

(7) Screening of rooftop equipment.

~~(a)~~ New or replacement rooftop equipment, including but not limited to, HVAC, kitchen vents, hood or exhausts equipment, shall be screened from view of adjacent properties and the nearest public rights-of-way and the nearest public rights-of-way on all sides the property. The method to screen rooftop equipment must complement the buildings color sale, materials, and architectural style unless the building official and/or zoning administrator can demonstrate a hardship which requires modification and/or waiving this requirement. Rooftop screening on a one story structures may be accomplished by using ground level vegetation that will mature in growth within five (5) years at the time of planting; location of the planting will be at the discretion of the zoning administrator (or designee). The zoning administrator (or designee) may require cross-section details to confirm compliance.

~~(b) The provisions of this subsection excludes a one for one replacement of existing roof top equipment providing the replacement is the same dimensions or a reduction in dimensions as the original roof top equipment. Any replacement equipment that is an increase in dimension over the original equipment shall be subject to the provisions in subsection (a).~~

(e) *Fenestration of all new ~~nonresidential~~ buildings, and where practical in rehabbed building, in the R-4, R-6, C-1, C-2, C-3, and C-4 districts.*

(3) Windows above the first floor must be vertical in proportion (whether a single unit or combined units) and where deemed impractical due to structural limitations, ~~. L~~all ~~arge~~ windows must be broken-up to maintain the same~~a~~ vertical proportion.

(4) Windows and glass doors must be clear glass and not tinted. Samples shall be provided in advance of installation to ensure compliance with this requirement.

Sec. 28-120. Accessory structures.

Accessory structures may be erected as an integral part of the principal use or may be erected detached from such principal use.

(2) Detached. The following provisions apply to detached accessory structures and garages.

a. Location and size.

1. Shall be no larger than the first floor of the principal structure and not occupy more than thirty (30) percent of any require rear yard space or more than twenty (20) percent of any required side yard space; and

2. – 4. Unchanged; and

5. Shall not occupy any portion of the required front nor be located closer to the road right-of-way than the front building line; and

6. Garages/sheds are limited in quantity to two (2); and

7. All finished materials shall complement the principal structure; and

8. All exterior utilities (i.e. A/C compressor) shall be shielded from public view at a height no less than that of the structure and of a material complementary to the principal structure.

c. Swimming pools. Swimming pools may be erected exclusively for use of residents of the property and their guest, provided that no such portion shall be located within the portion of the prescribed front yard. Side and rear yard setback of at least eight (8) feet in depth must be maintained. Fencing must be provided in advance of utilizing the pool and designed/built as required by the most current edition of the International Building Code~~in this chapter~~.

d. Satellite dishes. All satellite dishes shall be mounted on the rear wall of a structure and/or in the rear yard, and where practical fully screened from view at the road right-of-way.

Sec. 28-125. Standards for fences, walls, and landscape berms.

All fences, walls, and landscape berms of any nature, type or description located in the City of Jackson must conform to the following regulations:

(c) Fences and walls in residential districts and manufactured housing communities.

(5) Fencing materials must be all weather and zero maintenance. If using ~~T~~treated wood (lattice design is prohibited) it must meet the American Wood Protection Association's UC4B standard for ground contact (heavy duty).

(d) Fences and walls in commercial and industrial districts.

(4) All fences and walls must be ornamental in nature and should be made of wrought iron, wood (excluding dog eared or lattice design), brick, stone, and similar replication of these materials. However, when abutting residentially zoned and/or used property, and when used to screen parking or outdoor storage areas, the fence must be constructed of an opaque weatherproof material.

(f) Prohibited fences. The following fences are prohibited:

(7) A fence with all metal opaque paneling (e.g. barn siding roof material, etc.) unless it is part of a conditional use permit request for an automobile wrecking and salvage yard (see subsection 28-71(14) of this chapter), junkyard (see subsection 28-71(80) of this chapter, or similar use. Additionally, the zoning administrator may consider the use of these materials if deemed complementary to the primary structure.

ARTICLE V. DEVELOPMENT APPROVAL PROCEDURES

Sec. 28-130. Nonconforming lots, building, structures, and use of buildings, structures and land.

- *Verify the proper usage of buildings versus structures (multiple locations)*
- *Define ordinance repairs (multiple locations)*

Sec. 28-135. Site plan review procedures and requirements.

(e) Required site plan contents. The following date must be included with and as part of, all applications requiring site plan review:

Table of Required Site Plan Data		
	FSP	PSP
Topography on the site and within 100 feet of the site at six (6) inch~~two foot~~ contour intervals, referenced to a USGS benchmark;	X~~(2)~~	

~~(2) Only if required by the zoning administrator (or designee).~~ Renumber rest

Sec. 28-160. Planned building group shopping center.

(5) Screening. No building shall be less than twenty-five (25)~~one hundred (100)~~ feet distance from any boundary of the tract on which the shopping center is located . . .

ARTICLE VI. DISTRICT CHANGES AND AMENDMENTS

Sec. 28-183. Procedures for change.

The application for a proposed zoning change shall be directed to the planning staff on forms prescribed for such purposes, accompanied by sufficient information, so as to assure the fullest presentation of facts for the permanent record.

(1) By application. . .

e. Action by city council. Such amendment, supplement, or change, accompanied by the report of the city planning commission, shall then be presented by the city council. The city council shall consider ~~hold a public hearing on such~~ the proposed amendment, supplement and notice requirements prescribed in this section. ~~Following such public hearing, s~~Such amendment, supplement or change may be adopted or denied only by the affirmative votes of no less than four (4) members of the city council.

ARTICLE VIII. ZONING BOARD OF APPEALS

Sec. 28-242. Appointment and membership.

(a) The zoning board of appeals shall consist of five (5)~~seven (7)~~ members and two (2) alternate members appointed by the mayor with the approval of the city council for three-year terms. . .

ARTICLE IX. SIGN REGULATIONS

Sec. 28-253. Signs subject to permit or other approval.

The signs outlined in the following table are subject to a permit or other approval s indicated. Unless stated otherwise within the article, all other sign types are exempt from the permit requirements. The design requirements and other provisions for such sign are also prescribed. Permit application requirements are found in Sec. 28-254. These signs include the following and are defined in Sec. 28-5.

Table of Sign Standards for Signs Subject to a Permit Unless Otherwise Specified			
	Sign Types, Districts Permitted Required approvals	Size Restriction	Additional Restrictions
(f)	Monument (Ground) Signs Permitted in the R-4, R-6, C-1, C-2, C-3, C-4, I-1, and I-2 Districts subject to a sign permit.	Unchanged	unchanged

	Permitted in the R-1, R-2, and R-3 Districts subject to conditional use approval (Sec. 28-147)		
(g)	Murals (rest unchanged)	Number: One (1) per structure Total Sign Area: no more than 50% of any one wall area	Colors and design shall complement the structure and neighborhood
(l)	Wall Signs Permitted in the R-4, R-6, C-1, C-2, C-3, C-4, I-1 and I-2 Districts, subject to a sign permit	Number (no change) Total Sign Area (no change) Height. Signs to be placed on the wall below the roof line for one story buildings and below the bottom of the second floor for multiple story buildings in the downtown (C-3 district) and as a conditional land use when located above the second floor of a building.~~.~~	unchanged

Section 4. Effective Date

This Ordinance takes effect thirty (30) days from the date of adoption.

CITY OF JACKSON
Founded 1829

City Treasurer/City Clerk

161 W. Michigan Ave. - Jackson, MI 49201
Treasurer: (517) 788-4043 • Clerk: (517) 788-4025

MEMO TO: Mayor and City Councilmembers

FROM: Andrew J. Wrozek, Jr., City Treasurer/Clerk

DATE: October 25, 2016

SUBJECT: Second Reading and Adoption of Ordinance 2016-28

Recommendation:

Adopt Ordinance 2016-28 amending Section 28-32, of Chapter 28, of the Code of Ordinances of the City of Jackson.

Attached is Ordinance 2016-28, which was announced and a public hearing held at the October 11, 2016 meeting.

I recommend approval of Ordinance 2016-28. Your consideration and concurrence is appreciated.

ORDINANCE NO. 2016-28

An Ordinance to amend Section 28-32, of Chapter 28, of the Code of Ordinances of the City of Jackson.

THE PEOPLE OF THE CITY OF JACKSON ORDAIN:

Section 1. That Section 28-32 of Chapter 28, of the Code of Ordinances, City of Jackson, Michigan, be and the same hereby is, amended by changing the map of the use districts required by said Section and said Chapter, and incorporated therein by reference as follows:

Change two (2) properties known legally as the following from R-4 (high density apartment and office) to C-4 (general commercial):

Property Address: 707 Madison Street, Jackson, MI
Legal Description: 2-244800000

Property Address: 1216 Clinton Road, Jackson, MI
Legal Description: 2-2434.2000

Section 2. This ordinance shall take effect thirty (30) days from date of adoption.

* * * * * * *

Adopted:

CITY OF JACKSON
Founded 1829

City Attorney's Office

161 W. Michigan Ave. • Jackson, MI 49201
Phone: (517) 788-4050, (517) 788-4023 • Facsimile: (866) 971-2117

MEMO TO: Honorable Mayor and City Councilmembers

FROM: Bethany M. Smith, City Attorney

DATE: Council Meeting – October 25, 2016

SUBJECT: ***Second Addendum to Development Agreement***
Detroit Entrepreneur Development, LLC

Recommendation: APPROVE execution of the attached *Second Addendum to Development Agreement*, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

Your consideration and concurrence is appreciated.

DEPARTMENT REPORT

MEMO TO: Honorable Mayor and City Councilmembers

FROM: Bethany M. Smith, City Attorney

DATE: Council Meeting – October 25, 2016

RECOMMENDATION: APPROVE execution of the attached *Second Addendum to Development Agreement* with Detroit Entrepreneur Development, LLC, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

SUMMARY

The attached *Addendum to Development Agreement* sets out the rights and responsibilities of the City of Jackson and Detroit Entrepreneur Development, LLC regarding the purchase of property. This Addendum is to a Development Agreement previously approved by the City Council and executed on July 1, 2016.

HISTORY, BACKGROUND and DISCUSSION

The City entered into a Purchase Agreement and Development Agreement for the sale and development of property located at the Northeast corner of the former Consumer's Energy parking lot between Louis Glick Highway and Pearl Street. In the original agreements, certain timelines were established. Due to issues with the MDEC, Detroit Entrepreneur Development, LLC will not be able to meet the established deadlines to close. This Second Addendum seeks to grant Detroit Entrepreneur Development, LLC additional time to close on the property. The following date changes will occur in the Development Agreement and Purchase Agreement:

Letter of Intent to Close	September 15, 2016 **now** October 31, 2016
Closing on sale	October 1, 2016 **now** November 15, 2016
Letter of Credit	September 15, 2016 **now** October 31, 2016
Commencement of Construction	November 1, 2016 **now** November 30, 2016

You must either approve both this agenda item and the corresponding Addendum to Purchase Agreement, or disapprove both items.

POSITIONS

APPROVE execution of the attached *Second Addendum to Development Agreement* with Detroit Entrepreneur Development, LLC, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

ATTACHMENTS: Second Addendum
Original Addendum
Original Agreement

SECOND ADDENDUM TO DEVELOPMENT AGREEMENT

This is an Addendum to Development Agreement entered into on the _____ day of _____, 2016 between the **City of Jackson**, a Michigan municipal corporation, with offices at 161 West Michigan Avenue, Jackson, Michigan 49201 (hereinafter "the City"), **and Detroit Entrepreneur Development, LLC**, a Michigan limited liability company, with offices at 13821 Fawn Woods Ct., Plymouth, MI 48170, Michigan (hereinafter "DED").

This Addendum shall be and is incorporated into the Development Agreement dated July 1, 2016 between the City and DED (hereinafter "the Development Agreement").

The City and DED agree to the following changes and/or additions to the Development Agreement:

A. Paragraph 5 of the Development Agreement shall be amended to read as follows:

> "5. PROMISSORY NOTE AND LETTER OF CREDIT. All members of Developer's limited liability company must personally execute Promissory Notes at closing in favor of the City of Jackson for all amounts due under this Agreement, jointly and severally. In addition, Developer must provide a letter of credit to City in the amount of TWENTY-FIVE THOUSAND DOLLARS ($25,000.00) by October 31, 2016. This amount corresponds to the amount stated in Paragraph 20 of this Agreement."

B. Paragraph 14 of the Development Agreement shall be amended to read as follows:

> 14. LETTER OF INTENT TO CLOSE. Developer must serve the City with a written Letter of Intent to Close no later than October 31, 2016.

This Addendum is to be effective as of the date above.

IN WITNESS WHEREOF, the parties hereto have caused this Addendum to be executed as a proper corporate act of the City and Detroit Entrepreneur Development, LLC on the day and year first written above.

THE **CITY OF JACKSON, MICHIGAN**

By: _____
Patrick H. Burtch
Its City Manager

STATE OF MICHIGAN)
) SS:
JACKSON COUNTY)

Subscribed and sworn to before me, this ____ day of _____, 2016.

_____
Notary Public
Jackson County, Michigan
My commission expires:

DETROIT ENTREPRENEUR DEVELOPMENT, LLC
A Michigan limited Liability Company

By: _____
Nick Dyc
Its President

STATE OF MICHIGAN)
)SS:
JACKSON COUNTY)

Subscribed and sworn to before me, this ____ day of _____, 2016.

_____
Notary Public
Jackson County, Michigan
My commission expires:

Drafted by:

Bethany M. Smith (P57913)
City Attorney
161 West Michigan Avenue
Jackson, MI 49201

ADDENDUM TO DEVELOPMENT AGREEMENT

This is an Addendum to Development Agreement entered into on the 23rd day of September, 2016 between the **City of Jackson**, a Michigan municipal corporation, with offices at 161 West Michigan Avenue, Jackson, Michigan 49201 (hereinafter "the City"), **and Detroit Entrepreneur Development, LLC**, a Michigan limited liability company, with offices at 13821 Fawn Woods Ct., Plymouth, MI 48170, Michigan (hereinafter "DED").

This Addendum shall be and is incorporated into the Development Agreement dated July 1, 2016 between the City and DED (hereinafter "the Development Agreement").

The City and DED agree to the following changes and/or additions to the Development Agreement:

A. Paragraph 5 of the Development Agreement shall be amended to read as follows:

"5. PROMISSORY NOTE AND LETTER OF CREDIT. All members of Developer's limited liability company must personally execute Promissory Notes at closing in favor of the City of Jackson for all amounts due under this Agreement, jointly and severally. In addition, Developer must provide a letter of credit to City in the amount of TWENTY-FIVE THOUSAND DOLLARS ($25,000.00) by October 15, 2016. This amount corresponds to the amount stated in Paragraph 20 of this Agreement."

B. Paragraph 9 of the Development Agreement shall be amended to read as follows:

"9. DEADLINE FOR COMMENCEMENT AND COMPLETION OF CONSTRUCTION. Commencement of construction must occur on or before November 15, 2016. If Developer purchases the Property, all construction must be

complete no later than twenty-four (24) months from the date of commencement of construction or pay the City an additional amount of either ONE HUNDRED THOUSAND DOLLARS ($100,000.00), or FIFTY THOUSAND DOLLARS ($50,000.00) plus an electronic copy of the building drawings with non-exclusive rights to use of the drawings."

C. Paragraph 14 of the Development Agreement shall be amended to read as follows:

14. LETTER OF INTENT TO CLOSE. Developer must serve the City with a written Letter of Intent to Close no later than October 15, 2016.

This Addendum is to be effective as of the date above.

IN WITNESS WHEREOF, the parties hereto have caused this Addendum to be executed as a proper corporate act of the City and Detroit Entrepreneur Development, LLC on the day and year first written above.

THE **CITY OF JACKSON, MICHIGAN**

By: Patrick H. Burtch
Patrick H. Burtch
Its City Manager

STATE OF MICHIGAN)
) SS:
JACKSON COUNTY)

Subscribed and sworn to before me, this 21st day of September, 2016.

TIERNEY M. O'DOWD
NOTARY PUBLIC, Jackson County, MI
My Commission Expires Oct. 29, 2018

Tierney M. O'Dowd
Notary Public
Jackson County, Michigan
My commission expires:

DETROIT ENTREPRENEUR DEVELOPEMNT, LLC
A Michigan limited Liability Company

By: _____
Nick Dyc
Its President

STATE OF MICHIGAN)
)SS:
JACKSON COUNTY)

Subscribed and sworn to before me, this 23rd day of September, 2016.

DEBRA A. NOGA
NOTARY PUBLIC, Hillsdale County, MI
My Commission Expires March 4, 2019
Acting in Jackson County, MI

Notary Public
Jackson County, Michigan
My commission expires:

Drafted by:

Bethany M. Smith (P57913)
City Attorney
161 West Michigan Avenue
Jackson, MI 49201

DEVELOPMENT AGREEMENT

THIS DEVELOPMENT AGREEMENT ("Agreement"), is entered into as of the date appearing below, by and between the CITY OF JACKSON, a Michigan municipal corporation, with offices located at 161 West Michigan Avenue, Jackson, Michigan 49201, ("City"), and Detroit Entrepreneur Development, LLC, a Michigan limited liability company, whose address is 13821 Fawn Woods Ct., Plymouth, MI 48170 ("DED" or "Developer").

WITNESSETH:

WHEREAS, the Developer is purchasing real property from the City located at the Northeast corner of the former Consumer's Energy parking lot between Louis Glick Highway and Pearl Street in Jackson, Michigan, which is more particularly described as:

(See Exhibit A, attached hereto and incorporated by reference)

with a fifteen (15) foot easement off the Right-of-Way line retained by the City. Hereinafter referred to as "the Property." The legal description is an approximate description of the Property and may vary at the time of the closing on the Property. An sketch of the Property is attached as Exhibit B to show the approximate boundaries; and

WHEREAS, the Developer intends to develop a mixed-use and/or residential development on the Property which is referred to hereinafter as "the Project." The Project is to consist of at least 4 stories (with 4 separate floors) with at least three floors of residential units.

WHEREAS, the Developer agrees that the Project scope and design must be approved by the City and be in compliance with all federal, state and local laws, rules and regulations; and

WHEREAS, the Developer agrees to comply with all conditions of the City of Jackson Chief Building Official, and Zoning Administrator and shall obtain approval of same for all building materials and design.; and

WHEREAS, the City desires that the Developer comply with certain registration and financial obligations imposed upon the Developer by the City of Jackson Code of Ordinances, Resolutions or regulations; and

WHEREAS, part of the consideration to the City for this Development Agreement is Developer's promise to develop the Property to generate residential housing and commercial development in the Downtown Development District; and

WHEREAS, the parties desire to ensure that the Development will take place, and set forth the terms of the Development.

NOW, THEREFORE, in consideration of the above recitals, the parties agree as follows:

1. RECITALS. The foregoing recitals are incorporated in and form a part of this Agreement.

2. GRANT OF OWNERSHIP AND RIGHT TO DEVELOP. In consideration of One Dollar ($1.00), receipt of which City acknowledges, paid by Developer to City, the City grants the Developer ownership and the right to develop the real property described on Exhibit A with all easements, rights and appurtenances (hereinafter "the Property") located at the Northeast corner of the former Consumer's Energy parking lot between Louis Glick Highway and Pearl Street in Jackson, Michigan and legally described on Exhibit A

attached with a fifteen (15) foot easement off of the Right-of-Way line retained by the City. The legal description is an approximate description of the Property and may vary at the time of closing. An aerial view of the Property is attached as Exhibit B to show the approximate boundaries of the Property.

3. SCOPE OF THE PROJECT. It is the understanding of the parties that Developer intends to develop a mixed-use and/or residential development at the Property, which is hereinafter referred to as "the Project." The Project shall consist of a structure of at least four (4) stories (with 4 separate floors) with at least three floors of residential units. The structure must substantially resemble the structure depicted on the attached rendition shown as Exhibit C. The Project scope and design must be approved by the City of Jackson and be in compliance with all federal, state and local laws, rules and regulations, and conditions of the Zoning Enforcement Officer through a separate Administrative site plan review. Developer must construct all improvements made to the area inside the dotted lines on Exhibit C.

4. TERM OF AGREEMENT. The term of this Agreement shall be seven (7) years from the date of execution. The term of this Agreement may be extended by the mutual consent of both parties. This Agreement will not take effect unless Developer takes title to the Property.

5. PROMISSORY NOTES AND LETTER OF CREDIT. All members of Developer's limited liability company must personally execute Promissory Notes at closing in favor of the City of Jackson for all amounts due under this Agreement, jointly and severally In addition, Developer must provide a letter of credit to City in the amount of Twenty-Five Thousand ($25,000.00) Dollars by July 28, 2016. This amount corresponds to the amounts stated in Paragraph 20 of this Agreement.

6. SUBSEQUENT SALE BY DEVELOPER. If Developer purchases the property from the City, and subsequently sells the property to a third party, Developer must pay to the City One Hundred Thousand ($100,000) Dollars if the sale to a subsequent purchaser occurs within two (2) years of the date that the certificate of occupancy is issued to Developer

for the primary structure on the Property. However any amounts that Developer paid to the City for the purchase price will be deducted. The parties agree to this provision in consideration for the reduced price at which the City sold the Property to Developer for the purposes of building a specific project considered necessary economic development. For purposes of this paragraph, a sale shall include a sale or transfer to a related entity, unless permission for the sale or transfer has been received from the City of Jackson City Council prior to the sale or transfer.

7. PARKING.

A. *Availability of Parking*. City and Developer recognize that access to parking is critical to redevelopment of the Property. As a result, City will make parking hang tags available to Developer for the Property. The parking may be in parking spaces located in either surface lots or parking decks within a reasonable distance to the Property. City determines the location of the spaces in which parking is available. Parking permit hangtags will be issued to the Developer upon Developer's request. This provision on parking is not effective unless Developer closes on the Property within the time periods set forth in the Purchase Agreement between the Parties.

B. *Price of Parking*. The price of each parking permit hang tag shall be Fifty and 0/100 Dollars ($50.00) per month per tag. The price of each parking permit hang tag shall increase by Three percent (3%) per year for the first five (5) years from the date of exercise of this Option. After five (5) years, the price of the parking permit hang tag shall be increased annually on the anniversary of the effective date of this Agreement by a percentage equal to the percentage increase in the Consumer Price Index, All Cities, published by the U.S. Department of Labor for the month this Agreement goes into effect and the most recently published index at the anniversary date of this Agreement, and shall not exceed a Three (3%) Percent increase at any time.

8. TWO WAY CONVERSION. Developer shall have no obligation to close on the sale of the Property unless Developer has received a commitment in writing prior to exercise of this Agreement from the City of Jackson City Council that Louis Glick Highway and Washington Street loop will be converted to two-way streets. Said conversion project is an MDOT project which is planned to commence at the completion of the West Michigan Avenue road construction project. The two way conversion project is anticipated to be completed by December 31, 2017. If MDOT decides not to pursue the project, and MDOT's decision is made publicly known prior to exercise of this Agreement, then Developer may terminate this Agreement.

9. DEADLINE FOR COMMENCEMENT AND COMPLETION OF CONSTRUCTION. Commencement of construction must occur on or before November 1, 2016. If Developer purchases the Property, all construction must be completed no later than twenty-four (24) months from the date of commencement of construction or pay the City an additional amount of either ONE HUNDRED THOUSAND DOLLARS ($100,000.00), or FIFTY THOUSAND DOLLARS ($50,000) plus an electronic copy of the building drawings with non-exclusive rights to use of the drawings

10. CONDITION OF THE PROPERTY. Both City and Developer acknowledge that they are aware of the present condition of the Property and that the City has no present plans to repair or preserve the Property. The City shall have no obligation under the terms of this Agreement to repair or maintain the Property in any other manner. Developer acknowledges that any repairs that are made to the property are done solely for the benefit of the Developer in order to preserve the Property for Developer's intended Project.

11. INSURANCE. As a precondition to the Developer entering the Property prior to completing the closing to transfer the Property, it shall be required to show evidence of commercial general liability insurance, worker's compensation insurance and professional liability insurance (where applicable), which is reasonably acceptable to the City. The commercial general liability insurance policies shall name the City, its agents, representatives, officers and employees as additional insureds to protect their interests.

Both bodily injury and property damage insurance must be on an occurrence basis; and such policies shall provide that the coverage afforded thereby shall be primary coverage to the full limits of liability stated in the declarations, and if the City, agents, representatives, officers or employees have other insurance against the loss covered by said policies, that other insurance shall be excess insurance only. Such insurance coverage shall be issued by financially responsible insurance companies, licensed in the State of Michigan, and approved by the City. Upon request by the City, the Developer shall submit all insurance policies for review. Each policy shall provide for thirty (30) days written notice of cancellation, expiration, termination, or change of policy to the City.

12. AUTHORIZATION TO ENTER. City authorizes Developer to enter upon the Property at any time prior to closing to survey the Property, to determine the exact dimensions and legal description thereof, to make soil borings to determine the suitability of the land for the intended uses, and to analyze the soil borings to ascertain the level of contaminants. Developer bears the expense of all borings, surveying and testing. The Developer may inspect the Property and all buildings on the Property and conduct such tests, as Developer may desire, including an environmental assessment of the Property. The Developer or any party the Developer designates is granted reasonable access to the Property for inspection. In each instance, the Developer must inform City of the time and date when Developer or others acting on its behalf wish to inspect the Property so that those visits can be scheduled at times that accommodate City's schedule. Developer must repair all damage caused to the Property to City's satisfaction within 30 days of the visit.

13. POSSESSION. Developer shall have possession of the Property immediately after the closing is completed.

14. LETTER OF INTENT TO CLOSE. Developer must serve the City with a written Letter of Intent to Close no later than September 15, 2016.

15. WATER MAIN TAP. City shall install and pay the costs of constructing the water main tap to the Property line for the use of the subject Property if the Developer closes on the Property.

16. UTILITY RELOCATION COSTS. Developer shall pay the costs to relocate any utilities, other than those utilities owned by the City, which would need to be relocated due to construction by Developer. The City shall not be responsible to pay the costs to relocate or construct any utilities due to any construction by the Developer, other than those regarding the water main tap.

17. REVOCABLE LICENSES. Developer must apply for revocable licenses for the dumpster surround, electrical service area, and all portions of the building that overhang the property line.

18. SIDEWALKS AND ALLEY. Developer will pay to construct all infrastructure and install all landscaping within the boundaries outlined by dotted lines on Exhibit C.

19. BROKER'S FEES; FINDER'S FEES; DEVELOPMENT FEES; DEVELOPER'S AGENT. No broker's fees will be paid in connection with the Property for this transaction.

20. REVERSION OF PROPERTY AND PENALTIES.

    a. If the parties do not complete the closing to transfer the Property by the date specified in this Agreement, this Agreement is null and void, Developer shall pay to City TWENTY-FIVE THOUSAND DOLLARS ($25,000.00), all closing costs, personnel and labor cost, and all other actual costs and expenses incurred by the City related to the "Option and Preliminary Development Agreement" dated March 28, 2016, the Purchase Agreement, and this Development Agreement.

    b. If the parties complete the closing to transfer the Property, but Developer does not commence construction on or before the date specified in the Development Agreement, the Property shall revert back to the City, the Developer shall pay to the City all personnel and labor cost, closing costs, transfer taxes, recording fees

and all other costs and expenses, not to exceed Twenty Five Thousand Dollars ($25,000), incurred by the City as a result of the original sale to Developer and/or from the subsequent sale to the City, plus any unpaid taxes that have accrued during the Developer's period of ownership of the Property, and all other actual costs and expenses incurred by the City related to the "Option and Preliminary Development Agreement" dated March 28, 2016, the Purchase Agreement, and this Development Agreement. The phrase "construction has been commenced" or "commencement of construction" for purposes of this Agreement shall mean that plans and specifications have been approved, all necessary permits have been issued, excavation according to the approved plans has begun on the Project site, and installation of a footer has occurred.

c. If Developer commences construction but does not complete construction by the date specified in this Development Agreement, the Property shall revert back to the City, the Developer shall pay to the City the cost for the City to remove and abate any and all construction or improvements made to the Property by Developer, Developer shall immediately pay and fully satisfy all liens, mortgages, or other encumbrances on the Property. Developer shall pay to City all personnel and labor cost, closing costs, transfer taxes, recording fees and all other costs and expenses, not to exceed Twenty Five Thousand Dollars ($25,000), incurred by the City as a result of the original sale to Developer and/or from the subsequent sale to the City, plus any unpaid taxes that have accrued during the Developer's period of ownership of the Property, and all other actual costs and expenses incurred by the City related to the "Option and Preliminary Development Agreement" dated March 28, 2016, the Purchase Agreement, and this Development Agreement, and all building, site, engineering, and construction plans and drawings related to the construction or improvements made to the Property by Developer shall be provided to and owned by the City.

21. DEVELOPMENT CRITERIA.

a. CODE COMPLIANCE. If and when Developer obtains title, it will construct and operate the Project in compliance with all applicable state statutes, local ordinances, building codes, zoning, and other restrictions of record.

b. PLANS AND SPECIFICATIONS. Developer must submit plans and specifications, when available, in a form acceptable to the City of Jackson Department of Neighborhood and Economic Operations no less than thirty (30) days prior to the commencement of construction activities.

c. DEVELOPMENT SIZE and INVESTMENT. Developer will construct a structure of at least 4 separate floors with at least three floors of residential units and at least one commercial unit on the first floor (ground level).

d. SPECIFIC DEVELOPMENT CRITERIA.

i. "Commencement of the Development" means that all necessary permits and approvals have been obtained, all construction contracts, signed, all construction financing, if any, will be arranged, all site preparation completed, and actual physical Development activity is underway. "Completion of the Development" means that all repairs and rehabilitation set forth in the plans and specifications submitted by Developer to the City has been finalized, the structure on the Property is ready for use, and all amounts due pursuant to this Agreement have been fully paid City in its sole discretion shall determine whether Developer has completed the development of the Property.

ii. Developer must comply with the following:

A. Developer must be in full compliance with all requirements of the City of Jackson Meterless Parking System and be current on all payments due pursuant to the Meterless Parking System within ninety (90) days from the date of execution of this Development Agreement. ;

B. Developer must be registered under the City of Jackson Non-owner Occupied Residential Property Registry within Thirty (30) from the granting of a certificate of occupancy for a residential

unit, unless and until such registration requirement is removed from the City of Jackson ordinances;

C. Developer must obtain all housing inspections required by the City of Jackson Code of Ordinances and Resolutions and comply with the Housing Code;

D. Developer must obtain a zoning compliance certificate prior to commencement of construction;

E. Developer must obtain City approval of all building materials used and the placement of all building materials prior to any construction, repair or rehabilitation of the Property;

F. In addition to the landscaping standards set forth in the City of Jackson Code of Ordinances, Developer shall plant up to six (6) street trees along the frontage of the Property that have been provided with electrical power so as to illuminate tree lights which are required for each street tree. . Developer shall reimburse City for all costs to the City associated with the planting and illumination of these street trees; and

G. Developer shall screen any equipment placed on the roof of the Property in a manner approved by the Zoning Enforcement Officer and Chief Building Official.

22. INSPECTIONS. Developer must permit inspections of the Property as needed by the City, and the City will provide reasonable notice to Developer unless an emergency arises, in which case, the City will make a good faith attempt to contact Developer.

23. DEFAULT BY DEVELOPER. Developer shall be deemed to be in default of this Agreement if the Developer fails to comply with any covenants, clauses, provisions or agreements herein contained and City has provided Developer with ten (10) days written notice of the default and the opportunity to cure such default, which shall not exceed thirty (30) days. Upon default by Developer, this Agreement shall be null and void. If any default has not been cured within thirty (30) days of the delivery of the notice to the

address of Developer specified in Paragraph 10, *infra,* this Agreement shall be null and void. Provided that Developer has been properly served with notice of default to the addresses provided herein, Developer must pay to City, within thirty (30) days of the passing of the applicable deadline, liquidated damages in the amount of Two Hundred ($200.00) Dollars per day for each day that Developer is in default of this Agreement, and/or Two Hundred ($200.00) Dollars per day for failure to comply with any City ordinance, resolution or regulation.

24. TAXES, UTILITIES, AND ASSESSMENTS. Developer must pay the yearly payment of taxes, City assessments, City utilities, and outstanding City debts related to the Property when such become due. In addition, Developer must require its contractors and subcontractors comply with the City of Jackson income tax requirements.

25. CHANGE OF OWNERSHIP INTEREST. Except for mortgages, security interests, and other liens to secure debt granted to Developer in connection with the Development, neither the managing member of the Development, nor any successor in interest to the managing member of the Developer, may transfer or otherwise change the ownership of the Property or duties under this Agreement, without the prior written approval of the City. Any such transfer or other change will not release, in any manner, the Developer or Developer's successors in interest, from any obligation under this Agreement, unless the City releases the Developer or his successors in interest in writing.

26. BINDING EFFECT. This Agreement binds the parties, and their respective successors, legal representatives, and assigns.

27. NON-DISCRIMINATION REQUIREMENT. The Developer, its successors and assigns, and every successor in interest to the Property or any part thereof, must not discriminate upon the basis of race, color, religion, sex, sexual orientation, gender identity, or national origin in the rental, use or occupancy of the Property or any improvements to be erected thereon, or any part thereof.

28. MODIFICATION AND ASSIGNMENT. The promises, covenants, terms, and conditions herein contained may not be modified, altered, or extended without the mutual written consent of the parties. Developer may not transfer, assign and/or convey its rights and obligations under this Agreement to an affiliated or related entity, without the consent of the City.

29. NOTICE. Except as otherwise specified herein, all notices, consents, approvals, requests, and other communications (collectively called "Notices") required or permitted under this Agreement must be given in writing and are effective on delivery. Delivery may be effectuated by personal service with receipt obtained; certified mail or first-class mail with delivery proof; or nationally recognized overnight courier delivery service with next business day delivery. Notices must be addressed as follows:

If to the City, to:	City of Jackson 161 West Michigan Avenue Jackson, Michigan 49201 Attn: City Manager
With a copy to:	City Attorney's Office 161 West Michigan Avenue Jackson, Michigan 49201 Attn: City Attorney
If to Developer, to:	Detroit Entrepreneur Development LLC 13821 Fawn Woods Ct. Plymouth, MI 48170

30. INDEMNIFICATION. To the extent provided by law, Developer shall assume all liability for and protect, indemnify, and save City, its officers, directors, employees, volunteers, invitees, agents and representatives (hereinafter collectively "the City") from and against all actions, claims, demands, judgments, losses, expenses, suits or action and attorney fees, for any injury or death of any person or persons, and loss or damage of the property of any person or persons whomsoever, including Developer or the City, and their respective agents, contractors, subcontractors, and employees, arising in connection with, or as a direct or indirect result of this Development Agreement. The provisions of this Development Agreement shall apply to each and every such injury, death, loss, and

damage, however caused, whether due, or claimed to be due to Developer's negligence, City's negligence, Developer's and City's combined negligence, or otherwise; provided, however, Developer shall not be required to indemnify the City for such injury, death, loss, or damage caused by the City's sole negligence. Developer's obligation to indemnify City shall survive termination and/or expiration of this Agreement.

31. SEVERABILITY. If any one or more provisions of this Agreement, or in any instrument or other document delivered pursuant to this Agreement, or the application thereof to any person or circumstance is, to any extent, declared or determined to be invalid or unenforceable, the validity, legality, and enforceability of the remainder of this Agreement, or the application of such provision to persons or circumstances other than those as to which it is invalid or unenforceable, will not be affected or impaired thereby, and each provision of this Agreement is valid and enforceable to the fullest extent of the law.

32. COUNTERPARTS. This Agreement may be executed in counterparts, each of which is deemed an original document, but together constitute one instrument.

33. ENTIRE AGREEMENT. The parties agree that the Purchase Agreement and this Development Agreement contain the entire terms and conditions between the City and Developer and that there are no other agreements, representations, statements, or understandings which have been relied on by the parties. The Purchase Agreement and this Development Agreement supersede the "Option and Preliminary Development Agreement" dated March 28, 2016.

34. GOVERNING LAW AND INTERPRETATION. The laws of the State of Michigan govern this Agreement and the venue for all proceedings in connection with this Agreement shall be Jackson County, Michigan. The pronouns and relative words used are written in the masculine and singular only. If more than one joins in the execution hereof as Developer or is of the feminine sex or a corporation or limited liability company, such words are read as if written in plural, feminine, or neuter, respectively. All captions, headings, paragraph and subparagraph numbers and letters are solely for

reference purposes and do not supplement, limit, or otherwise vary the text of this Agreement. This Agreement is a result of negotiation between the parties, and accordingly, it will not be construed against either party if a dispute or litigation arises out of this Agreement.

35. HEADINGS. The sections and paragraph headings contained in this Agreement are for reference purposes only and shall not affect in any way the interpretation of the Agreement.

36. LEGAL REPRESENTATION. It is acknowledged that each party to this Agreement had the opportunity to be represented by counsel in the preparation of this Agreement and, accordingly, the rule that a contract shall be interpreted strictly against the party preparing same shall not apply due to the joint contribution of both parties.

37. WAIVER. The failure of City to exercise any right given hereunder or to insist upon strict compliance with regard to any provision of this Agreement, at any time, shall not constitute a waiver of such provision or the right by such at any time to avail itself of such remedies as it may have for any breach or breaches of such provision.

IN WITNESS WHEREOF, the parties have executed this Agreement on the 1ST day of July, 2016.

THE CITY OF JACKSON

By: Patrick H. Burtch
Patrick H. Burtch, City Manager

STATE OF MICHIGAN)
)SS
COUNTY OF JACKSON)

The foregoing instrument was acknowledged before me, this 1ST day of July, 2016, by Patrick H. Burtch, the City Manager of the City of Jackson, a Michigan municipal corporation, on behalf of the corporation.

LAURIE L. HUFF
Notary Public, State of Michigan
County of Jackson
My Commission Expires Sep. 03, 2019
Acting in the County of Jackson

Laurie L. Huff
Laurie L. Huff, Notary Public
Jackson County, Michigan
My commission expires 09/03/2019

DETROIT ENTREPRENEUR DEVELOPMENT, LLC, a Michigan limited liability company

By: _____
Nick Dyc
Its: President

STATE OF MICHIGAN)
)SS
COUNTY OF JACKSON)

The foregoing instrument was acknowledged before me, this 1st day of July, 2016, by Nick Dyc, as President of Detroit Entrepreneur Development, LLC, a Michigan limited liability company.

LAURIE L. HUFF
Notary Public, State of Michigan
County of Jackson
My Commission Expires Sep. 03, 2019
Acting in the County of

_____, Notary Public
Jackson County, Michigan
My commission expires: 09/03/2019

EXHIBIT A – LEGAL DESCRIPTION

Land situated in the City of Jackson, County of Jackson and State of Michigan legally described as:

> Part of Lots 5 & 8, B2N, R1W of the original plat of Jacksonburg, as platted in the original Stratton map of the City of Jackson, County of Jackson, State of Michigan, being further described as beginning at a point 10 feet south of the northeast corner of said Lot 5, thence S89°40'55"W parallel to the north line of Lots 5 & 8, 203.35 feet, thence S00°19'05"E 57.33 feet, thence N89°40'55"E 203.12 feet to the east line of Lot 5, thence North along said east line 57.33 feet to the point of beginning.

Exhibit B
Approximate Property Boundaries

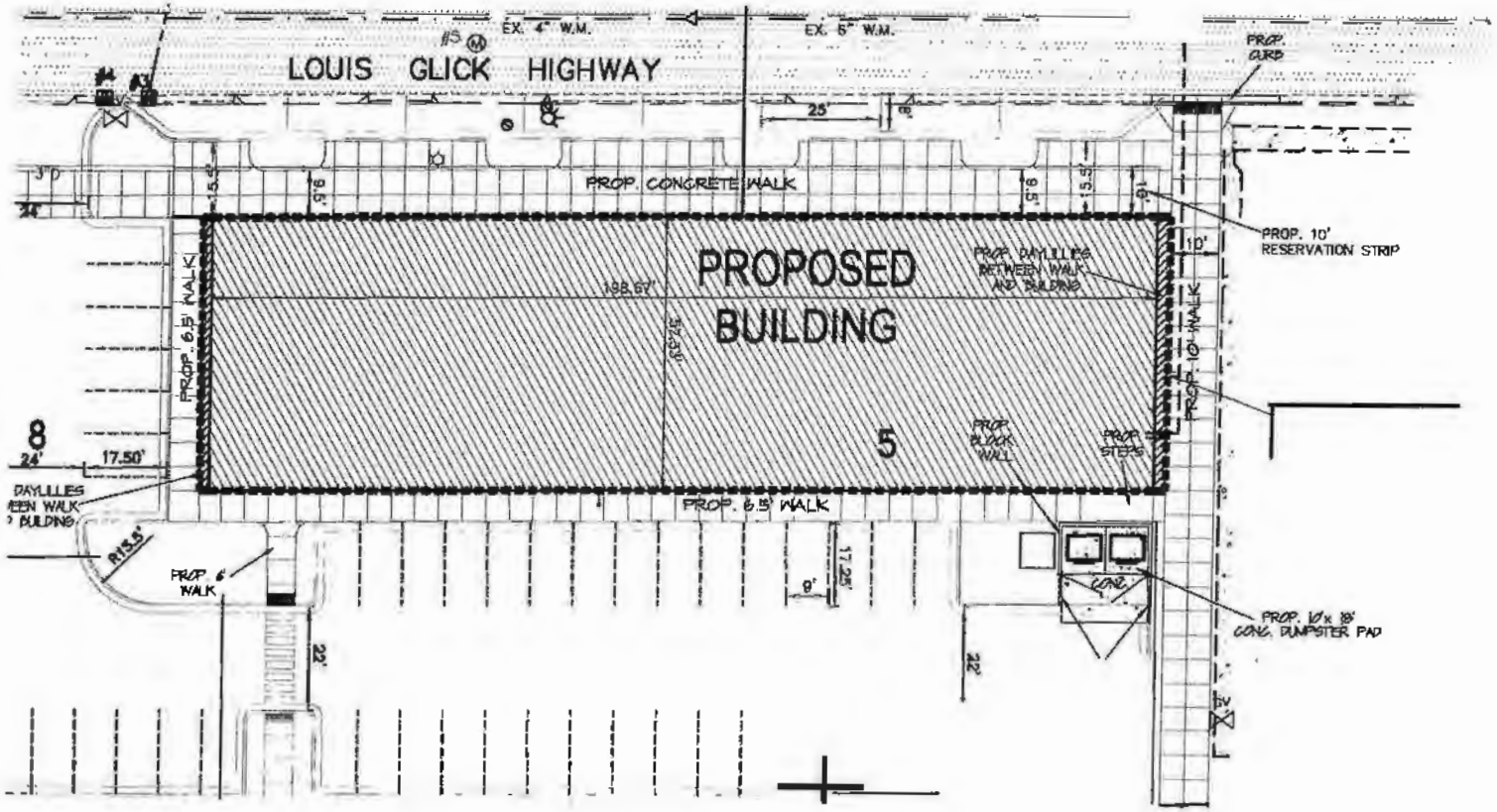
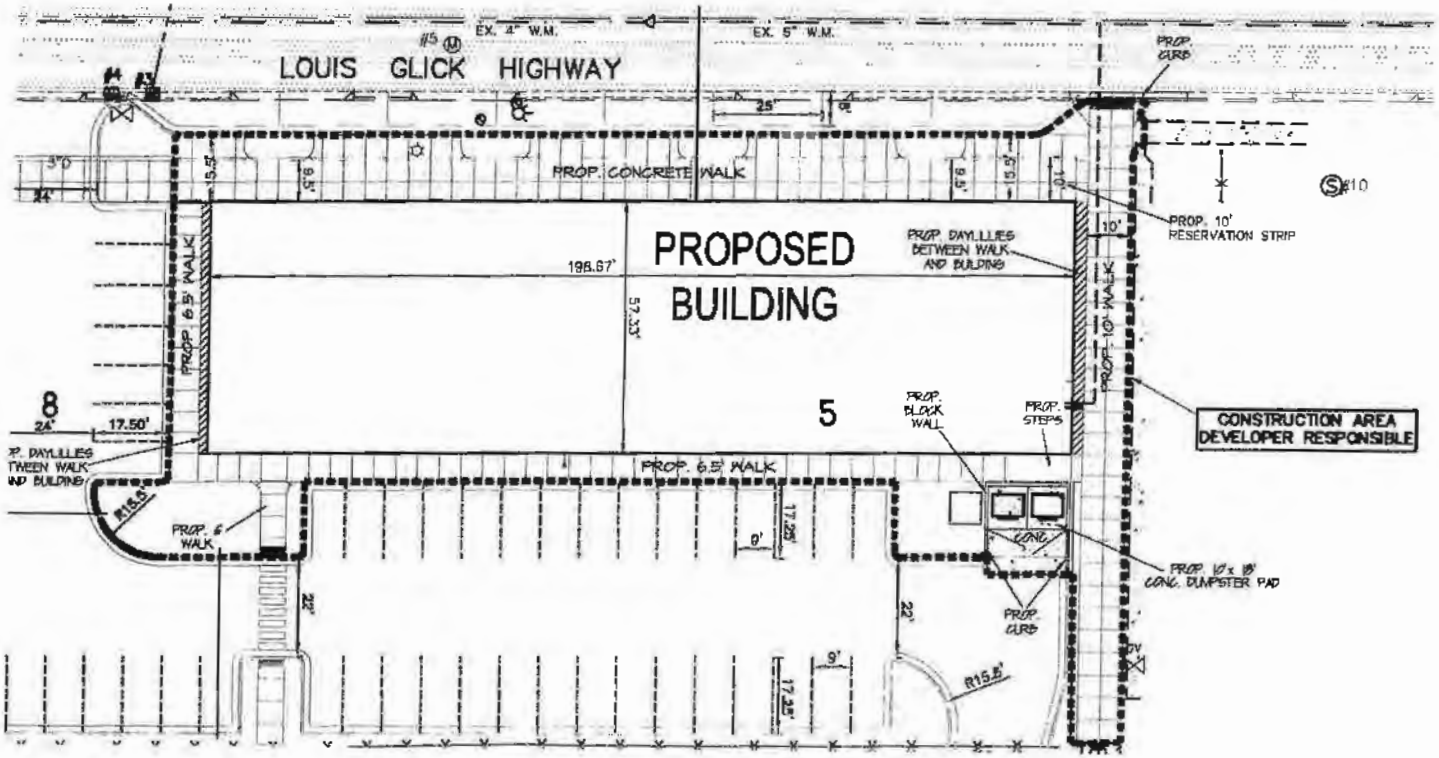


Exhibit C
Area of Property that Developer Must Construct



CITY OF JACKSON
Founded 1829

City Attorney's Office

161 W. Michigan Ave. • Jackson, MI 49201
Phone: (517) 788-4050, (517) 788-4023 • Facsimile: (866) 971-2117

MEMO TO: Honorable Mayor and City Councilmembers

FROM: Bethany M. Smith, City Attorney

DATE: Council Meeting – October 25, 2016

SUBJECT: **Second *Addendum to Purchase Agreement***
Detroit Entrepreneur Development, LLC

Recommendation: APPROVE execution of the attached *Second Addendum to Purchase Agreement*, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

Your consideration and concurrence is appreciated.

DEPARTMENT REPORT

MEMO TO: Honorable Mayor and City Councilmembers

FROM: Bethany M. Smith, City Attorney

DATE: Council Meeting – October 25, 2016

RECOMMENDATION: APPROVE execution of the attached *Second Addendum to Purchase Agreement* with Detroit Entrepreneur Development, LLC, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

SUMMARY

The attached *Second Addendum to Purchase Agreement* sets out the rights and responsibilities of the City of Jackson and Detroit Entrepreneur Development, LLC regarding the purchase of property. This *Second Addendum* is to a Purchase Agreement previously approved by the City Council and executed on July 1, 2016.

HISTORY, BACKGROUND and DISCUSSION

The City entered into a Purchase Agreement and Development Agreement for the sale and development of property located at the Northeast corner of the former Consumer's Energy parking lot between Louis Glick Highway and Pearl Street. In the original agreements, certain timelines were established. Due to issues with the MDEC, Detroit Entrepreneur Development, LLC will not be able to meet the established deadlines to close. This *Second Addendum* seeks to grant Detroit Entrepreneur Development, LLC additional time to close on the property. The following date changes will occur to the Development Agreement and Purchase Agreement:

Letter of Intent to Close	September 15, 2016 **now** October 31, 2016
Closing on sale	October 1, 2016 **now** November 15, 2016
Letter of Credit	September 15, 2016 **now** October 31, 2016
Commencement of Construction	November 1, 2016 **now** November 30, 2016

You must either approve both this agenda item and the corresponding *Second Addendum to Development Agreement*, or disapprove both items.

POSITIONS

APPROVE execution of the attached *Second Addendum to Purchase Agreement* with Detroit Entrepreneur Development, LLC, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

ATTACHMENTS: Addendum
Original Agreement

SECOND ADDENDUM TO PURCHASE AGREEMENT

This is an Addendum to Purchase Agreement entered into on the _____ day of _____, 2016 between the **City of Jackson**, a Michigan municipal corporation, with offices at 161 West Michigan Avenue, Jackson, Michigan 49201 (hereinafter "the City"), **and Detroit Entrepreneur Development, LLC**, a Michigan limited liability company, with offices at 13821 Fawn Woods Ct., Plymouth, MI 48170, Michigan (hereinafter "DED").

This Addendum shall be and is incorporated into the Purchase Agreement dated July 1, 2016 between the City and DED (hereinafter "the Development Agreement").

The City and DED agree to the following changes and/or additions to the Purchase Agreement:

A. Paragraph 29 of the Purchase Agreement shall be amended to read as follows:

"29. LETTERS OF CREDIT.

Buyer must provide the City a Letter of Credit in the amount of Twenty-Five Thousand ($25,000.00) Dollars by October 31, 2016. This Letter of Credit is required as part of the Developer's obligations contained in Paragraph 28. "

This Addendum is to be effective as of the date above.

IN WITNESS WHEREOF, the parties hereto have caused this Addendum to be executed as a proper corporate act of the City and the Detroit Entrepreneur Development, LLC on the day and year first written above.

THE **CITY OF JACKSON, MICHIGAN**

By: _____
Patrick H. Burtch
Its City Manager

STATE OF MICHIGAN)
) SS:
JACKSON COUNTY)

Subscribed and sworn to before me, this ____ day of _____, 2016.

_____
Notary Public
Jackson County, Michigan
My commission expires:

DETROIT ENTREPRENEUR DEVELOPMENT, LLC
A Michigan limited Liability Company

By: _____
Nick Dyc
Its President

STATE OF MICHIGAN)
)SS:
JACKSON COUNTY)

Subscribed and sworn to before me, this ____ day of _____, 2016.

_____
Notary Public
Jackson County, Michigan
My commission expires:

Drafted by:

Bethany M. Smith (P57913)
City Attorney
161 West Michigan Avenue
Jackson, MI 49201

ADDENDUM TO PURCHASE AGREEMENT

This is an Addendum to Purchase Agreement entered into on the 23rd day of September, 2016 between the **City of Jackson**, a Michigan municipal corporation, with offices at 161 West Michigan Avenue, Jackson, Michigan 49201 (hereinafter "the City"), **and Detroit Entrepreneur Development, LLC**, a Michigan limited liability company, with offices at 13821 Fawn Woods Ct., Plymouth, MI 48170, Michigan (hereinafter "DED").

This Addendum shall be and is incorporated into the Purchase Agreement dated July 1, 2016 between the City and DED (hereinafter "the Development Agreement").

The City and DED agree to the following changes and/or additions to the Purchase Agreement:

A. Paragraph 6 of the Purchase Agreement shall be amended to read as follows:

"6. CLOSING

Closing shall take place at the office of the Title Company. If title can be conveyed in the condition required under this Agreement and all contingencies have been satisfied or waived, closing shall take place on a date and time as is mutually agreeable to the parties and as dictated by the ability and availability of Buyer's lender, if any, to close, provided that closing shall occur no later than November 1, 2016."

B. Paragraph 29 of the Purchase Agreement shall be amended to read as follows:

"29. LETTERS OF CREDIT.

Buyer must provide the City a Letter of Credit in the amount of Twenty-Five Thousand ($25,000.00) Dollars by October 15, 2016. This Letter of Credit is required as part of the Developer's obligations contained in Paragraph 28. "

This Addendum is to be effective as of the date above.

IN WITNESS WHEREOF, the parties hereto have caused this Addendum to be executed as a proper corporate act of the City and the Detroit Entrepreneur Development, LLC on the day and year first written above.

THE **CITY OF JACKSON, MICHIGAN**

By: _____
Patrick H. Burtch
Its City Manager

STATE OF MICHIGAN)
) SS:
JACKSON COUNTY)

Subscribed and sworn to before me, this 21st day of September 2016.

TIERNEY M. O'DOWD
NOTARY PUBLIC, Jackson County, MI
My Commission Expires Oct. 29, 2018

_____
Notary Public
Jackson County, Michigan
My commission expires:

DETROIT ENTREPRENEUR DEVELOPEMNT, LLC
A Michigan limited Liability Company

By: _____
Nick Dyc
Its President

STATE OF MICHIGAN)
)SS:
JACKSON COUNTY)

Subscribed and sworn to before me, this 23rd day of September, 2016.

DEBRA A. NOGA
NOTARY PUBLIC, Hillsdale County, MI
My Commission Expires March 4, 2019
Acting in Jackson County, MI

Notary Public
Jackson County, Michigan
My commission expires:

Drafted by:

Bethany M. Smith (P57913)
City Attorney
161 West Michigan Avenue
Jackson, MI 49201

PURCHASE AGREEMENT

BY SIGNING THIS PURCHASE AGREEMENT (Agreement), **the City of Jackson**, a Michigan municipal corporation, whose address is 161 W. Michigan Avenue, Jackson, MI 49201 (Seller), and **Detroit Entrepreneur Development, LLC**, a Michigan limited liability company, whose address is 13821 Fawn Woods Ct., Plymouth, MI 48170 (Buyer), agree to sell and purchase the following real estate located in the City of Jackson, Jackson County, Michigan, described as follows:

See Exhibit A attached

(the Property), together with all improvements and appurtenances, now on the Property, with Buyer to pay One Dollar **($1.00)** and 00/100's (the Purchase Price), subject to building and use restrictions and easements, if any, and zoning ordinances, if any and to the execution of a Development Agreement as set forth herein. The approximate boundaries of the property are as shown on Exhibit B attached.

1. EVIDENCE OF TITLE

As evidence of title, Seller, at Seller's expense, agrees to furnish Buyer as soon as possible a commitment for title insurance issued by American Title Company of Jackson (the Title Company) in an amount not less than the Purchase Price and bearing a date later than the acceptance of this Agreement, with the owner's policy pursuant to the commitment to be issued insuring marketable title to the Property in Buyer.

2. TITLE OBJECTIONS

If objection to title is made in the commitment for title insurance or based on a written opinion of Buyer's attorney that the title is not in the condition required for performance under this Agreement, Seller, at Seller's sole option, shall have thirty (30) days from the date Seller is notified in writing of the particular defects claimed, either (1) to fulfill the requirements in the commitment or to remedy the title defects set forth in Buyer's attorney's opinion or (2) to refund the deposit in full termination of this Agreement. If Seller is able and elects to comply with such requirements or remedy such defects within the time specified, as evidenced by written notification, revised commitment, or endorsement to commitment, Buyer agrees to complete the sale within fourteen (14) days of receipt of a revised commitment or endorsement to commitment, subject to any other contingency contained in this Agreement.

3. EARNEST MONEY DEPOSIT

On the Effective Date (as defined below) of this Agreement, Buyer shall make an earnest money deposit of $1.00, which shall be held by the Title Company and applied toward the Purchase Price at closing if the sale is consummated.

4. TAXES AND PRORATED ITEMS

All taxes which have become a lien on the land as of the date of closing shall be paid by Seller, except that: (a) all current property taxes shall be prorated and adjusted between Seller and Buyer as of the date of closing on a due-date basis, without regard to lien date, as if paid prospectively (e.g., taxes due July 1 will be treated as if paid for the period July 1 through the following June 30, and taxes due December 1 shall be treated as if paid for the period December 1 through the following November 30); and (b) Buyer shall be responsible for the payment of all property taxes falling due after the date of closing without regard to lien date. Seller shall be responsible for payment of all installments due on or before closing for any special assessment against the Property. Buyer shall be responsible for payment of all installments due after closing on any special assessment against the Property. If any special assessment must be paid in full at closing, Buyer shall make such payment at closing.

5. IMPROVEMENTS

This is a parcel of vacant land with no improvements.

6. CLOSING

Closing shall take place at the office of the Title Company. If title can be conveyed in the condition required under this Agreement and all contingencies have been satisfied or waived, closing shall take place on a date and time as is mutually agreeable to the parties and as dictated by the ability and availability of Buyer's lender, if any, to close, provided, however, that closing shall occur no later than October 1, 2016.

7. PAYMENT OF FEES, CLOSING COSTS, ETC.

Buyer shall pay all closing fees and all costs associated with recording the required Deed and any loan documents. The parties agree that the Title Company shall prepare the required Deed and closing documents necessary to complete this transaction, that the Title Company shall conduct the closing, and that the cost of same, together with any document preparation fee, excepting as to loan documents, shall be paid by Seller and Buyer equally. At closing, the parties shall execute closing statements prepared by the Title Company and all income or other tax and governmental reporting documents as required by the Title Company.

8. POSSESSION

Possession of the Property is to be given at closing.

9. INSPECTION CONTINGENCY

This offer is contingent on the Buyer, at the Buyer's option, having the land and any structures examined for physical condition including, but not limited to, environmental contamination or conditions; satisfactory foundations; drainage; grading; and construction; by a contractor/professional inspector of Buyer's own choice and at Buyer's own expense within sixty (60) days of the Effective Date (as defined below). Unless Buyer notifies Seller, in writing, within sixty (60) days of the Effective Date (as defined below) that Buyer has substantial cause to be dissatisfied with the results of such examinations, and which writing shall specifically recite the causes of such dissatisfaction, Buyer will be conclusively presumed to accept the condition of the premises "AS IS." If Buyer duly notifies Seller of Buyer's dissatisfaction, Seller shall have the option to make the required repairs or declaring this Agreement null and void and returning all deposits to Buyer. For the purpose of this Property Inspection Contingency, no individual cause for dissatisfaction costing less than **Ten Thousand and NO/100 ($10,000.00) Dollars** to repair, as determined by the reasonable estimate of Seller's contractor, shall constitute "substantial cause to be dissatisfied."

10. CONDITION OF PROPERTY

Buyer acknowledges and agrees that the Property shall be sold, and Buyer shall accept possession of the Property on the Closing Date, "AS IS- WHERE IS, WITH ALL FAULTS," with no right of setoff or reduction in the Purchase Price, and Buyer shall assume the risk that adverse physical, environmental, economic or legal conditions may not have been revealed by Buyer's investigations during the Due Diligence Period or otherwise. Seller nor their respective officials, officers, employees, agents, representatives, successors or assigns (each, a "Seller's Representative" and, collectively, "Seller's Representative's") have or shall be deemed to have made any representations or warranties, express or implied, regarding the Property or any matters affecting the Property, including without limitation the physical condition of the Property, title to or boundaries of the Property, soil conditions, the presence or absence, location or scope of any Hazardous Materials in, at, or under the Property, compliance with building, health, safety, land use or zoning Laws, other engineering characteristics, traffic patterns and all other information pertaining to Property. Buyer moreover acknowledges (i) that Buyer is a sophisticated buyer, knowledgeable and experience in the financial and business risks attendant to an investment in real property and capable of evaluating the merits and risks of entering into this Agreement and purchasing the Property, (ii) that Buyer has entered into this Agreement in reliance on its own (or its experts') investigation of the physical, environmental, economic and legal condition of the Property, and (iii) that Buyer is not relying upon any representation or warranty concerning the Property made by Seller or Seller's Representatives other than as expressly set forth. Seller shall not have any liability of any kind or nature for any subsequently discovered defects in the Property whether those defects were latent or patent.

11. LEGAL DESCRIPTION

Buyer and Seller acknowledge and agree that the legal description for the Property shall be that as set forth in the commitment for title insurance to be obtained by Seller and furnished to Buyer pursuant to this Purchase Agreement.

12. BUYER'S DEFAULT

If Buyer fails to perform any of its obligations under this Agreement for any reason other than Seller's default or the permitted termination of this Agreement by either Seller or Buyer as herein expressly permitted, Seller shall have the right, in its sole discretion, to (a) terminate this Agreement and receive and retain the Earnest Money hereunder, which retention shall operate to terminate this Agreement and release Buyer from any and all liability hereunder, and/or (b) enforce specific performance of Buyer's obligation to execute the documents and pay the Purchase Price required for Seller to convey the Property to Buyer. Seller shall give 10 days' notice and an opportunity to cure any breach by Buyer occurring less than 10 days prior to the agreed upon date of Closing.

13. SELLER'S DEFAULT

If Seller defaults under this Agreement, Buyer may, at Buyer's option, pursue all legal and equitable remedies available to Buyer under Michigan law, or demand and be entitled to an immediate refund of Buyer's entire deposit in full termination of this Agreement. If Buyer elects to a return of the deposit, the deposit shall be returned as liquidated damages. Buyer acknowledges and agrees that Buyer's election of a return of the deposit shall be Buyer's sole remedy, and Buyer shall have voluntarily waived any other legal or equitable remedy Buyer may have as a result of the default.

14. RISK OF LOSS

The risk of loss shall remain with the Seller until title transfer. Should such property be substantially damaged by fire or other casualty prior to filing the Deed the Buyer shall have the option to void this agreement in which event all earnest moneys shall be returned to the buyer and such agreement shall become null and void, or have such insurance proceeds deposited into escrow thereupon the purchase.

15. BUYER'S ACCESS TO PROPERTY

While this Agreement remains in effect, Buyer and Buyer's representatives shall have the right to enter upon the Property for the purpose of inspecting the Property and making engineering tests and other investigations, inspections and tests related to Buyer's development of the Property.

16. BINDING AGREEMENT

This Agreement shall bind and inure to the benefit of the heirs, executors, administrators, successors, and assigns of the respective parties. Buyer's acceptance of the Deed shall be deemed a discharge of all of the obligations of Seller under this Agreement.

17. TIME OF THE ESSENCE

Time is of the essence of this Agreement, but Buyer may waive this provision for the purpose of curing title defects.

18. BROKERS

Seller and Buyer represent and warrant to each other that they have not used or employed the services of any real estate brokers, sales agents, or finders in connection with the purchase and sale of the Property, and that any commissions owed to any broker, sales agent or finder shall be the sole responsibility of Buyer. Other than commissions owed to, if any, which shall be paid by Buyer, Seller and Buyer agree to indemnify, defend, and hold one another harmless with respect to any broker's commissions and/or finder's fees which are asserted or may become due as a result of the purchase and sale of the Property.

19. ENTIRE AGREEMENT

The parties agree that this Purchase Agreement and the Development Agreement contain the entire terms and conditions between Seller and Buyer and that there are no other agreements, representations, statements, or understandings which have been relied on by the parties to this Purchase Agreement which are not stated in this Purchase Agreement. This Purchase Agreement and the Development Agreement supersede the "Option and Preliminary Development Agreement" dated March 28, 2016.

20. REPRESENTATIONS & WARRANTIES

Buyer represents and warrants to Seller as follows:

(A) Buyer is a duly formed and validly existing Limited Liability Company organized under the laws of the State of Michigan (and is qualified under the laws of the Commonwealth of Michigan to conduct business therein.)

(B) Buyer has the full legal right, power, authority and financial ability to execute and deliver this Agreement and Buyer's Documents, to consummate the transactions contemplated hereby, and to perform its obligations hereunder and under Buyer's Documents.

(C) This Agreement and Buyer's Documents have been duly authorized by all requisite corporate action, action on the part of Buyer, and are the valid and legally binding obligations of Buyer, enforceable in accordance with their respective terms.

(D) This Agreement and Buyer's Documents do not and will not contravene any provision of the articles and bylaws; partnership agreement; operating agreement; management agreement of Buyer, any judgment, order, decree, writ or injunction issued against Buyer, or any provision of any Laws applicable to Buyer. The consummation of the transactions contemplated hereby will not result in a breach or constitute a default or event of default by Buyer under any agreement to which Buyer or any of its assets are subject or bound and will not result in a violation of any Laws applicable to Buyer.

(E) Buyer has no knowledge as of the date hereof of pending actions, suits, proceedings or investigations to which Buyer is a party before any court or other Governmental Authority which is likely to have material adverse impact on the transactions contemplated herby.

The representations and warranties of Buyer set forth in this Agreement shall be true, accurate and correct in all material respects upon the execution of this Agreement, shall be deemed to be repeated on and as of the Closing Date (except as they relate only to an earlier date) and shall survive the Closing for a period of 90 days and shall not be merged in the Deed for that period, and no action or claim based thereon shall be commenced after that period unless the factual basis of the claim or cause of action asserted in the action was first identified with reasonable clarity in a written notice delivered to Buyer not later than 90 days following the Closing Date.

21. NOTICES

(a) All notices, elections, consents, approvals, demands, objections, requests or other communications which Seller, Buyer or Title Company may be required or desire to give pursuant to, under or by virtue of this Agreement must be in writing and sent by (i) first class U.S. certified or registered mail, return receipt requested, with postage prepaid, or (ii) nationally-recognized courier guarantying next business day delivery, addressed as follows:

<u>If to Seller:</u>

City of Jackson
Attn: City Manager
161 W. Michigan Ave.
Jackson, MI 49201

<u>With a copy to:</u>

City of Jackson
Attn: City Attorney

161 W. Michigan Ave.
Jackson, MI 49201

If to Buyer:

Detroit Entrepreneur Development, LLC
13821 Fawn Woods Ct.,
Plymouth, Michigan 48170

If to Title Company:

American Title Company of Jackson
280 W. Cortland Avenue
Jackson, MI 49201

22. GENERAL CONDITIONS

Each of the Exhibits referred to in this Agreement and attached to this Agreement are incorporated herein by this reference. The caption headings in this Agreement are for convenience only and are not intended to be a part of this Agreement and shall not be construed to modify, explain or alter any of the terms, covenants or conditions herein contained. This Agreement may be executed in a number of identical counterparts, each of which shall be an original for all purposes. If so executed, each of such counterparts shall, collectively, constitute one agreement. If any provision of this Agreement shall be unenforceable or invalid, the same shall not affect the remaining provisions of this Agreement and to this end the provisions of this Agreement are intended to he and shall be severable.

23. FURTHER ASSURANCES

Each party agrees that it will without further consideration execute and deliver such other documents and take such other action, whether prior or subsequent to Closing, as may be reasonably requested by the other party to consummate more.

24. INDEMNIFICATION

The Buyer agrees to release Seller, its agents, officials and employees from, and shall indemnify and save harmless the Seller, its agents, officials and employees against and, from all liabilities, obligations, damages, penalties, claims, costs, charges, losses and expenses (including, without limitation, fees and expenses of attorneys, whether inside or outside counsel, expert witnesses and other consultants) which may be imposed upon, incurred by or asserted against the Seller by reason of the following occurring during the term of this Agreement and particularly, but not solely, during the Inspection Period: any negligent or tortuous act or omission of the Buyer or its agents, employees or assigns

resulting in personal injury, bodily injury, sickness, disease or death, or injury to or destruction of tangible and/or real property, including the loss of use therefrom.

25. ALL AGREEMENTS IN WRITING

The parties agree that this Purchase Agreement (and written and signed addenda, if any) cannot be modified, altered, or otherwise amended without a writing being duly signed or initialed, as the case may be, by both Seller and Buyer.

26. CHOICE OF LAW

This Agreement shall be governed by the laws of the State of Michigan and venue shall be in Jackson County, Michigan.

27. EFFECTIVE DATE

The effective date of this Agreement, i.e., the date on which the timing provisions and contingencies of this Agreement begin (the Effective Date), shall be the date on which the last party to sign this document shall have signed the document. If the parties fail to insert the date they signed this Agreement beneath their signatures below, the Effective Date shall be the date on which Buyer received a fully executed copy of this document. **IT IS THEREFORE VERY IMPORTANT FOR EACH PERSON SIGNING THIS DOCUMENT TO PLACE THE DATE OF SIGNING IN THE SPACE PROVIDED BELOW HIS OR HER SIGNATURE.**

28. DEVELOPMENT AGREEMENT

Buyer agrees that this Purchase Agreement is contingent upon the Buyer signing a Development Agreement prior to or contemporaneous with the closing on the Property between the parties, in which Buyer agrees to complete and abide by the terms and conditions stated in the Development Agreement.

a. If the parties do not complete the closing to transfer the Property by the date specified in this Agreement, this Agreement is null and void, Buyer shall pay to Seller TWENTY-FIVE THOUSAND DOLLARS ($25,000.00), or all closing costs, personnel and labor cost, and all other actual costs and expenses incurred by the City related to the "Option and Preliminary Development Agreement" dated March 28, 2016, this Agreement, and the Development Agreement, not to exceed Twenty Five Thousand Dollars ($25,000), whichever is less.

b. If the parties complete the closing to transfer the Property, but Buyer does not commence construction on or before the date specified in the Development Agreement, the Property shall revert back to the Seller, the Buyer shall pay to Seller all personnel and labor cost, closing costs, transfer taxes, recording fees and all other costs and expenses incurred by the City as a result of the original sale to

Grantee and/or from the subsequent sale to the City, plus any unpaid taxes that have accrued during the Grantee's period of ownership of the Property, and all other actual costs and expenses, not to exceed Twenty Five Thousand Dollars ($25,000), incurred by the City related to the "Option and Preliminary Development Agreement" dated March 28, 2016, this Agreement, and the Development Agreement. Buyer agrees that Seller has no obligation to close on the Property if the Development Agreement as referenced above is not signed by the Buyer prior to the closing on the Property that is the subject of this Agreement, and (3) that Buyer cannot construct any structure (including but not limited to sheds, garages, or parking facilities, on the Property prior to complete construction of the principal structure shown on Exhibit C. The phrase "construction has been commenced" or "commencement of construction" for purposes of this Agreement shall mean that plans and specifications have been approved, all necessary permits have been issued, excavation according to the approved plans has begun on the Project site, and installation of a footer has occurred.

c. If Buyer does not complete construction by the date specified in the Development Agreement, the Property shall revert back to the Seller, the Buyer shall pay to Seller the cost for the Seller to remove and abate any and all construction or improvements made to the Property by Buyer, Buyer shall immediately pay and fully satisfy all liens, mortgages, or other encumbrances on the Property. Buyer shall pay to Seller all personnel and labor cost, closing costs, transfer taxes, recording fees and all other costs and expenses, not to exceed Twenty Five Thousand Dollars ($25,000), incurred by the City as a result of the original sale to Grantee and/or from the subsequent sale to the City, plus any unpaid taxes that have accrued during the Grantee's period of ownership of the Property, and all other actual costs and expenses incurred by the City related to the "Option and Preliminary Development Agreement" dated March 28, 2016, this Agreement, and the Development Agreement, and all building, site, engineering, and construction plans and drawings related to the construction or improvements made to the Property shall be provided to, possessed, and owned by the City.

29. LETTERS OF CREDIT

Buyer must provide the City a Letter of Credit in the amount of Twenty-Five Thousand ($25,000.00) Dollars by July 28, 2016. This Letter of Credit is required as part of the Developer's obligations contained in Paragraph 28.

30. TWO WAY CONVERSION

Buyer shall have no obligation to close on the sale of the Property unless Buyer has received a commitment in writing prior to exercise of this Agreement from the Buyer that Louis Glick Highway and Washington Street loop will be converted to two-way streets. Said conversion project is an MDOT project which is planned to commence at the completion of the West Michigan Avenue road construction project. The two way

conversion project is anticipated to be completed by December 31, 2017. If MDOT decides not to pursue the project, and MDOT's decision is made publicly known prior to exercise of this Agreement, then Buyer may terminate this Agreement.

31. CITY COUNCIL AUTHORIZATION

Notwithstanding any other provision, this Agreement is subject to the approval of the City of Jackson City Council.

ACCORDINGLY, Seller and Buyer have executed this Purchase Agreement as of the date written below.

BUYER:

DETROIT ENTREPRENEUR DEVELOPMENT, LLC, ~~LLC~~ PMD MD

By _____ Nicholas Dyc
Its: President
Dated: 7/1/16

By: _____
Its: _____
Dated: _____

By _____
Its: _____
Dated: _____

By: _____
Its: _____
Dated: _____

STATE OF MICHIGAN)
)SS
COUNTY OF JACKSON)

The foregoing instrument was acknowledged before me in Oakland County, Michigan this 1st day of July, 2016 by Nicholas Dyc, the President of Detroit Entrepreneur Development LLC a Michigan limited liability company, on behalf of the company.

LAUREL L. HUFF
Notary Public, State of Michigan
County of Jackson
My Commission Expires Sep. 03, 2019
Acting in the County of Jackson

Laurel L. Huff
Notary Public, Jackson County, Michigan
My Commission Expires: 09/03/2019

STATE OF MICHIGAN)
)SS
COUNTY OF JACKSON)

The foregoing instrument was acknowledged before me in _____ County, _____ this _____ day of _____, 2016 by _____, the _____ of _____, a Michigan limited liability company, on behalf of the company.

_____
Notary Public, Jackson County, Michigan
My Commission Expires:_____

STATE OF MICHIGAN)
)SS
COUNTY OF JACKSON)

The foregoing instrument was acknowledged before me in _____ County, _____ this _____ day of _____, 2016 by _____, the _____ of _____, a Michigan limited liability company, on behalf of the company.

_____
Notary Public, Jackson County, Michigan
My Commission Expires:_____

STATE OF MICHIGAN)
)SS
COUNTY OF JACKSON)

The foregoing instrument was acknowledged before me in _____ County, _____ this _____ day of _____, 2016 by _____, the _____ of _____, a Michigan limited liability company, on behalf of the company.

_____
Notary Public, Jackson County, Michigan
My Commission Expires:_____

SELLER:

CITY OF JACKSON

Patrick H Burtch

By: Patrick H. Burtch
Its: City Manager

Dated: 7/1/2016

STATE OF MICHIGAN)
)SS
COUNTY OF JACKSON)

The foregoing instrument was acknowledged before me in Jackson County, Michigan this 1st day of July, 2016 by Patrick H. Burtch, the City Manager of the City of Jackson, a Michigan municipal corporation, on behalf of the corporation.

LAURIE L. HUFF
Notary Public, State of Michigan
County of Jackson
Commission Expires Sep. 09, 2019
Acting County of Jackson

Laurie L. Huff
Notary Public, Jackson County, Michigan
My Commission Expires: 09/03/2019

EXHIBIT A – LEGAL DESCRIPTION

Land situated in the City of Jackson, County of Jackson and State of Michigan legally described as:

> Part of Lots 5 & 8, B2N, R1W of the original plat of Jacksonburg, as platted in the original Stratton map of the City of Jackson, County of Jackson, State of Michigan, being further described as beginning at a point 10 feet south of the northeast corner of said Lot 5, thence S89°40'55"W parallel to the north line of Lots 5 & 8, 203.35 feet, thence S00°19'05"E 57.33 feet, thence N89°40'55"E 203.12 feet to the east line of Lot 5, thence North along said east line 57.33 feet to the point of beginning.

EXHIBIT B – PROPOSED BOUNDARIES OF STRUCTURE

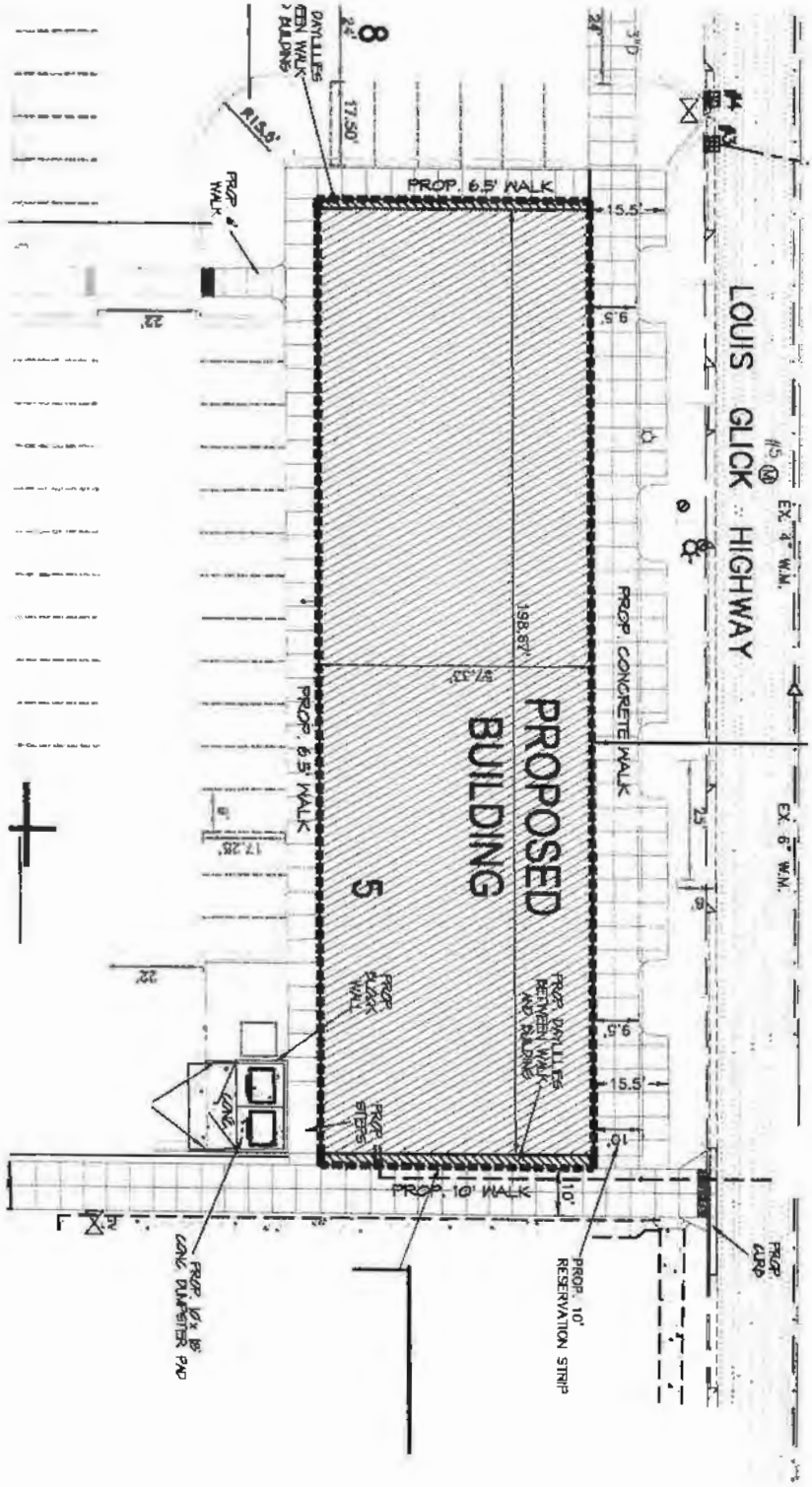


EXHIBIT C – RENDITION OF PROPOSED STRUCTURE

CITY OF JACKSON
Founded 1829

City Attorney's Office

161 W. Michigan Ave. • Jackson, MI 49201
Phone: (517) 788-4050, (517) 788-4023 • Facsimile: (866) 971-2117

MEMO TO: Honorable Mayor and City Councilmembers

FROM: Bethany M. Smith, City Attorney (B)

DATE: Council Meeting – October 25, 2016

SUBJECT: ***Construction Access Easement***
Detroit Entrepreneur Development, LLC

Recommendation: APPROVE execution of the attached *Construction Access Easement*, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

Your consideration and concurrence is appreciated.

DEPARTMENT REPORT

MEMO TO: Honorable Mayor and City Councilmembers

FROM: Bethany M. Smith, City Attorney

DATE: Council Meeting – October 25, 2016

RECOMMENDATION: APPROVE execution of the attached *Construction Access Easement* in favor of Detroit Entrepreneur Development, LLC, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

SUMMARY

The attached *Construction Access Easement* grants an easement for ingress and egress for the sole purpose of storage of dirt during construction of Detroit Entrepreneur Development's project along Louis Glick Highway.

HISTORY, BACKGROUND and DISCUSSION

Detroit Entrepreneur Development, LLC currently has a purchase agreement and development agreement with the City to purchase property along Louis Glick Highway north of N. Jackson Street. During the construction phase, DED has requested that the City grant it an easement on property north of the proposed development for the placement of dirt during the construction phase. The attached *Construction Access Agreement* will give DED the right to enter to deposit dirt on the property. No other use of the property is permitted by the *Construction Access Agreement*.

POSITIONS

APPROVE execution of the attached *Construction Access Easement* with Detroit Entrepreneur Development, LLC, authorize the City Manager to sign same, authorize the City Attorney to make minor modifications and to take all actions necessary to finalize the Agreement.

ATTACHMENTS: Construction Access Agreement

CONSTRUCTION ACCESS EASEMENT

NOW ALL MEN BY THESE PRESENTS, that THE CITY OF JACKSON, a Michigan Municipal Corporation, whose address is 161 W. Michigan Avenue, Jackson, MI 49201 ("Grantor"), for and in consideration of One ($1.00) Dollar, receipt and sufficiency of which is hereby acknowledged, hereby grants and conveys to Detroit Entrepreneur Development, LLC, a Michigan limited liability company, with offices at 13821 Fawn Woods Ct., Plymouth, MI 48170, Michigan ("Grantee"), being exempt pursuant to MCLA 207.505(a), and MCLA 207.526 (a) an easement for the purpose of temporary ingress, egress and materials storage in, over, upon and through the following described premises situated in the City of Jackson, Jackson County, State of Michigan, to wit:

> The North 66 feet of lots 9, B2N, R1W of the original Plat of Jacksonburg, as platted in the original Stratton map of the City of Jackson.

Exempt pursuant to MCLA 207.505(a) and MCLA 207.526(a)

Grantee reserves an easement over the Easement Area described above for use by the Grantee for temporary ingress, egress and storage of dirt only during the construction of a structure on the adjoining property to the East. The term of the Easement shall be for six months from the date signed below.

This instrument shall be binding and inure to the benefit of the parties hereto, their heirs, representatives, successors and assigns.

Dated this _____ day of _____, 2016.

Signed by:

City of Jackson

_____
Patrick H. Burtch
Its: City Manager

STATE OF MICHIGAN)
)SS
COUNTY OF _____)

The foregoing instrument was acknowledged before me this _____ day of _____, 2016, by Patrick H. Burtch, as the City Manager of the City of Jackson.

_____
Notary Public
_____ County, Michigan
My Commission Expires

Dated this _____ day of _____, 2016.

Signed by:

Detroit Entrepreneur Development, LLC

_____
Nick Dyc
Its: President

STATE OF MICHIGAN)
)SS
COUNTY OF _____)

The foregoing instrument was acknowledged before me this _____ day of _____, 20____, by Nick Dyc, as President of Detroit Entrepreneur Development, LLC.

_____
Notary Public
_____ County, Michigan
My Commission Expires:

Drafted by:
Bethany M. Vujnov, City Attorney
City of Jackson
161 W. Michigan Ave.
Jackson, MI 49201

JACKSON
Founded 1829

City Manager's Office

161 W. Michigan Ave. - Jackson, MI 49201
Telephone: (517) 788-4035 • Facsimile: (517) 768-5820

MEMO TO: Mayor and City Councilmembers

FROM: Patrick H. Burtch, City Manager

DATE: October 25, 2016

SUBJECT: **Region 2 Planning Commission Invoice – Local Share Cost of JACTS Unified Work Program FY 2017**

Recommendation:

> **Approve payment of the invoice from Region 2 Planning Commission for local share cost of Jackson Area Comprehensive Transportation Study (JACTS) Unified Work Program for FY 2017, in the amount of $19,493.50, in accordance with the recommendation of the City Engineer, and authorize the City Engineer to sign the Local Funding Resolution.**

Attached is a report from Jon Dowling, City Engineer, regarding approval of payment to JACTS for the City's local share cost of the JACTS Unified Work Program for FY 2017, and authorization to sign the resolution.

I recommend approval of the payment and resolution. Your consideration and concurrence is appreciated.

PHB

Attachments

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DEPARTMENTAL REPORT

MEMO TO: Patrick Burtch, City Manager

FROM: Jon H. Dowling, P.E., City Engineer

DATE: October 25, 2016

RECOMMENDATION: **Approve payment of the invoice from Region 2 Planning Commission for local share cost of Jackson Area Comprehensive Transportation Study (JACTS) Unified Work Program for FY 2017, in the amount of $19,493.50, in accordance with the recommendation of the City Engineer, and authorize the City Engineer to sign the Local Funding Resolution.**

SUMMARY

The attached invoice and funding resolution from Region 2 Planning Commission is for the local agencies' matching requirement for the fiscal year 2017 JACTS Unified Work Program.

BUDGETARY CONSIDERATIONS

This invoice of $19,493.50 will be paid from the Major Street Fund.

HISTORY, BACKGROUND and DISCUSSION

Originally this cost was a soft match to Region 2 with City staff working in conjunction with the Unified Work Program. Years ago, the Federal Highway Commission changed their policy and wanted to see actual payments from the local agencies to the planning agencies. Since FY201-2011, this has appeared in the City's budget in Major Street Fund Street and Bridge Construction (202-451) for JACTS Planning Region 2.

DISCUSSION OF THE ISSUE

Region 2 Panning Commission is the state designated Metropolitan Planning Organization (MPO) for the Jackson urbanized area. The MPO oversees the Unified Work Program and receives planning funds from the Federal Highway Administration. These planning funds are required to have a local match of 18.15%. This local match is split between the City and the County Department of Transportation.

POSITIONS

I request approval of payment of the invoice and authorization for the City Engineer to sign the resolution.

ATTACHMENTS

JHD/sms

REGION 2 PLANNING COMMISSION / JACKSON AREA COMPREHENSIVE TRANSPORTATION STUDY FY 2017 UNIFIED WORK PROGRAM LOCAL FUNDING RESOLUTION

WHEREAS, the urban transportation planning regulations implementing sections of the Moving Ahead for Progress in the 21st Century (MAP-21) legislation requires that each urbanized area, as a condition of receipt of Federal capital or operating assistance, have a continuing, cooperative, and comprehensive urban transportation planning process that results in plans and programs consistent with the comprehensively planned development of the urbanized areas; and

WHEREAS, the Region 2 Planning Commission (R2PC), as the state designated Metropolitan Planning Organization (MPO) for the Jackson urbanized area, conducts the continuing, cooperative, and comprehensive planning process through the Jackson Area Comprehensive Transportation Study (JACTS), a forum for cooperative transportation decision-making developed under federal guidelines for the purposes of urban transportation planning conduct; and

WHEREAS, JACTS annually develops an urban transportation Unified Work Program (UWP) which identifies activities and costs necessary for the conduct of the urban transportation planning process; and

WHEREAS, transportation planning funds provided by the U.S. Department of Transportation to the Michigan Department of Transportation and are passed through to the R2PC to carry out the activities defined in the UWP; and

WHEREAS, these funds, available under MAP-21 as Federal Highway Administration (FHWA) PL require a local matching contribution of 18.15 percent; and

WHEREAS, the Region 2 Planning Commission has recommended that the local match contribution required to assure the timely conduct of JACTS activities be divided and contributed equally by the City of Jackson Neighborhood & Economic Operations Department and the Jackson County Department of Transportation; and

WHEREAS, it has been determined that the total local share costs for the JACTS Unified Work Program for FY 2017 (October 1, 2016 – September 30, 2017) is $38,987;

NOW, THEREFORE BE IT RESOLVED,

That the City of Jackson Neighborhood & Economic Operations Department agrees to participate in 50 percent of the funding of the local share costs by providing $19,493.50 to the Region 2 Planning Commission by December 1, 2016;

BE IT FURTHER RESOLVED,

That the Region 2 Planning Commission agrees to reimburse the City of Jackson Neighborhood & Economic Operations Department for planning activities necessary for the completion of, and identified within, the JACTS FY 2017 Unified Work Program.

_____
Carl Rice, Jr., Chair
Region 2 Planning Commission

_____
Date

_____
Steven Duke, Executive Director
Region 2 Planning Commission

_____
Date

_____
Jon H. Dowling, P.E., City Engineer
City of Jackson Neighborhood & Economic Operations Dept.

_____
Date

Region 2 Planning Commission

120 W. Michigan Avenue
Jackson, MI 49201

Invoice

DATE: October 13, 2016
INVOICE NO.: 3442
FOR: *FY 2017 Local Share Cost*

Jon Dowling, Engineering Department
City of Jackson
161 W. Michigan Avenue
Jackson, MI 49201

DESCRIPTION	AMOUNT
City of Jackson Engineering Department	
Local share cost of JACTS Unified Work Program for FY 2017 (October 1, 2016- September 30, 2017)	$ 19,493.50
Please refer to the enclosed resolution.	
TOTAL	$ 19,493.50

Make all checks payable to the Region 2 Planning Commission.
If you have any questions concerning this invoice, please contact
LaTasha Thompson, Accountont ot 517.768.6834 or email to lthompson@co.jackson.mi.us

Thank you.

CITY OF JACKSON
Founded 1829

City Attorney's Office

161 W. Michigan Ave. • Jackson, MI 49201
Phone: (517) 788-4050, (517) 788-4023 • Facsimile: (866) 971-2117

MEMO TO: Mayor and City Councilmembers

FROM: Bethany M. Smith, City Attorney
Courtney A. Gabbara, Staff Attorney

DATE: October 25, 2016

SUBJECT: Revisions to Chapter 18, Section 31 of the City Code of Ordinances – Obstruction

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Recommendation:

Approve Ordinance Revisions to Chapter 18, Section 31, Obstruction, by adding language that would help protect the health, safety, and welfare of the citizens of the City of Jackson, Michigan when on government-owned property.

Attached is a memo from the City Attorney's Office, regarding revising Chapter 18 of the City of Jackson Code of Ordinances, as well as a clean and blacklined version of Section 18-31 of the City of Jackson Code of Ordinances.

We recommend approval of the above mentioned recommendation. Your consideration and concurrence is appreciated.

DEPARTMENTAL REPORT
October 25, 2016

MEMO TO: Honorable Mayor and City Councilmembers

FROM: Patrick H. Burtch, City Manager
Bethany M. Smith, City Attorney
Courtney A. Gabbara, Staff Attorney

DATE: October 25, 2016

RECOMMENDATION: Approve Ordinance Revision to Chapter 18, Section 31, Obstruction, by adding language that would help protect the health, safety, and welfare of the citizens of the City of Jackson, Michigan when on government-owned property.

SUMMARY

The recommended action is approval of a Revision to Chapter 18, Section 31 of the City of Jackson Code of Ordinances by adding language to Section 18-31, which is relevant to the health, safety, and welfare of the citizens of the City of Jackson, Michigan. This action is being recommended in order to allow designated City officials to take action when a person located on government-owned property engages in activity which unreasonably interferes with the use and operation of government-owned property. Specifically, designated City officials would be given the authority to temporarily bar individuals from entering government-owned property if the person is behaving in a manner that willfully or knowingly hinders, opposes, obstructs, or resists City employees in performing his or her duties.

BUDGETARY CONSIDERATIONS

There are no foreseen budgetary considerations or concerns.

HISTORY, BACKGROUND and DISCUSSION

By adding this language to Section 18-31, we will ensure that citizens and employees of the City of Jackson remain safe while on government-owned property. The current language states that a person may not obstruct a City employee while they are performing their regular duties. The addition of the proposed language will provide the City with ways of regulating what designated City employees consider threats to the safety of its citizens and employees when on government-owned property.

POSITIONS

The Jackson City Attorney's Office recommends approval of the Revisions made to Section 18-31, which would amend language necessary to protect the health, safety, and welfare of the citizens and employees of the City of Jackson.

ATTACHMENTS
A memo from the City Attorney's Office, regarding revising Chapter 18, Section 31 of the City of Jackson Code of Ordinances, as well as clean and black lined versions of Chapter 18, Section 31 of the City of Jackson Code of Ordinances.

ORDINANCE 2016 - ____

An Ordinance amending Chapter 18, Section 31 of the Code of Ordinances of the City of Jackson, Michigan in an effort to regulate the use of City owned property for the health, safety, and welfare of the citizens of the City of Jackson.

THE PEOPLE OF THE CITY OF JACKSON ORDAIN:

Section 1. Purpose.

The City Council adopts this ordinance in an effort to regulate the use of City owned property for the health, safety, and welfare of the citizens of the City of Jackson.

Section 2.

That Chapter 18, Section 31 of the City of Jackson, Michigan Code of Ordinances, be amended to read as follows:

Sec. 18-31. - Obstruction.

No person shall willfully and knowingly hinder, oppose, obstruct or resist any law enforcement officer, city official, city officer, city employee, city appointee, or agent of the city in performing his duties as such. Any person who, while on government-owned property, violates these regulations or engages in activity which unreasonably interferes with the use and operation of government-owned property may be barred from said government-owned property by the City Manager, the City Manager's designee, or any police officer. A person so barred shall be informed of the time period during which that person is excluded from a government-owned property or government-owned properties. An order excluding a person for more than 48 hours must be approved by the City Manager or a designee. No person shall enter or remain on government-owned property during the time when that person is barred from the government-owned property. A person banned pursuant to this section may appeal to the City Attorney in writing within fourteen (14) days.

* * * * *

Section 3. This Ordinance takes effect thirty (30) days from the date of adoption.

ORDINANCE 2016 - ____

An Ordinance amending Chapter 18, Section 31 of the Code of Ordinances of the City of Jackson, Michigan in an effort to regulate the use of City owned property for the health, safety, and welfare of the citizens of the City of Jackson.

THE PEOPLE OF THE CITY OF JACKSON ORDAIN:

Section 1. Purpose.

The City Council adopts this ordinance in an effort to regulate the use of City owned property for the health, safety, and welfare of the citizens of the City of Jackson.

Section 2.

That Chapter 18, Section 31 of the City of Jackson, Michigan Code of Ordinances, be amended to read as follows:

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* * * * *

Section 3. This Ordinance takes effect thirty (30) days from the date of adoption.

CITY OF JACKSON
Founded 1829

City Attorney's Office

161 W. Michigan Ave. • Jackson, MI 49201
Phone: (517) 788-4050, (517) 788-4023 • Facsimile: (866) 971-2117

MEMO TO: Mayor and City Councilmembers

FROM: Bethany M. Smith, City Attorney
Courtney A. Gabbara, Staff Attorney

DATE: October 25, 2016

SUBJECT: Revisions to Chapter 19, Article I of the City Code of Ordinances—Parks and Recreation, In General allowing designated City officials to ban disorderly individuals from the use of City-owned parks

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Recommendation:

Approve Ordinance Revisions to Chapter 19, Article I, In General, by adding language that would help protect the health, safety, and welfare of the citizens of the City of Jackson, Michigan when in a City-owned park. Specifically, the proposed revisions would allow designated City officials to temporarily ban disorderly individuals from the use of public parks if found to have used threatening, obscene, profane, or indecent language in a park with the intent to interfere with the proper use and enjoyment of other persons visiting such park.

Attached is a memo from the City Attorney's Office, regarding revising Chapter 19 of the City of Jackson Code of Ordinances, as well as a clean and blacklined version of Chapter 19, Article I of the City of Jackson Code of Ordinances.

We recommend approval of the above mentioned recommendation. Your consideration and concurrence is appreciated.

DEPARTMENTAL REPORT
October 25, 2016

MEMO TO: Honorable Mayor and City Councilmembers

FROM: Patrick H. Burtch, City Manager
Bethany M. Smith, City Attorney
Courtney A. Gabbara, Staff Attorney

DATE: October 25, 2016

RECOMMENDATION: Approve Ordinance Revision to Chapter 19, Article I, In General, by adding language that would permit designated City officials to temporarily ban disorderly individuals from using City-owned parks for interfering with the use and enjoyment of City-owned parks by others, which would protect the health, safety, and welfare of the citizen of the City of Jackson, Michigan when on government-owned property.

SUMMARY

The recommended action is approval of a Revision to Chapter 19, Article I of the City of Jackson Code of Ordinances by adding language to Article I, which would be relevant to the health, safety, and welfare of the citizens of the City of Jackson, Michigan. This action is being recommended in order to allow designated City officials to take action when a person located within a City-owned park engages in activity which unreasonably interferes with the use and operation of the City-owned park. Specifically, designated City officials would be given the authority to temporarily bar such individuals from entering City-owned parks if the person is behaving in a manner that willfully or knowingly hinders, opposes, obstructs, or resists City employees in performing his or her duties.

BUDGETARY CONSIDERATIONS

There are no foreseen budgetary considerations or concerns.

HISTORY, BACKGROUND and DISCUSSION

By adding this language to Article I, we will ensure that citizens and employees of the City of Jackson remain safe while present at City-owned parks. The current language states that a person may not obstruct a City employee while they are performing their regular duties. The addition of the proposed language will provide the City with ways of regulating what designated City employees consider threats to the safety of its citizens and employees when on government-owned property.

POSITIONS

The Jackson City Attorney's Office recommends approval of the Revisions made to Section 18-31, which would amend language necessary to protect the health, safety, and welfare of the citizens and employees of the City of Jackson.

ATTACHMENTS:

A memo from the City Attorney's Office, regarding revising Chapter 19, Article I of the City of Jackson Code of Ordinances, as well as clean and black lined versions of Chapter 19, Article I of the City of Jackson Code of Ordinances.

ORDINANCE 2016 - ____

An Ordinance amending Chapter 19, Article I of the Code of Ordinances of the City of Jackson, Michigan, which would allow designated City officials to temporarily ban persons interfering with the proper use and enjoyment of City-owned parks by others in an effort to regulate the use of City owned parks for the health, safety, and welfare of the citizens of the City of Jackson.

THE PEOPLE OF THE CITY OF JACKSON ORDAIN:

Section 1. Purpose.

The City Council adopts this ordinance in an effort to regulate the use of City owned parks for the health, safety, and welfare of the citizens of the City of Jackson.

Section 2.

That Chapter 19, Article I of the City of Jackson, Michigan Code of Ordinances, be amended to read as follows:

* * * * *

Sec. 19-5. - Disorderly conduct in parks and recreation.

No person shall indulge in any disorderly or indecent conduct in any park, place, or square, or in any games, act or demeanor calculating or intending to interfere with the proper enjoyment of other persons who may be visiting such parks, squares or places. No person shall post, exhibit or distribute any advertising matter or handbills therein. Any person who, while in a park, violates this section or engages in activity which unreasonably interferes with the peaceful use of parks or neighboring property by others may be barred from a park or parks by the City Manager; the City Manager's designee; the Director of Parks, Recreation, and Cemeteries; or any police officer. A person so barred shall be informed of the time period during which that person is excluded from the park. An order excluding a person for more than 48 hours must be approved by the City Manager; the Director of Parks, Recreation, and Cemeteries; or a designee. No person shall enter or remain in a park during the time when that person is barred from the park. A person banned pursuant to this section may appeal to the City Attorney in writing within fourteen (14) days.

* * * * *

Sec. 19-8. – Penalties.

Any person who fails to comply with this Article is subject, upon adjudication, to the penalties provided for under Section 1-18.

* * * * *

Section 3. This Ordinance takes effect thirty (30) days from the date of adoption.

ORDINANCE 2016 - ____

An Ordinance amending Chapter 19, Article I of the Code of Ordinances of the City of Jackson, Michigan, which would allow designated City officials to temporarily ban persons interfering with the proper use and enjoyment of City-owned parks by others in an effort to regulate the use of City owned parks for the health, safety, and welfare of the citizens of the City of Jackson.

THE PEOPLE OF THE CITY OF JACKSON ORDAIN:

Section 1. Purpose.

The City Council adopts this ordinance in an effort to regulate the use of City owned parks for the health, safety, and welfare of the citizens of the City of Jackson.

Section 2.

That Chapter 19, Article I of the City of Jackson, Michigan Code of Ordinances, be amended to read as follows:

* * * * *

Sec. 19-5. - ~~Persons excluded from parks and City Hall.~~Disorderly conduct in parks and recreation.

No person shall ~~use any threatening, obscene, profane or indecent language in any park, place or square or~~ indulge in any disorderly or indecent conduct ~~therein~~in any park, place or square, or in any games, act or demeanor calculating or intending to interfere with the proper enjoyment of other persons who may be visiting such parks, squares or places. No person shall post, exhibit or distribute any advertising matter or handbills therein. Any person who, while in a park, violates this section or engages in activity which unreasonably interferes with the peaceful use of parks or neighboring property by others may be barred from a park or parks by the City Manager; the City Manager's designee; the Director of Parks, Recreation, and Cemeteries; or any police officer. A person so barred shall be informed of the time period during which that person is excluded from the park. An order excluding a person for more than 48 hours must be approved by the City Manager; the Director of Parks, Recreation, and Cemeteries; or a designee. No person shall enter or remain in a park during the time when that person is barred from the park. A person banned pursuant to this section may appeal to the City Attorney in writing within fourteen (14) days.

* * * * *

Sec. 19-8. – Penalties.

Any person who fails to comply with this Article is subject, upon adjudication, to the penalties provided for under Section 1-18.

* * * * *

Section 3. This Ordinance takes effect thirty (30) days from the date of adoption.

RESOLUTION IN SUPPORT OF TRAINING CITY INSPECTORS AND OTHER RELEVANT STAFF TO IDENTIFY SIGNS OF HUMAN TRAFFICKING

BY THE CITY COUNCIL:

WHEREAS, every year an increasing number of people fall victim to human trafficking, mainly for sexual exploitation, but many for underpaid illegal labor; and

WHEREAS, such trafficking is the modern form of slavery, which treats human beings as a commodity to be bought and sold, to be put to forced labor, to be paid very little or nothing; and

WHEREAS, trafficking is the third largest source of illegal income after drugs and illegal arms in the United States, generating more than $30 billion in illegal income through the illicit trade of nearly 21 million people, according to a United Nations study on the topic; and

WHEREAS, Michigan ranks No. 2 in the country for human trafficking, behind only Nevada, due to the state's close proximity to Canada and waterways, which help to make the exploitation of vulnerable people a lucrative business in this state; and

WHEREAS, the City of Jackson recognizes these trends, and has worked with the Jackson County Prosecutor's Office and local law enforcement in the past to identify and prosecute human trafficking in the area; and

WHEREAS, other local units of government have worked to educate their staff to spot signs of human trafficking, such as the Jackson County Health Department training food inspectors to recognize and report potential human trafficking evidence in restaurants; and

WHEREAS, City housing inspectors perform roughly 4,000 inspections per year within the City of Jackson,

NOW, THEREFORE, BE IT RESOLVED, the Jackson City Council requests the City Manager implement a training policy for all City inspectors, and other relevant staff, to be educated to identify evidence and signs of human trafficking.

* * * * * * * *

State of Michigan)
County of Jackson) §
City of Jackson)

I, Andrew J. Wrozek, City Treasurer/Clerk in and for the City of Jackson, County and State aforesaid do hereby certify that the foregoing is true and complete copy of a resolution adopted by the Jackson City Council on the 25th day of October, 2016.

IN WITNESS WHEREOF, I have hereunto affixed my signature and the seal of the City of Jackson, Michigan, on this 25th day of October, 2016.

_____

Andrew J. Wrozek, City Treasurer/Clerk

RESOLUTION IN SUPPORT OF MICHIGAN SENATE BILLS 1061-1065

BY THE CITY COUNCIL:

WHEREAS, Michigan Senate Bills 1061-1065 serve to amend the Brownfield Redevelopment Financing Act to allow a transformational brownfield plan to authorize the use of sales and use tax capture revenue, and income tax capture revenue for economic development purpose on a limited basis; and

WHEREAS, the proposed bills complement the City of Jackson's Brownfield Redevelopment Authority, and help facilitate the implementation of brownfield plans and create brownfield redevelopment zones to capture tax revenue attributable to increases in State income and sales tax levied within the area or district; and

WHEREAS, the proposed legislation is necessary to line up more financing options for projects that originators traditionally have a difficult time developing — those that involve cleaning up lead, asbestos or other contaminants, known as brownfields; and

WHEREAS, municipalities in Michigan can benefit from additional tools to foster large-scale economic developments of mixed-use properties within an urban core,

NOW, THEREFORE BE IT RESOLVED, the Jackson City Council supports Michigan Senate Bills 1061-1065 and calls for their ratification.

* * * * * * * *

State of Michigan)
County of Jackson) §
City of Jackson)

I, Andrew J. Wrozek, City Treasurer/Clerk in and for the City of Jackson, County and State aforesaid do hereby certify that the foregoing is true and complete copy of a resolution adopted by the Jackson City Council on the 25th day of October, 2016.

IN WITNESS WHEREOF, I have hereunto affixed my signature and the seal of the City of Jackson, Michigan, on this 25th day of October, 2016.

_____

Andrew J. Wrozek, City Treasurer/Clerk