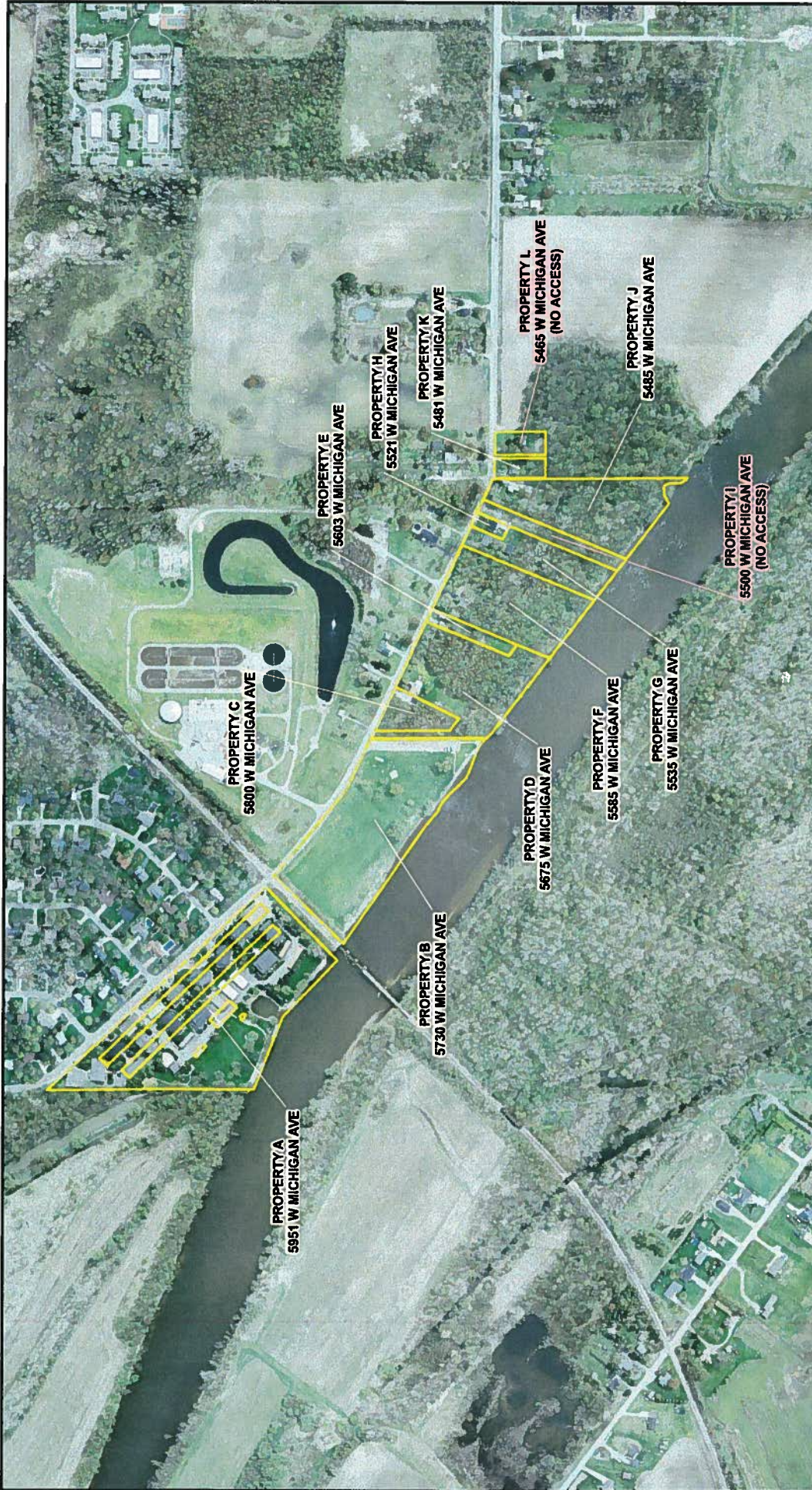


ATTACHMENT A

Site Map



Legend

Approximate Property Boundaries

0 400 Feet

N

NOTES:

Prepared For:

U.S. EPA REGION V
 Contract: EP-S5-0604
 TDD: S05-0012-0802-011
 DCN: 390-2A-ACFH

Prepared By:

WESTON SOLUTIONS, INC.
 7800 West Outer Drive, Suite 200
 Detroit, Michigan 48235

Figure 3-1
 EU002 Property Boundaries
 Residential Floodplain Sampling
 Saginaw, Michigan

ATTACHMENT B

Site Areas Map



Figure 5-1
 EU002 Areas of Concern
 Residential Floodplain Sampling
 Saginaw, Michigan

Prepared By:
WESTON SOLUTIONS, INC.
 7800 West Outer Drive, Suite 200
 Detroit, Michigan 48235

Prepared For:
U.S. EPA REGION V
 Contract: EP-S5-0604
 TDD: S05-0012-0802-011
 DCN: 390-

NOTES:
 ECA - Elevated Contamination Area
 MUZ - Moderate Use Zone
 WMP - West Michigan Park

Legend

TEQ Results (ppt)

- < 90
- 90 - 1,000
- > 10,000

Areas:

- Elevated Contamination Area
- Moderate Use Zone
- West Michigan Park

Scale: 0 to 360 Feet
 North Arrow

ATTACHMENT C

Action Memorandum

MEMORANDUM

SUBJECT: ENFORCEMENT ACTION MEMORANDUM: Determination of an Imminent and Substantial Threat to Public Health and the Environment for Exposure Unit 002 of the Tittabawassee River Dioxin Spill Site, Saginaw County, Michigan (Site ID #B5KF, Operable Unit 6)

FROM: Brian Schlieger, On-Scene Coordinator
Emergency Response Branch 2 – Removal Section 3

TO: Richard C. Karl, Director
Superfund Division

THRU: Jason H. El-Zein, Chief
Emergency Response Branch 1

I. PURPOSE

The purpose of this Action Memorandum is to document the determination of an imminent and substantial threat to public health and the environment and to select a time-critical removal action for Exposure Unit 002 (“EU002”), located within the Tittabawassee River Dioxin Spill Site, (also referred to as the “Site” or the “Tittabawassee River Site”). EU002 is located in Saginaw County, Michigan, and is contaminated with hazardous substances, pollutants, or contaminants (specifically dioxins and furans) that have or may have come to be located at the site from The Dow Chemical Company (“Dow”) Midland Plant property, with an address of 1000 East Main Street, 1790 Building, Midland Michigan, 48667 (the “Midland Plant”).

EU002 is in Saginaw Township, Saginaw County, approximately three miles upstream of the confluence of the Tittabawassee and Shiawassee Rivers (approximately 5700 W. Michigan Avenue) and includes: (1) West Michigan Park - a 5-acre public use park; (2) a condominium complex located directly adjacent to and west of West Michigan Park; (3) several residential properties directly adjacent to and east of West Michigan Park; and (4) a CSX rail line, all depicted in Figure 2-1. The properties are further described as follows:

- (1) West Michigan Park
- Property B, 5730 West Michigan Avenue
- (2) condominium complex:
- Property A, 5951 West Michigan Avenue

(3) residential parcels

- Property C, 5800 West Michigan Avenue
- Property D, 5675 West Michigan Avenue
- Property E, 5603 West Michigan Avenue
- Property F, 5585 West Michigan Avenue
- Property G, 5535 West Michigan Avenue
- Property H, 5521 West Michigan Avenue
- Property I, 5500 West Michigan Avenue
- Property J, 5485 West Michigan Avenue
- Property K, 5481 West Michigan Avenue
- Property L, 5465 West Michigan Avenue

EU002 is bound by a residential property to the east, West Michigan Avenue to the north, an unnamed drain to the west, and the Tittabawassee River to the south. EPA has identified several areas at EU002 containing elevated levels of dioxins and furans in soil:

(1) West Michigan Park;

(2) two elevated contamination areas on Property A near condominiums¹ and four elevated contamination areas near single-family residences located on Properties D, E and J² (“ECAs”); and

(3) a moderate-use zone (“MUZ”) in several areas located on the wooded portions of Properties.

These areas are depicted in Figure 3-3.

EU002 is a location where Dow historically disposed of hazardous substances, pollutants, or contaminants from the Midland Plant via deposition, during periods of flooding, of contaminated sediments containing dioxin which originated at the Midland Plant. EU002 is a source for dioxin contamination in the Tittabawassee River, Saginaw River, and Saginaw Bay. EU002 is located approximately 20 miles down river from the Midland Plant

The response actions proposed in this Action Memorandum will mitigate threats to public health, welfare, and the environment presented by the presence of an uncontrolled release of dioxin and furans (hazardous substances) that pose a high risk of direct contact to humans and wildlife in soils and dust located within EU002. Due to the contaminated nature of the soil in EU002, the continuing release of contamination into the environment and the food chain, and frequent use of the park by the local residents, a potential human exposure exists, classifying this removal action as time-critical.

¹ Samples identified as ECA-01 (A-025); ECA-02 (A-015).

² Samples identified as ECA-03 (D-026); ECA-04 (D012); ECA-05 (E-008); and ECA-06 (J-032).

The removal actions for EU002 include obtaining access to all properties within EU002, excavation and disposal of contaminated soils as defined by figure 5-1 at the surface for West Michigan Park, establishment of a marker barrier for remaining contaminated soil below the excavated areas (if necessary), air monitoring, backfilling and restoration of the impacted areas, removal of highly contaminated soils from and paving of the parking lot and drive, and elimination of potential exposures to exposed soils along the riverbank. Activities will include cleaning of all hard surfaces within West Michigan Park. Playground equipment will be raised to minimize potential re-deposition of dioxin contaminated soils during flooding. Excavation and disposal activities will be conducted in a manner as protective as possible of existing structures and to preserve mature trees. Barrier control techniques, as determined by development of the work plan, will be established for the ECAs to mitigate the exposure pathway. Additionally, further investigation of the MUZ will be conducted to assess the full extent of use by residents. If it is determined that the MUZ level of use is significant and constitutes an exposure threat, barrier controls will be established to mitigate the exposure pathway. Finally, a post removal site control ("PRSC") plan will be established for EU002 to assess potential recontamination. The response activities will require approximately 45 on-site working days to complete.

According to Directive 9360.0-19, from the Office of Solid Waste and Emergency Response ("OSWER"), March 3, 1989, U.S. EPA Headquarters consultation must occur prior to conducting removal actions at sites that are not listed on the National Priorities List ("NPL") where taking that removal action may be nationally significant or precedent-setting. That Directive at Section I.3 identifies as nationally significant or precedent-setting "[r]emoval actions at sites involving any form of dioxin when it is one of the principal contaminants of concern. Rationale: HQ concurrence will ensure national consistency in dioxin cleanup. The Dioxin Disposal Advisory Group (DDAG) in HQ must review all dioxin removal actions to verify that the proposed action will provide an acceptable level of protection from dioxin exposure. Therefore, EPA Region 5 will obtain Headquarters concurrence prior to implementing this Action Memorandum for EU002.

II. SITE CONDITIONS AND BACKGROUND

CERCLIS ID #MID 980 994 354

A. Physical Location and Description

EU002 is in Saginaw Township, Saginaw County, approximately, three miles upstream of the confluence of the Tittabawassee and Shiawassee Rivers, (approximately 5700 W. Michigan Avenue) and includes several residential properties directly adjacent to the east and west of West Michigan Park, as depicted by Figure 3-1. The geographical coordinates for EU002 are longitude 84° 01' 50" West and latitude 43° 24' 09" North.

EU002 is in Saginaw Township, Saginaw County, approximately three miles from the confluence of the Tittabawassee and Shiawassee Rivers (approximately 5700 W. Michigan Avenue) and includes: (1) West Michigan Park - a 5-acre public use park; (2) a condominium complex located directly adjacent to and west of West Michigan Park; (3) several residential properties directly adjacent to and east of West Michigan Park; and (4) a CSX rail line, all depicted in Figure 2-1. The properties are further described as follows:

- (1) West Michigan Park
 - Property B, 5730 West Michigan Avenue
- (2) condominium complex:
 - Property A, 5951 West Michigan Avenue
- (3) residential parcels
 - Property C, 5800 West Michigan Avenue
 - Property D, 5675 West Michigan Avenue
 - Property E, 5603 West Michigan Avenue
 - Property F, 5585 West Michigan Avenue
 - Property G, 5535 West Michigan Avenue
 - Property H, 5521 West Michigan Avenue
 - Property I, 5500 West Michigan Avenue
 - Property J, 5485 West Michigan Avenue
 - Property K, 5481 West Michigan Avenue
 - Property L, 5465 West Michigan Avenue

EU002 is bound by a residential property to the east, West Michigan Avenue to the north, an unnamed drain to the west, and the Tittabawassee River to the south. EPA has identified several areas at EU002 containing elevated levels of dioxins and furans in soil:

- (1) West Michigan Park;
- (2) two elevated contamination areas on Property A near condominiums³ and four elevated contamination areas near single-family residences located on Properties D, E and J⁴ ("ECAs"); and
- (3) a moderate-use zone ("MUZ") in several areas located on the wooded portions of Properties.

These areas are depicted in Figures 3-3 and 5-1.

³ Samples identified as ECA-01 (A-025); ECA-02 (A-015).

⁴ Samples identified as ECA-03 (D-026); ECA-04 (D012); ECA-05 (E-008); and ECA-06 (J-032).

West Michigan Park is operated by the Saginaw Township Parks and Recreation Department. The park is approximately 5 acres in size, is open to the public, and is equipped with river access, boat launch, grills, play equipment, soccer field, picnic area, park benches, and open space. Fishing from the riverbanks has also been documented in the park. The park is frequently used by nearby residents.

The ECAs are areas in where significantly elevated concentrations of dioxin contamination were identified in residential high-use areas. Specifically, the ECAs 1-6 correspond to the following samples collected during U.S. EPA's Residential Floodplain Sampling in April of 2008: ECA-01 (A-025); ECA-02 (A-015); ECA-03 (D-026); ECA-04 (D012); ECA-05 (E-008); and ECA-06 (J-032). ECAs correlate to samples collected as part of the Residential Floodplain Sampling. The MUZ consists of the wooded areas of land in which significantly elevated concentrations of dioxin contaminated soils were identified. "Moderate use" is considered as areas located on private property that have been documented to be used by the residents for a variety of uses including, fishing, pet walking, use of children's play area, and use of fire pits. The properties surrounding the park are primarily residential.

EU002 is a location where Dow historically disposed of hazardous substances, pollutants, or contaminants from the Midland Plant via deposition, during periods of flooding, of contaminated sediments containing dioxin which originated at the Midland Plant

B. Background

The Midland Plant began operations in 1897. The Midland Plant covers approximately 1,900 acres. The majority of the Midland Plant is located on the east side of the Tittabawassee River and South of the City of Midland.

The Tittabawassee River is a tributary to the Saginaw River, draining 2,600 square miles of land in the Saginaw River watershed. The Tittabawassee River flows south and east for a distance of approximately 80 miles to its confluence with the Shiawassee River approximately 22 miles southeast of Midland. Upstream of the Midland Plant, the Tittabawassee River flow is regulated by the Secord, Smallwood, Edenville, and Sanford dams. The current operation of the hydroelectric station at Sanford results in water releases from Sanford Dam during peak electricity usage periods to provide peaking power to Consumers Energy. Sanford Lake has limited flood storage capacity due to a narrow range of permitted lake levels. The Dow Dam is located adjacent to the Midland Plant. Below the Dow Dam, the river flow is free flowing to its confluence with the Shiawassee and Saginaw Rivers. Tittabawassee River flow and water level fluctuate daily in response to releases from the Sanford Dam. The average and 100-year flood discharge for the Tittabawassee River based on data from 1937 to 1984 are approximately 1,700 cubic feet per second ("cfs") and 45,000 cfs, respectively. The relatively large ratio between the 100-year flood discharge and the long-term average discharge (26.5) indicates that the river is "flashy," or has a flow regime that is characterized by highly variable flows with a rapid rate of

change.

The average monthly discharge from 1937 to 2003 for the Tittabawassee River 2,000 feet downstream of the Dow Dam ranged from approximately 600 cfs (in August) to 3,900 cfs (in March), with an average of 1,700 cfs. Discharge is typically highest in March and April during spring snowmelt and runoff. The maximum recorded historical crest of the Tittabawassee River occurred in 1986. A large storm in September 1986 produced up to 14 inches of rain in 12 hours. The discharge of the river near the Dow Dam reached nearly 40,000 cfs, and the river stage was 10 feet above flood stage at its crest (Deedler, Undated). Flows greater than 20,000 cfs have occurred in 22 of the 95 years between 1910 and 2004, with flows greater than 30,000 cfs occurring in 1912, 1916, 1946, 1948, and 1986. In March 2004, the river discharge reached approximately 24,000 cfs.

Portions of the Tittabawassee River floodplain are periodically inundated by floodwaters. Sheet piling has been used to stabilize the banks of the Tittabawassee River along numerous stretches within the Midland Plant area and in several downstream locations. This type of bank stabilization increases channel velocity in the immediate area during flood stage by restricting the cross-sectional area of the river and, depending on the local cross-section, may increase downstream flood elevations and erosive forces by increasing the flows and velocities of water that can no longer be stored on the overbank above the stabilized banks.

The Saginaw River is located within the Saginaw Bay and River watershed and drains over 6,300 square miles of land. It is formed by the confluence of the Tittabawassee River and the Shiawassee River just south of Saginaw, Michigan. The river itself is about 22.3 miles in length. Most of the Saginaw River flow originates in its major tributaries with 39 percent of flow contributed by the Tittabawassee River, 11 percent of flow contributed by the Shiawassee River, 20 percent of flow contributed by the Flint River, 14 percent of flow contributed by the Cass River and 16 percent of flow contributed by other sources. Most of the rivers in the watershed, including the Cass and Flint Rivers, indirectly discharge into the Saginaw River. The Flint River discharges into the Shiawassee River approximately six miles upstream of the confluence of the Tittabawassee and Shiawassee Rivers. The Cass River also discharges into the Shiawassee River, approximately five miles downstream of the Flint River and about one mile upstream of the Tittabawassee/Shiawassee/Saginaw confluence.

The Saginaw River flows through Saginaw, Michigan and from there to Bay City, where the river discharges into Saginaw Bay in Lake Huron. Saginaw Bay water surface elevations and seiche effects (oscillations in water surface elevations caused by meteorological events) can affect Saginaw River water levels and flow rates for its entire length.

Site topography is influenced largely by past glacial activity. The area is relatively flat with gentle rolling plains. In general, the land surface slopes gently eastward toward Lake Huron. Terminal moraines, eskers, and drumlins provide the only significant relief over the region. Low elevation areas are typically wetlands.

Initially, the Midland Plant operations involved extracting brine from groundwater pumped from production wells ranging in depth from 1,300 to 5,000 feet below groundwater surface. Over the time of its operation, the Midland Plant has produced over 1,000 different organic and inorganic chemicals. These chemicals include the manufacture of 24 chlorophenolic compounds since the 1930s.

Earlier in the history of the Midland Plant, wastes were discharged directly into the Tittabawassee River and, sometime later, wastes were stored and treated in ponds. Other wastes were disposed of at the Midland Plant either on land or by burning. Over time, changes in waste management practices included installation and operation of a modern wastewater treatment plant as well as use of incinerators instead of open burning. Changes in the waste water treatment plant and subsequent incorporation of pollution controls into both the operations of and emissions from the incinerators have reduced or eliminated releases and emissions from the Midland Plant.

Air deposition appears to be among the sources of elevated furans and dioxins, and other hazardous substances, found in surface soils in the Midland Plant area. Elevated dioxin and furan levels in and along the Tittabawassee River appear to be primarily attributable to aqueous discharges related to brine electrolysis for chlorine manufacturing, and associated waste management practices for the period at the Midland Plant. Prior to the construction of wastewater storage ponds in the 1920s, waste from manufacturing processes was discharged directly to the Tittabawassee River. Flooding of the Midland Plant property may have resulted in discharges to the Tittabawassee River of stored brines and untreated or partially treated process wastewaters. The primary source of furans and dioxins from the Midland Plant to the Tittabawassee River is believed to be historic releases of aqueous wastes. The chlorine manufacturing process was the likely source of comparatively high furan toxicity equivalent ("TEQ") readings in and along the Tittabawassee River. Dioxins and furans would have been discharged directly to the Tittabawassee River. Dioxins and furans found in more recent sediments may be related to chlorophenol production that began in the mid-1930s.

The Michigan Department of Environmental Quality ("MDEQ") issued to Dow its current Resource Conservation and Recovery Act ("RCRA") Hazardous Waste Management Facility Operating license for the Midland Plant, with an effective date of June 12, 2003, and an expiration date of June 12, 2013 (the "License"). Under its License, Dow has been conducting corrective action work. As part of the RCRA corrective action work, Dow has conducted "GeoMorph" sampling and analysis in Tittabawassee River. The sampling is being conducted to identify areas contaminated with dioxins and furans, and other potential contaminants of interest.

Sampling conducted as part of the corrective action under the License indicates that the dioxin/furan contamination in the Tittabawassee River adjacent to and downstream of Dow is associated with the Midland Plant. Soil samples collected upstream of the City of Midland did not contain elevated levels of dioxins or furans. Dioxin and furan concentrations from these

sample locations are consistent with statewide background concentrations. Sampling within tributaries to the Tittabawassee River has not identified any significant sources of dioxins or furans. No significant sources of dioxins or furans are known within the City of Midland other than Dow. Dioxin/furan congener profile charts for Tittabawassee River sediments and floodplain soils downstream of the Midland Plant are similar among themselves and very different from sample locations upstream of the Midland Plant. Dioxin and furan contamination within the estimated 100-year flood plain downstream of the Midland Plant has been documented.

Comparison of the dioxin and furan sample results from the samples collected at EU002 with the samples results collected as part of the RCRA RIWP under the License and other studies indicates that the dioxin/furan contamination in the Tittabawassee River adjacent to and downstream of Dow, including at EU002, is associated with the Midland Plant.

U.S. EPA's understanding of potential hazardous substances in soils at the Site is based on various sampling, analysis and studies contained in the Administrative Record for this document regarding dioxin TEQs, the Tittabawassee River, the Saginaw River the Saginaw Bay, and the City of Midland, including the following:

-2/1/07 Dow Chemical "GeoMorph Pilot Site Characterization Report – Upper Tittabawassee River and Floodplain Soils – Midland, Michigan"

-June 2003 MDEQ "FINAL REPORT: Phase II Tittabawassee/Saginaw River Dioxin Flood Plain Sampling Study"

-7/7/06 Dow Chemical Company "GeoMorph Sampling and Analysis Plan – Upper Tittabawassee River – Midland, Michigan"

-9/17/07 Dow Chemical "Remedial Investigation Work Plan (RIWP) for the Tittabawassee River"

-October 2007 Dow Chemical "Midland Area Soils Remedial Investigation Work Plan"

-10/15/07 Dow Chemical "Direct Contact Criteria Report for Midland Soils"

-2/24/05 Dow Chemical "Pilot Study Report: Oral Bioavailability of Dioxins/Furans in Midland and Tittabawassee River Flood Plain Soils"

-6/12/06 Dow Chemical "Follow-up Study Report: Oral Bioavailability of Dioxins/Furans in Midland and Tittabawassee River Flood Plain Soils"

-12/1/06 Dow Chemical "Remedial Investigation Work Plan (RIWP): Tittabawassee River and Upper Saginaw River and Floodplain Soils – Midland, Michigan"

- April 1985 U.S. EPA Region 5 “Study of Dioxin & Other Toxic Pollutants – Midland, Michigan”
- March 1987 U.S. EPA Region 5 “Dow Chemical Building 703 Incinerator Exhaust and Ambient Air Study”
- July 1985 U.S. EPA Region 5 “Dow Chemical Wastewater Characterization Study – Tittabawassee River Sediments and Native Fish”
- April 1988 U.S. EPA Region 5 “Final Risk Assessment for Dioxin Contamination at Midland, Michigan”
- December 1988 “Risk Management Recommendations for Dioxin Contamination at Midland, Michigan”
- Fall 2007 Dow Chemical GeoMorph Data
- 2/1/07 Dow Chemical “GeoMorph Pilot Study Characterization Report: Upper Tittabawassee River and Floodplain Soils – Midland, Michigan”
- August 2006 University of Michigan “Measuring People’s Exposure to Dioxin Contamination Along the Tittabawassee River and Surrounding Areas” (aka University of Michigan Dioxin Exposure Study (“UMDES”))
- 11/5/84 Dow Chemical “Point Sources and Environmental Levels of 2378-TCDD (2,3,7,8-Tetrachlorobenzo-P-Dioxin) on the Midland Plant Site of the Dow Chemical Company and in the City of Midland, Michigan”
- 8/31/06 MDEQ “Final Report – Dioxin-Like Toxicity in the Saginaw Bay Watershed & PBDE Distribution in the Saginaw Bay Watershed
- 8/8/78 U.S. EPA Memo from F. Kover to J. Merenda re: “Interim Status Report 8EHQ-0778-0209”
- July 1981 U.S. EPA R5 “A Report on Polychlorinated Dibenzo-P-Dioxin (PCDDs) and Polychlorinated O Benzo Furan (PCDFs): A Summary of Studies Conducted in the Great Lakes Area”
- 10/24/80 Science magazine “Trace Chemistries of Fire: A Source of Chlorinated Dioxins”
- 8/29/02 MDEQ “Baseline Chemical Characterization of Saginaw Bay Watershed

Sediments:

- 11/1/07 ATSDR Health Consultation “A Pilot Exposure Investigation: Dioxin Exposure in Adults Living in the Tittabawassee River Flood Plain”
- April 2004 MDEQ “Tittabawassee River Floodplain Screening-Level Ecological Risk Assessment – Polychlorinated Dibenzo – P- Dioxins, Polychlorinated Dibenzofurans”
- 7/30/04 U.S. EPA R5 memorandum “Subject: (1) Health Risk Analysis of Tittabawassee Fish with Dioxin (2) Recommendations for Risk Evaluation”
- October 2003 MDEQ “Tittabawassee River Aquatic Ecological Risk Assessment – Results”
- March 2006 ToxFAQs: CABS/Chemical Agent Briefing Sheet: Dioxins
- ATSDR Toxicological Profile for Chlorinated Dibenzo-p-dioxins (Update) (PB/99/121998).

As part of Dow’s GeoMorph sampling and analysis in 2007, several transects were placed across the Tittabawassee River to collect soil and sediment for analysis. As part of their actions under their operating license requirements, Dow submitted analytical data from the samples that had been analyzed to MDEQ in the fall of 2007. Based on the analytical results, MDEQ identified several areas where sample results indicated that potential risk to public health may be present due to higher contaminant concentrations in residential or high public use areas.

In February, 2008, MDEQ, U.S. EPA, and MDCH met to evaluate data previously provided by Dow to determine the need to conduct further assessment of properties in the floodplain. The team determined that additional assessment, including sampling, would be necessary. The purpose of the sampling was to determine if there was substantial risk to those people accessing or living on the properties. During the discussions, it was decided that MDEQ would lead the effort to prioritize areas to be further assessed. These areas would be called “exposure units.” MDEQ recommended that EU002 be given priority after EU001. MDCH concurred. U.S. EPA selected 12 properties for inclusion in EU002 (Areas A through L, Table 3-1 and Figure 3-1). With assistance from MDEQ, and MDCH, U.S. EPA prioritized the properties based on land use and identified property owners within EU002.

Dioxins and furans are listed as hazardous constituents in RCRA Appendix VIII to 40 CFR 261. Additionally, dioxins and furans are listed as a hazardous substance as defined by Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); and Part 111, Hazardous Waste Management, of Michigan’s Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, Michigan Compiled Laws (“MCL”) 324.101 et seq. (“NREPA”).

C. Environmental Justice Analysis

To meet Region 5's Environmental Justice ("EJ") concern criteria, the area within 1 mile of a Site must have a population that is at least twice the state's average low-income percentage and/or twice the state minority percentage. Among all Michigan residents, the low-income percentage is 29% and the minority percentage is 21%. To meet EJ concern criteria, the area must be at least 58% low-income and/or 42% minority. U.S. EPA's EJ analysis of the population within 1 mile of EU002 determined that the low-income percentage is 28% and the minority percentage is 24%. Therefore, EU002 does not meet the Region's EJ criteria based on demographics, as identified in "Region 5 Interim Guidelines for Identifying and Addressing a Potential EJ Case, June 1998."

D. Risk Assessments

1. Human Health Risk Assessments

On July 30, 2004, U.S. EPA issued its "(1) Health Risk Analysis of Tittabawassee Fish with Dioxin and (2) Recommendations for Risk Evaluation."

In the "(1) Health Risk Analysis of Tittabawassee Fish with Dioxin and (2) Recommendations for Risk Evaluation," U.S. EPA evaluated the risks to humans from consuming fish from the Tittabawassee River. Tittabawassee River fish data collected by MDEQ in 2003 and made available to U.S. EPA in June 2004 was analyzed to assess risks to fish consumers. The conclusion was that dioxins in River fish present unacceptable risks to public health. Cancer risks to a frequent (high-end) fish consumer are as great as one in a 1,000 exceeding U.S. EPA cancer risk management guidelines of one in 10,000 to one in 1,000,000. Non-cancer risks (e.g., reproductive and congenital defects) are up to 10 times acceptable exposure values for adults and 25 times above safe levels for children. There is particular concern of risks to women of childbearing age and to the developing fetus. The "(1) Health Risk Analysis of Tittabawassee Fish with Dioxin and (2) Recommendations for Risk Evaluation" also identified unacceptable risks to wildlife (Tittabawassee Ecological Assessment Report, MDEQ, Galbraith Environmental Services, 2003). The assessment concluded that dioxin and dibenzofurans are at levels posing "serious" reproductive impairment to fish, fish eating birds and mammals. Furthermore, dioxin levels are elevated in area turkey, deer and other game (Dow Chemical, July 2004) indicating terrestrial food chain contamination due to contamination of flood plain soils, posing potential public health risks. Dioxin contamination of sediments and flood plain soils appears to extend over 50 miles, into Saginaw Bay (MDEQ November, 2003 update).

On May 15, 2008, the MDCH issued a Wild Game Advisories for the Tittabawassee and Saginaw River Flood Plains Health Advisory for Consuming Wild Game from the Tittabawassee River Flood Plain due to excessive dioxin contamination. The advisory remains in place today, and warns against consuming wild game from the flood plain area.

2. Ecological Risk Assessments

a. October 2003 Assessment

In the MDEQ 2003 “Tittabawassee River Aquatic Ecological Risk Assessment,” risks to birds and mammals from consuming fish from the Tittabawassee River below the City of Midland were evaluated using a streamlined approach that included site-specific contaminant data and modeling related to TCDD (fish tissue and bird egg concentrations) and data from the scientific literature. The main conclusion of the MDEQ 2003 “Tittabawassee River Aquatic Ecological Risk Assessment” is that the possibility of unacceptable risks to aquatic receptors, as well as avian and mammalian piscivores in the Tittabawassee River floodplain, due to sediment contamination by dioxin cannot reasonably be discounted.

b. April 2004 Assessment

In the MDEQ 2004 “Tittabawassee River Floodplain Screening-level Ecological Risk Assessment” risks to six species of birds and mammals from consuming soils and invertebrate, mammalian, and avian prey from the floodplain of the Tittabawassee River downriver of the City of Midland were evaluated using a screening level ecological risk assessment. This analysis was based on empirical soil PCDD/PCDF concentrations and bioaccumulation, toxicological, and ecological data from the scientific literature. The question addressed by this ecological risk assessment was whether an unacceptable risk to ecological receptors in the Tittabawassee River floodplain could be reasonably discounted. The main conclusion of the MDEQ 2004 “Tittabawassee River Floodplain Screening-level Ecological Risk Assessment” is that the possibility of unacceptable risks to terrestrial receptors in the Tittabawassee River floodplain due to soil contamination by dioxin cannot reasonably be discounted. The high hazard index (“HI”) values obtained may be an indication that risk exists in the assessment area.

E. Site Assessments

The Administrative Record for the Tittabawassee River Site contains numerous reports which summarize the investigations conducted at the Site to date. The most recent assessment activity involving EU002 was a 2008 U.S. EPA/MDEQ/MDCH/ATSDR Residential Assessment Program.

In March, 2008, U.S. EPA, MDEQ, MDCH, and ATSDR initiated the Residential Assessment Program. This program was designed to better define the extent of contamination in areas of concern among residential locations along the floodplain of the Tittabawassee River. The sampling plans for EU002 were developed using U.S. EPA Visual Sampling Plan (“VSP”) software. The sampling was designed to meet confidence levels for the data to be comparable to what has been used previously at the Site by MDEQ.

On April 18, 2008, U.S. EPA and its contractors mobilized to site and began collecting samples

for dioxin/furan analysis. A total of 263 discrete outdoor soil sample locations were sampled as depicted in Figure 3-2. In addition, several of the residential units were also selected for dust and/or wipe sampling. In general, samples were collected from the soil via a hydraulic press (Geoprobe 420M) or by hand sampling with a slide hammer and probe or by the bucket auger method. The sample cores were logged and samples were collected from the 0-12 inch interval, the 18-24 inch interval, and the 30-36 inch interval. If refusal (i.e. probe or auger wouldn't push any further into the ground) was encountered, only the intervals represented were sampled.

Surface and subsurface soil sampling were conducted at 263 locations within EU002, yielding a total of 754 soil samples (including appropriate quality assurance samples). In addition, the sampling team collected a total of 2 wipe samples and 6 dust samples from interior locations. All samples were shipped under chain of custody to two laboratories for analysis of dioxins/furans. A total of 289 0-12 inch interval and quality assurance samples (including duplicates) were selected for analysis; the balances of samples are currently being archived for future at-depth analyses, if necessary. All EU002 sampling was completed and equipment and personnel were demobilized from site on May 02, 2008.

Although all samples collected were shipped to off-site independent laboratories for analysis, only the top interval has been analyzed. The bottom two intervals are the samples being held by the lab for further analyses if that information is needed during a response action at EU002.

The surface soil sample results from EU002 establish that dioxins and furans are present and widespread in the subject area. Of the first 289 surface (0-12 inch) soil samples analyzed, approximately 27 percent (%) exceed U.S. EPA's residential direct contact criteria of 1,000 ppt TEQ with a maximum soil sample result at 5,900 ppt TEQ. Results are presented in Figures 4-1 through 4-6 and Table 4-1 through 4-6.

In a summary of information e-mailed from MDEQ to EPA on February 24, 2009, a toxicology specialist for MDEQ explained the link between the dioxin TEQ profile for the contamination in the exterior soil. The following is text from that assessment:

“Relative distributions of dioxin and furan congeners can be used to evaluate potential sources of contamination in various environmental media.⁵ A comparison of the congener distributions from soil samples collected at EU002 indicates that the predominant dioxins and furans detected in the samples from EU002 are similar to those from the majority of soil and sediment samples collected in and along the Tittabawassee River downstream of The Dow Chemical Company, Midland Plant. Typically 2,3,7,8-tetrachlorodibenzofuran, 1,2,3,7,8-pentachlorodibenzofuran, 2,3,4,7,8-pentachlorodibenzofuran, and 1,2,3,4,7,8-hexachlorodibenzofuran make up 50% to

⁵ U.S. EPA. An Inventory of Sources and Environmental Releases of Dioxin-Like Compounds in the United States for the Years 1987, 1995, and 2000 (EPA/600/P-03/002f, Final Report, November 2006). U.S. Environmental Protection Agency, Washington, DC, EPA/600/P-03/002F.
<http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=159286>

greater than 90% of the TEQ in these samples. This pattern of congener distribution is typical for the contamination found in and along the Tittabawassee River floodplain downstream from The Dow Chemical Company, Midland Plant and is understood to be predominantly associated with a graphite anode, chloralkali process used at the plant.

On November 21, 2008 EPA's contractor conducted a property usage survey of the condominiums and residential properties within EU002. A physical survey and verbal interview with residents was conducted to document the property uses. Several of the residents regularly access the MUZ. The MUZ is a more frequently flooded portion in which concentrations of dioxins and furans consistently exceed 1,000 ppt. The residents access these portions of the property to for activities such as kayaking, walking of pets, fire pits, walking paths, children play area, and shoreline fishing. Figure 3-3 summarizes the various features and uses documented within EU002.

F. NPL Listing Status

The Site is not listed on the National Priorities List.

III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES

Conditions present at EU002 constitute a threat to public health, welfare or the environment based upon the factors set forth in 40 C.F.R. § 300.415(b)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"). The threats include, but may not be limited to, the following:

A. Actual or potential exposure to nearby populations, animals, or the food chain from hazardous substances or pollutants or contaminants

This factor is present at EU002 due to the presence of dioxin-contaminated soils at or near the ground surface with 181 samples (26%) of the samples exceeding 1000 ppt TEQ. The maximum concentration of dioxins and furans in soils is 5,900 ppt TEQ for EU002. Dioxins and furans are listed as a "hazardous substance" as defined by Section 101(14) of CERCLA, 42 U.S.C. § 9601(14). They are also listed in RCRA Appendix VIII to 40 CFR 261; and Part 111, Hazardous Waste Management, of Michigan's NREPA, as amended, MCL 324.101 et seq. The dioxin-contaminated soils are at the surface with actual or potential direct contact exposure in a high-use public park located between residential areas with unrestricted access by human and animal populations.

The potential threat posed by the dioxin is dependant on the concentration and the extent of human exposure. In an April 13, 1998, U.S. EPA guidance document entitled "Approach for

Addressing Dioxin in Soil at CERCLA and RCRA Sites”⁶, U.S. EPA recommends preliminary remediation goals (starting points) for setting cleanup levels for dioxin in soil at CERCLA and RCRA sites. 1,000 ppt dioxin or TEQs is to be generally used as a starting point for setting cleanup levels for CERCLA removal sites for dioxin in surface soil involving a residential exposure scenario. The level is based on the direct contact exposure pathway. 1,000 ppt dioxin or TEQ is designed to protect people exposed in a residential setting over a long term period.

West Michigan Park

This public park contains a play area with equipment for children, a soccer field and general green space. Christine Flaga, a toxicologist for MDEQ, has determined that usage and conditions specific to West Michigan Park are similar to those in a residential area and would, therefore, define the West Michigan Park exposure as comparable to a residential exposure. ATSDR and U.S. EPA toxicologists have concurred with this determination. Normal play activities in the West Michigan Park could be considered a potentially high-level direct contact exposure pathway as soils and turf are contacted during high-energy activities (i.e., running, jumping, diving) by sensitive populations, such as children.

Normal vehicle traffic and use of the driveway and parking lot of the park, comprised of dirt and gravel, constitutes potential inhalation and direct contact exposure pathways. The park is also maintained (grass cutting, trimming, trash removal pickup, driveway and parking grading, and soccer field upkeep) on a regular basis, possibly spreading dust. The maintenance activities within the entire park constitute a potential inhalation and dust contact exposure pathway.

The shoreline of the park is used for boat launching, fishing, and activities. This constitutes a potential direct exposure pathway as people engaged in these activities have a high potential to be in contact with beach material and shallow sediments. EPA contractors photographically documented children’s footprints, pet tracks, and anglers accessing the shoreline. Photographs also document bare soils underneath play equipment. Activities such as picnicking, grilling, and drinking, which have been documented at the site, are a potential incidental ingestion exposure pathway.

Condominiums and Other Residential Properties

Samples were collected in several of the condominium and residential properties. Sample analysis results at six locations (ECAs 1-6) meet or exceed the level of 1,000 ppt TEQ. These samples locations are considered to be in high-use areas; and are therefore, potential direct exposure pathways for the residents of these properties.

⁶ See also U.S. EPA guidance entitled “Frequently Asked Questions on the Update to the ATSDR Policy Guideline for Dioxins and Dioxin-Like Compounds in Residential Soil”, dated December 12, 2008.

The property usage survey and photographs document shoreline fishing on the condominium and residential properties which constitutes a potential direct contact exposure pathway for anglers. The condominiums also have grilling and picnicking areas which are considered direct contact and incidental ingestion exposure pathways. In addition, the condominiums have two golf holes at which residents are able to chip and putt. These golf holes are adjacent to two of the ECA identified during sampling. The inherent nature of turf/soil contact while golfing constitutes a direct contact exposure pathway. Other documented uses that constitute direct contact exposure pathways within the residential properties include kayak launching, dog walking, use of child play areas, use of fire pits, and walking pathways.

Portions of EU002 are subject to periodic, almost annual, flooding and erosion. This is particularly true during high river flow events. EU002 flooding results in the deposition of contaminated soil and sediment from upstream locations. This may result in an increase in the amount and/or level of dioxin contamination at EU002 in the future. Flooding and erosion of EU002 also may result in the spread of dioxin contamination to other locations within the flood plain, as well as to downstream locations. This may also result in further contamination of fish and invertebrates within the River and at downstream locations.

- B. High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;

This factor is present at EU002 due to the existence of dioxin-contaminated soil at or near the surface. Portions of EU002 are subject to periodic almost annual flooding. This may result in the spread of dioxin contamination to other locations within the flood plain, as well as to off-site and downstream locations. Additionally, human and pet tracking may spread contamination away from this source location and into homes in the area.

- C. Actual or potential contamination of sensitive ecosystems;

This factor is present at EU002 due to the existence of dioxin-contaminated soils at or near the surface, as well as at depth at the Site and is subject to periodic flooding and erosion. This may result in the spread of dioxin contamination to downstream locations and the contamination of the surface water in the Tittabawassee River, the Saginaw River, and ultimately Lake Huron.

- D. Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released;

The Tittabawassee River is often subjected to extreme weather conditions in the winter and spring, which may result in annual flooding of EU002. Frequent flooding enhances the threat of a release and migration of dioxins and furans to other areas in the floodplain and to the Tittabawassee and Saginaw Rivers. Frequent flooding also enhances the threat of continuing contamination of EU002 and the Site surfaces with dioxin from up-stream locations, again

leading to direct contact threats.

IV. ENDANGERMENT DETERMINATION

Given the conditions at EU002, the nature of the hazardous substance there, and the potential exposure pathways described above, the actual or threatened release of dioxin from EU002, if not addressed by implementing the response actions selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, or welfare, or the environment.

V. PROPOSED ACTIONS

A. Description of the Proposed Action

The response action to mitigate threats associated with dioxin-contaminated soil at EU002 involves the removal of contaminated material from residential exterior and interior areas, as well as the containment of contaminated material, pending its disposal. The required response actions include, but may not be limited to, the following tasks:

Develop a Performance Based Removal Work Plan ("RWP") and Site Health and Safety Plan ("HASP"). The actions described in this RWP will be completed by July 15, 2009, and generally include, but are not limited to, the following:

- a. Develop and implement a Sampling and Analysis Plan ("SAP") describing the sampling and data collection methods to be used. The SAP shall include the following:
 - i. methodologies for conducting air sampling during removal action work; and
 - ii. a process to determine disposal requirements for excavated soil.
- b. Obtain written access agreements for all properties within EU002.
- c. Develop and implement a plan to assess any soil movement from the southern extent of EU002 to the northern portion of property I and/or property L. If EPA determines that any such soil movement occurred, a sampling and analysis plan shall be developed and implemented to assess the areas to which soils were moved. If, after reviewing the sampling analysis, EPA determines that the sampled areas constitute potential exposure pathways resulting in actual or potential exposure to nearby human populations from dioxin contaminated soils, a barrier control plan shall be developed and implemented to mitigate potential

direct contact threats related to any potential exposure pathways identified in sampled areas.

d. Excavate contaminated soils 12 inches below ground surface (“bgs”) at West Michigan Park in the areas defined by Attachment B.

e. After excavation is complete at West Michigan Park, line the excavated area with a marker layer (e.g., geomembrane fabric, plastic snow fencing if uncontaminated native soil or clay is not reached).

f. Backfill excavated areas at West Michigan Park with clean fill to at least the original grade. The final 6 inch surface lift of the backfill shall be topsoil. Re-vegetate disturbed vegetated areas. The RWP will describe how fill will be characterized to ensure that it is free of priority contaminants.

g. Remove all equipment in all child play areas in EU002, clean all hard surfaces on the playground equipment, excavate to a depth of 1 foot bgs where playground equipment was removed, backfill the excavated areas with clean fill to an elevation of 12 inches above original grade to minimize recontamination, and return the cleaned playground equipment. The raised area will be sloped down to the lower grade to ease accessing the playground equipment. The RWP will describe how equipment will be characterized to confirm dioxin TEQ contaminant levels (if any) for cleaned equipment.

h. Excavate soil for gravel driveway and parking lot at West Michigan Park to a minimum depth of 6”, backfill the excavated driveway and parking lot with clean fill and pave the driveway and parking lot to a minimum thickness of 2”.

i. Transport and dispose of all dioxin TEQ-contaminated soils removed from EU002. Waste shall be transported off-site for proper disposal at a landfill approved to accept dioxin TEQ remediation waste. Waste must be disposed of in compliance with the U.S. EPA Off-Site Rule 40 C.F.R. Section 300.440.

j. Develop and implement a plan to assess the full extent of use of the MUZ by the owner/occupant(s) of each parcel within the MUZ. If it is determined after the assessment that uses within the MUZ constitute potential exposure pathways resulting in actual or potential exposure to nearby human populations from dioxin contaminated soils, a barrier control plan will be developed and implemented to mitigate potential direct contact threats related to any potential exposure pathways within the MUZ.

k. Develop and implement a barrier control plan for ECAs 1-6 to mitigate potential direct contact threats related to any potential exposure pathways within

each ECA resulting in actual or potential exposure to nearby human populations from dioxin contaminated soils identified during EPA's site assessment.

The removal action will be conducted in a manner not inconsistent with the National Contingency Plan. The On-scene Coordinator has initiated planning for provisions of post-removal site control ("PRSC") consistent with the provisions of Section 300.415(i) of the NCP. Since EU002 sits in the floodplain of the Tittabawassee River and there exists and documented upstream contamination, it is anticipated that without engineering controls in place, future repeat flood events may lead to recontamination of this area. There is a need for PRSC at EU002. Specifically there is a need to assess the impact of flooding in EU002. MDEQ has indicated that it may address this issue. Post-removal Site controls may include: elevation of EU002 to a level which removes it from repetitive flood events, placing a physical barrier between the area and the River, a long term monitoring program to determine if recontamination is occurring, or any other activity not mentioned here which would prevent future deposition of contaminated sediments in these residential yards.

The response actions described in this memorandum directly address actual or threatened releases of hazardous substances, pollutants, or contaminants at the site which may pose an imminent and substantial endangerment to public health and safety and the environment. These response actions do not impose a burden on the affected property disproportionate to the extent to which that property contributes to the conditions being addressed.

These removal activities will require approximately 45 days to be completed.

B. Contribution to Remedial Performance

This action is recommended in consultation with MDEQ and Greg Rudloff from the U.S. EPA Region 5 Land and Chemicals Division. MDEQ administers Dow's RCRA operating license and is responsible for oversight of Dow's RCRA corrective action work along the Tittabawassee River.

C. Applicable or Relevant and Appropriate Requirements

All applicable or relevant and appropriate requirements ("ARARs") will be complied with to the extent practicable. U.S. EPA, Region 5 sent a letter to Allan Taylor of MDEQ on January 23, 2009 requesting identification of any potential state ARARs for this response action. U.S. EPA received a reply on February 26, 2009 and will comply with the state ARARs, as referenced in the letter, to the extent practicable. Waste must be disposed of in compliance with the US EPA Off-Site Rule 40 C.F.R. Section 300.440.

VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

Continued risk to public health and the environment will result if response action is delayed or not taken. Delayed action increases the likelihood that human and/or wildlife populations with access to the area will come into direct contact with dioxin-contaminated sediments and floodplain soils.

VII. OUTSTANDING POLICY ISSUES

Due to the priority contaminant for this Site being dioxin, Region 5 is mandated by the March 3, 1989, HQ memo to submit this action memo to HQ for concurrence prior to authorization or funding of this work.

VIII. ENFORCEMENT

For administrative purposes, information concerning the enforcement strategy associated with this removal action is contained in a confidential Enforcement Addendum.

IX. RECOMMENDATION

This decision document represents the selected response action for EU002, within the EU002 area of the Tittabawassee River Dioxin Spill Site. It was developed in accordance with CERCLA as amended, and is not inconsistent with the NCP. This decision is based upon the Administrative Record for the removal action, an index of which is attached to this Action Memorandum.

Conditions at the EU002 of the Tittabawassee River Dioxin Spill Site meet the criteria of Section 300.415(b) of the NCP for a removal action, and I recommend your approval of the proposed removal action. Region 5 expects that the potentially responsible party will perform all removal actions under the oversight of the OSC. You may indicate your decision by signing below.

APPROVE: Richard C. Karl DATE: 2-27-09
Richard C. Karl, Director
Superfund Division

DISAPPROVE: _____ DATE: _____

Richard C. Karl, Director
Superfund Division

Enforcement Addendum

Attachments

1. Environmental Justice Analysis
2. Administrative Record Index
3. Figures for EU002
4. Tables for EU002

cc: David Chung, U.S. EPA, 5104A
Michael Chezik, U.S. DOI, w/o Enf. Addendum
Steven E. Chester, Director, Michigan DEQ, w/o Enf. Addendum
Michael Cox, Michigan Attorney General, w/o Enf. Addendum
Alan Taylor, Waste and Hazardous Materials Division, Michigan DEQ

bcc: M. Colvin, MRS-10J, w/o Enf. Addendum
A. Marouf, SR-6J, w/o Enf. Addendum
M. Durno, ME-W
J. El-Zein, SE-5J
M. Johnson, ATSDR, ATSD-4J, w/o Enf. Addendum
W. Messenger, SE-5J
R. Gonzalez, P-19J, w/o Enf. Addendum
ERB Read File (C. Beck), SE-5J
ERB Delivery Order File (C. Norman/G. Nabasny), SE-5J
ERB Site File (M. Bedford, SF Central File Room), SMR-7J
J. Kimble, SE-GI
B. Schlieger, SE-5J
J. Cahn, ORC, C-14J
C. Garypie, ORC C-14J
G. Rudloff, LCD, LU-9J

ENFORCEMENT ADDENDUM

**West Michigan Park (Within Exposure Unit 002)
of the Tittabawassee River Dioxin Spill Site
Saginaw County, Michigan**

February 2009

**ENFORCEMENT CONFIDENTIAL
NOT SUBJECT TO DISCOVERY**

[SEE SEPARATE FILE]