



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
EMERGENCY RESPONSE BRANCH
9311 GROH ROAD, ROOM 216
GROSSE ILE, MI 48138-1697

MEMORANDUM

SUBJECT: ENFORCEMENT ACTION MEMORANDUM: Determination of an Imminent and Substantial Threat to Public Health and the Environment at the Riverside Boulevard Area (Exposure Unit 001) of the Tittabawassee River Dioxin Spill Site, Saginaw County, Michigan (Site ID #B5KF, Operable Unit 5)

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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 at the Riverside Boulevard (Blvd) area of contamination, Exposure Unit 001, located within the Tittabawassee River Dioxin Spill Site, (also referred to as the "Site" or the "Tittabawassee River Site"). For purposes of this action memorandum, the Riverside Blvd area of contamination of the Site shall be referred to as "EU001." EU001 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 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").

EU001 is located along a private road and is generally located approximately 4 miles to the west and 2 miles to the south of the intersection of Interstate 75 and State Route 46 in Saginaw, Saginaw County, Michigan. EU001 is approximately 1,000-foot long by 150-foot wide area along the north bank of the Tittabawassee River just above its confluence with the Shiawassee River. EU001, for practical purposes, is broken out into three areas as depicted in Attachment 3. Area 1 is the residential property (all residences and lands immediately surrounding those homes), Area 2 zoned for industrial use and is considered to be the western most parcel of EU001 to a ditchline, and Area 3 is considered to be the state land to the north (bounded by a land berm) and the state land which is a forested area to the east. Riverside Blvd runs through

EU001 and is located just south of the land berm located on the northern edge of EU001. EU001 contains 26 parcels of property that includes 11 residences and open lots that can be accessed from Riverside Blvd. Riverside Blvd is privately owned by one of the neighborhood property owners. EU001 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. EU001 is a source for dioxin contamination in the Tittabawassee River, Saginaw River, and Saginaw Bay. EU001 is located approximately 22 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 the EU001. Due to the contaminated nature of the soil, the continuing release of contamination into the environment and the food chain, and potential exposure to the public, this removal action is classified as time-critical. The removal actions for EU001 include obtaining access and assessing two parcels where access was previously denied, excavation and disposal of contaminated soil at the surface, excavation and/or containment of 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 Riverside Blvd and driveways, and the cleanup of the residential interiors contaminated with dioxin. Excavation and disposal activities will be conducted in a manner as protective as possible of existing structures and to preserve mature trees. The response activities will require approximately 75 on-site working days to complete.

A March 3, 1989, Directive from the Office of Solid Waste and Emergency Response ("OSWER") requires U.S. EPA Headquarters consultation before taking 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. OSWER Directive 9360.0-19. 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.*" Also, OSWER Directive 9360.3-12, "Response Actions at Sites with Contamination Inside Buildings" (August 12, 1993) indicates that responses to indoor contamination have the potential of being nationally significant or precedent setting. This directive indicates EPA Regions should consult with Headquarters to determine whether CERCLA authority can and should be used to respond to the problem, and obtain Headquarters concurrence prior to approval of the Action Memo by the Region. Based on these Directives, and because U.S. EPA is selecting a time-critical removal action to address dioxin contamination at a non-NPL site and to address indoor contamination, EPA Region 5 will obtain Headquarters concurrence prior to implementing this Action Memorandum for EU001.

II. SITE CONDITIONS AND BACKGROUND

CERCLIS ID #MID 980 994 354

A. Physical Location and Description

EU001 is located along a private road and is generally located approximately 4 miles to the west and 2 miles to the south of the intersection of Interstate 75 and State Route 46 in Saginaw, Saginaw County, Michigan. EU001 is approximately 1,000-foot long by 150-foot wide area along the north bank of the Tittabawassee River just above its confluence with the Shiawassee River. EU001, for practical purposes, is broken out into three areas as depicted in Attachment 3. Area 1 is the residential property (all residences and lands immediately surrounding those homes), Area 2 zoned for industrial use and is considered to be the western most parcel of EU001 to a ditchline, and Area 3 is considered to be the state land to the north (bounded by a land berm) and the state land which is a forested area to the east. Riverside Blvd runs through EU001 and is located just south of the land berm located on the northern edge of EU001. EU001 contains 26 parcels of property that includes 11 residences and open lots that can be accessed from Riverside Blvd. Riverside Blvd is privately owned by one of the neighborhood property owners. EU001 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. EU001 is a source for dioxin contamination in the Tittabawassee River, Saginaw River, and Saginaw Bay. EU001 is located approximately 22 miles down river from the Midland Plant. The geographical coordinates for EU001 are longitude 83° 58' 38" West and latitude 43° 23' 38" North.

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 EU001 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 EU001, 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 area to be further assessed. These areas would be called “exposure units.” MDEQ recommended that EU001 (the Riverside Boulevard area) would be given first priority. MDCH supported this program

Dioxins and furans are listed as hazardous constituents in RCRA Appendix VIII to 40 CFR 261; 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 EU001 determined that the low-income percentage is 65% and the minority percentage is 37%. Therefore, EU001 meets 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 September 14, 2004, the Michigan Department of Natural Resources (“MDNR”) issued a public 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 EU001 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 EU001 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. The team of U.S. EPA, MDEQ, and MDCH obtained access agreements from all of the EU001 property owners with the exception of one resident.

On April 1, 2008, U.S. EPA and its contractors mobilized to site and began collecting samples for dioxin/furan analysis. A total of 381 discrete outdoor soil sample locations were sampled. 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 381 locations within EU001, yielding a total of 1,238 soil samples (including appropriate quality assurance samples). In addition, the sampling team collected a total of 14 wipe samples and 9 dust samples from exterior (8 wipe samples) and interior locations. All samples were shipped under chain of custody to two laboratories for analysis of dioxins/furans. A total of 426 samples (which includes duplicates) were selected for analysis; the balances of samples are currently being archived for future at-depth analyses, if necessary. All EU001 sampling was completed on April 17, 2008 and equipment and personnel were demobilized from site on April 18, 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 EU001.

The surface soil sample results from EU001 establish that dioxins and furans are present and widespread in the subject area. Of the first 381 surface (0-12 inch) soil samples analyzed, approximately 59 percent (%) exceed U.S. EPA’s residential direct contact criteria of 1 ppb dioxin (1,000 ppt TEQ) with one surface soil sample result at 23,000 ppt TEQ. The average of the results from the 381 surface soil samples is 2,114 ppt. Several of the samples from the unpaved road contained dioxin contamination greater than 1,000 ppt. Interior dust sample dioxin concentration ranged from 55 to 3,100 ppt. Interior wipe sample dioxin contamination ranged from 6.1 to 210 pg/m².

In a summary of information e-mailed from MDEQ to EPA on June 26, 2008, a toxicology specialist for MDEQ explained the link between the dioxin TEQ profile for the contamination in the exterior soil and the contamination found inside the residential homes. 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.¹ A comparison of the soil, dust and wipe congener distributions indicates that the predominant dioxins and furans in the dust and wipe samples from EU001 are similar to those in the soils. 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 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 associated with a graphite anode, chloralkali process used at the plant.

The congener distributions for the dust and wipe samples from EU001 are very different from the congener distributions for the median, mean and 95%tile values reported for the dust samples collected as part of the University of Michigan, Dioxin Exposure Study (UMDES). The UMDES included samples collected from Jackson and Calhoun Counties in Michigan as a comparison population. The relative contribution of the four furan congeners predominant in the EU001 samples make up less than 10% of the TEQ in the UMDES dust samples for Jackson and Calhoun counties, indicating the contamination observed in dust samples from EU001 is not from typical background sources.”

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 EU001 area of the Tittabawassee River Dioxin Spill Site 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 EU001 due to the presence of dioxin-contaminated soils at or near the ground surface, as well as at depth. 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

¹ 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>

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 high-use residential yards with unrestricted access by human population. Human access to EU001 is unrestricted to people approaching EU001 from Riverside Blvd and from the Tittabawassee River. EU001 is largely made up of residential yards including flower beds and play areas for children. Wildlife in the area also has unrestricted access.

EU001 is also subject to periodic, almost annual, flooding and erosion. This is particularly true during high stream flow events. EU001 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 EU001 in the future. Flooding and erosion of EU001 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.

The EU001 area encompasses approximately 6.4 acres and contains 26 properties and 11 residential homes. Sampling within EU001 establishes dioxin contamination levels of up to 23,000 ppt dioxin for on-site soils, up to 3,100 ppt for dust samples collected inside homes, and up to 210 pg/m² for wipe samples collected inside homes. 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", 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 long term occupancy period. Many of the residents in this area have lived there for many years. Additionally, the average of the results from the 381 surface soil samples is 2,110 ppt.

Using U.S. EPA Superfund methodology for evaluating exposure and cancer risk, a 1,000 ppt dioxin TEQ concentration in residential soils/dusts corresponds to a long-term (e.g., 30 year) lifetime cancer risk of approximately 2.5 in 10,000 (2.5×10^{-4}). This cancer risk level of approximately 2.5×10^{-4} corresponds to a lifetime risk level above one in 10,000, a risk level which U.S. EPA can use to take actions to reduce exposure and risk, based upon the NCP and CERCLA. Based on the potential for direct soil contact and other exposure pathways (e.g., growing of garden foods), soils in the Riverside Drive area having over 10,000 ppt TEQ dioxin would yield estimated lifetime cancer risks of 2.5×10^{-3} .

Additionally, during the assessment, the U.S. EPA personnel observed large amounts of dust in the air from vehicle traffic on Riverside Blvd. Since surface samples from this road revealed dioxin contamination in several areas to be higher than 1,000 ppt, inhalation of these dusts is a

direct exposure pathway in this area. Additionally, these dusts are likely to migrate into adjacent homes where they combine with dust derived from yard soil. Ingestion of these soils and dusts can occur by transfer to mouth via direct contact. This is especially a concern for children playing in this area.

- 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 EU001 due to the existence of dioxin-contaminated soil at or near the surface, as well as at depth existing within EU001. EU001 is subject to 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 animal tracking may spread contamination away from this source location and into homes in the area. This migration of contaminants has been documented on-Site by the presence of dioxin contamination inside the residences that chemically matches the profile of the dioxins contaminating the soil. As noted above, during the assessment, the U.S. EPA personnel observed large amounts of dust in the air from vehicle traffic on Riverside Blvd. Since surface samples from this road revealed dioxin contamination in several areas to be higher than 1,000 ppt, inhalation of these dusts is a direct exposure pathway in this area. Additionally, ingestion of soils can occur from transfer to mouth via direct contact. This is especially a concern for children playing in this area.

- C. Actual or potential contamination of sensitive ecosystems;

This factor is present at EU001 due to the existence of dioxin-contaminated soils at or near the surface, as well as at depth at the Site. EU001 is subject to periodic flooding. 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 EU001. 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 the EU001 Site surface with dioxin from up-stream locations, again leading to direct contact threats. Floodwaters in EU001, when those floods are significant, have been shown to actually enter the residential units carrying the contamination with it.

USEPA's extensive characterization of the Riverside Blvd neighborhood clearly establishes that soils at the surface this entire residential area are consistently and highly contaminated with dioxin TEQ and that this contamination has migrated into residential interiors throughout the neighborhood via tracking and dust migration from the contaminated roadway (Riverside Blvd

itself). For this reason and in consideration of the contiguity of all the residential parcels, the response actions described below will be applied to the Riverside Blvd as a single area of contamination.

IV. ENDANGERMENT DETERMINATION

Given the conditions at EU001, the nature of the hazardous substance there, and the potential exposure pathways described above, the actual or threatened release of dioxin from EU001, 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 EU001 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 October 15, 2008, 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 to confirm dioxin TEQ contaminant levels (if any) in residential interiors following cleaning activities;
- ii. methodologies for conducting air sampling during removal action work; and
- iii. a process to determine disposal requirements for excavated soil.

The SAP may include the following:

- iv. methodologies to assess the two parcels (23 and 27 Riverside Boulevard) for dioxin TEQ contamination where access has previously been denied; and
- v. methodologies to confirm dioxin TEQ contaminant levels (if any) remaining in soils post-excavation.

b. Obtain written access agreements to private properties within EU001;

c. Excavate soil at EU001, including the two previously unassessed parcels (these two parcels must be assessed if access to conduct removal activities is denied by the owner), and excluding Riverside Boulevard and all driveways associated with the residential parcels as follows

i. EU001 Area 1 (Residential):

A. excavate all soil to a minimum depth of 24". After excavation is complete, line excavated area with a marker layer (e.g., geomembrane fabric, plastic snow fencing); OR

B.

1) identify the presence of in-situ pre-industrial native clay in EU001 between 0" and 24" as follows:

- a. conduct soil profiling to identify the presence of a defining clay layer; and
- b. complete dioxin TEQ sampling and analysis to demonstrate that the clay is pre-industrial and therefore is not contaminated (e.g., via comparison to background dioxin TEQ concentrations).

2) excavate all soil to in-situ pre-industrial native clay layer (if present) found at a depth between 0" and 24", including at least 2" of the clay layer itself.

ii. EU001 Area 2 (West Transition Area)

Excavate all soil to a minimum depth of 12" (or to 2" into pre-industrial native clay, as described above). After excavation is complete, line excavated area with a marker layer (e.g., geomembrane fabric, plastic snow fencing).

iii. EU001 Area 3 (North and East Transition Areas)

A. File a restrictive covenant, restricting all soil disturbance below 12", within 30 days of the Effective Date of an Administrative Order. After restrictive covenant is filed, excavate all soil to a minimum depth of 12" (or to 2" into pre-industrial native clay, as described above). After excavation is complete, line excavated area with a marker layer (e.g., geomembrane fabric, plastic snow fencing).

B. If a restrictive covenant, restricting all soil disturbance below 12", is not filed within 30 days of the Effective Date of an Administrative Order, excavate all soil to a minimum depth of 24" (or to 2" into pre-industrial native clay, as described above). After excavation is complete, line

excavated area with a marker layer (e.g., geomembrane fabric, plastic snow fencing).

d. Backfill excavated areas with clean fill to at least the original grade. The final 6" surface lift of the backfill shall be topsoil. Replace structures (patios, flower gardens, etc.) displaced during the removal process. Re-vegetate disturbed yard areas. The RWP will describe how fill will be characterized to ensure that it is free of priority contaminants;

e. Clean residential interiors of occupied homes (including but not limited to garages and workshops) within EU001, including but not limited to the cleaning of all hard surfaces (including hard floors beneath existing carpeting), the cleaning of upholstery, the cleaning of mattresses, the cleaning of ductwork, the removal and replacement of all carpeting, and the replacement of furnace filters. After cleaning is complete, confirm dioxin TEQ contaminant levels (if any) in residential interiors via sampling and analysis;

f. Excavate soil at Riverside Boulevard roadway and all driveways associated with the residential parcels to a minimum depth of 6", backfill the excavated roadway and driveways with clean fill and pave the Riverside Boulevard roadway and all driveways associated with the residential parcels; and

g. Transport and dispose of all dioxin TEQ-contaminated soils removed from EU001. 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 EPA Off-Site Disposal Rule (Section 300.440 of the NCP and 58 Fed. Reg. 49200).

The removal action will be conducted in a manner not inconsistent with the National Contingency Plan. The cleanup of the indoor contamination at this site is consistent with CERCLA and EPA guidance. 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 EU001 sits in the floodway of the Tittabawassee River and there is existing 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 EU001. Specifically there is a need to assess the impact of flooding in EU001. MDEQ has indicated that it may address this issue as part of a corrective action related to the Dow Midland Plant RCRA license. Post-removal Site controls may include: elevation of properties to a level which removes them 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 75 days to complete.

B. Contribution to Remedial Performance

This action is recommended in consultation with MDEQ and U.S. EPA Region 5's Land and Chemicals Division, which are responsible for oversight of Dow's State lead Tittabawassee River RCRA corrective action work. MDEQ administers Dow's RCRA corrective action operating license.

C. Applicable or Relevant and Appropriate Requirements

All applicable or relevant and appropriate requirements ("ARARs") of Federal will be complied with to the extent practicable. Region 5 will request that MDEQ identify potential state ARARs for this response action. Any state ARARs identified in a timely manner for this removal action will be complied with to the extent practicable.

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. HQ concurrence will also be sought due to a portion of this response addressing indoor dioxin contamination.

VIII. ENFORCEMENT

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

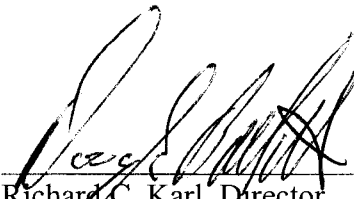
IX. RECOMMENDATION

This decision document represents the selected response action for the EU001 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 EU001 area 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:

for 
Richard C. Karl, Director
Superfund Division

DATE:

7/15/08

DISAPPROVE:

DATE:

Richard C. Karl, Director
Superfund Division

Enforcement Addendum

Attachments

1. Environmental Justice Analysis
2. Administrative Record Index
3. Map of EU001 Areas
4. Map of Final TEQs for EU001

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

ENFORCEMENT ADDENDUM

**Riverside Boulevard Area (Exposure Unit 001)
of the Tittabawassee River Dioxin Spill Site
Saginaw County, Michigan**

July 2008

ENFORCEMENT CONFIDENTIAL
NOT SUBJECT TO DISCOVERY

ATTACHMENT 1

EJ Analysis

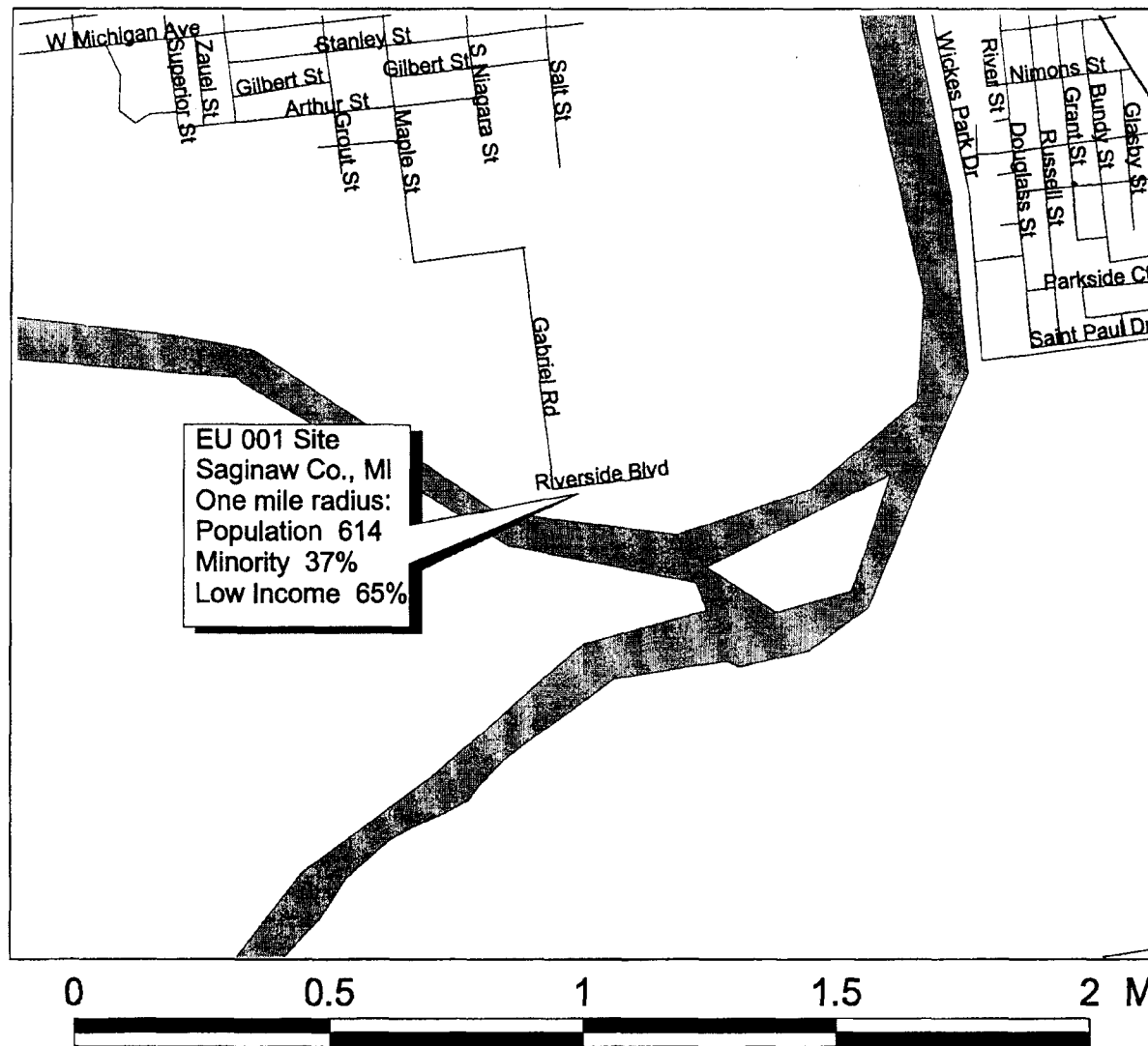
**Riverside Boulevard Area (Exposure Unit 001)
of the Tittabawassee River Dioxin Spill Site
Saginaw County, Michigan**

July 2008

Region 5 Superfund EJ Analysis

EU 001 Site

Saginaw, MI



State of Michigan averages:
Minority: 21%
Low Income: 29%

U.S. EPA Region 5
Environmental Justice Case Criteria
for State of Michigan

Minority: 42% or greater
Low Income: 58% or greater

Date of Map: 8/16/08

Source of Map: Census 2000 Database/
ArcView 3.0

ATTACHMENT 2

Administrative Record Index

**Riverside Boulevard Area (Exposure Unit 001)
of the Tittabawassee River Dioxin Spill Site
Saginaw County, Michigan**

July 2008

**ORIGINAL
July 2, 2008**

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1	3/04/02	MI Dept. of Community Health/ ATSDR	U.S. EPA	Petitioned Health Con- sultation: Dow Chemical Company Michigan Divi- sion Dioxin Contamination in Soil in Midland, Mid- land County, Michigan	113
2	11/02	MDEQ	File	Tittabawassee River Flood Plain Soil Sampling	167
3	03/30/07	MDEQ/ USACE	Dow Chemical Company/ Ann Arbor Technical Services, Inc.	Joint Permit Application to Remove Contaminated Deposits from the Tittaba- wassee River/SW Side of Saginaw Road, 1 Mile SE of Baily Bridge Road w/Attach- ments	27
4	06/03	State of Michigan	Public	Soil Movement Advisory for Private, Public, and Com- mercial Projects for the Tittabawassee River Furan and Dioxin Flood Plain Soil Soil and Sediment Contamina- tion	2
5	07/05	MDEQ	Public	Revised Supplemental Ad- visory: FAQs for Owners of Property Affected by Mi- grating Dioxin Contamina- tion	4
6	06/07/07	Guerriero, M., U.S. EPA	Bruchmann, G., MDEQ	Letter re: EPA Comments on the Revised RI Work Plans Submitted by Dow Chemical	2

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7	10/14/04	MDEQ	MDEQ	MDEQ Analysis of Wild Game from the Tittabawassee River Flood Plain	2
8	07/04	Dow Chemical Company	MDEQ	Dow Chemical Wild Game Study – Deer Liver	1
9	07/04	Dow Chemical Company	MDEQ	Dow Chemical Wild Game Study – Deer Muscle	1
10	07/04	Dow Chemical Company	MDEQ	Dow Chemical Wild Game Study – Turkey	1
11	07/04	Dow Chemical Company	MDEQ	Dow Chemical Wild Game Study – Squirrel	1
12	03/04/02	U.S. Dept. of Health and Human Services/ ARSDR	U.S. EPA	Petitioned Health Consultation: Public Comment Release, Dioxin Contamination in Soil, Dow Chemical Company Michigan Division Midland Location, Midland County, Michigan	75
13	03/15/02	U.S. Dept. of Health and Human Services/ ARSDR	U.S. EPA	Petitioned Health Consultation: Public Comment Release, Dioxin Contamination in Soil in the Tittabawassee River Floodplain South of Midland, Michigan	79
14	04/02-03	MDEQ	U.S. EPA	Fish Sampling Data from Smiths Crossing Road at the Tittabawassee River April 6, 1995-April 2, 2003	16
15	05/18/04	Smith, H., State of Delaware	Van Dam, T., Dow Chemical Company	Restated Certificate of Incorporation of the Dow Chemical Company	10
16	06/00/03	MDEQ	U.S. EPA	Final Report – Phase II Tittabawassee/Saginaw River Dioxin Flood Plain Sampling Study	49
17	06/12/03	MDEQ	Dow Chemical Company	Hazardous Waste Management Facility Operating License Amendment 3	90

18	08/27/03	Dow Chemical Company	File	Dow Chemical Michigan Operations Compliance Activity Schedule (Duration in Work Days)	6
19	10/00/03	Galbraith Environmental Services, LLC	MDEQ	Tittabawassee River Aquatic Ecological Risk Assessment/Polychlorinated Dibenzo-P-Dioxins, Polychlorinated Dibenzofurans	63
20	10/00/03	Galbraith, H., Galbraith Environmental Sciences	MDEQ	Presentation Slides: Tittabawassee River Aquatic Ecological Risk Assessment-Results	58
21	10/21/03	Taylor, A., MDEQ	Carrington, S., Dow Chemical Company	Letter re: Work Scope for the Interim Response Activity of Evaluating Wild Game from the Tittabawassee River Floodplain for Human Consumption w/Attachment	5
22	10/23/03	Galbraith, H., Galbraith Environmental Sciences	Brouillet, A., MDEQ	Memorandum re: Ecological Impacts due to PCDD/PCDF Contamination Along Tittabawassee River	2
23	11/20/03	MDEQ	U.S. EPA	Figure: Tittabawassee and Saginaw Rivers, and Saginaw Bay Sediment and Floodplain Soil Data in ppt TEQ Figure 1 – WHO Mammalian	1
24	04/00/04	Galbraith Environmental Sciences, LLC	MDEQ	Tittabawassee River Floodplain Screening Level Ecological Risk Assessment PCD-P-Ds and PCDFs	57
25	04/14/04	Galbraith, H., Galbraith Environmental Sciences	Brouillet, A., S. Kaelber-Matlock, MDEQ	Memorandum re: Review of Recently Published Studies on Effects of Dioxin-like Contaminants on Tree Swallows and Mink	5
26	07/16/04	Galbraith, H., Galbraith Environmental Sciences	Brouillet, A., S. Kaelber-Matlock & B. Brouillet, MDEQ	Memorandum re: GES Comments on Entrix (2004) Wild Game Study Report	6
27	07/22/04	Galbraith, H., Galbraith Environmental Sciences	Brouillet, A., S. Kaelber-Matlock & B. Brouillet, MDEQ	Memorandum re: GES Analysis of Data in Entrix (2004) Wild Game Study Report	5

28	07/30/04	Clark, M., U.S. EPA	File	Health Risk Analysis of Tittabawassee Fish with Dioxin and Recommendations for Risk Evaluation	8
29	06/00/04	ENTRIX, Inc.	Dow Chemical Company	Evaluation of PCDDs and PCDFs in Wild Game Taken From the Floodplain Along the Tittabawassee River	425
30	07/00/04	Dow Chemical Company	U.S. EPA	A Preliminary Evaluation of Dioxins (Polychloro- dibenzodioxins and Poly- chlorodibenzofurans) in Wild Game Taken from the Floodplain Along the Tittabawassee River	14
31	02/28/05	Galbraith, H., Galbraith Environmental Sciences	Brouillet, A., B. Brouillet & S. Kaelber- Matlock, MDEQ	Memorandum re: Contamina- tion of the Tittabawassee River Watershed by Dioxins and Furans	9
32	03/22/05	Pepin, R., U.S. EPA	Clark, M., U.S. EPA	Memorandum re: Dioxin and Congener Levels in the Tittabawassee Water- shed w/Attachment	18
33	07/27/05	U.S. Dept. of Health and Human Services/ ARSDR	U.S. EPA	Health Consultation: Tittabawassee River Fish Consumption Health Con- sultation	41
34	02/09/06	MDEQ	U.S. EPA	Presentation Slides: MDEQ Dioxin Data Overview – Shiawassee and Saginaw River Watersheds	10
35	08/31/06	MDEQ	U.S. EPA	Final Report: Dioxin-Like Toxicity in the Saginaw Bay Watershed and PBDE Distribution in the Saginaw Bay Watershed	77
36	06/07/07	U.S. EPA	MDEQ	U.S. EPA Comments on Re- sponses to MDEQ's March 2 and April 13, 2006 Notices of Deficiency Submitted to MDEQ by Dow Chemical Company	44
37	12/01/06	Ann Arbor Technical Services	Dow Chemical Company	Remedial Investigation Work Plan for the Tittabawassee River and Upper Saginaw River Floodplain Soils Vol. 1	1233

38	12/01/06	Ann Arbor Technical Services	Dow Chemical Company	Remedial Investigation Work Plan for the Tittabawassee River and Upper Saginaw River Floodplain Soils Vol. 2	1810
39	12/20/06	Simon, P. & P. Simon, Ann Arbor Technical Services, Inc.	Taylor, A., MDEQ	Letter re: Pilot Corrective Actions at the Upper Tittabawassee River w/Attachments	
40	12/20/06	Sygo, J., MDEQ	Guerriero, M., U.S. EPA	Letter re: Dow Chemical Company Tittabawassee River Interim Response Activities and Pilot Corrective Action Plans	3
41	04/07	Michigan Dept. of Community Health	Public	2007 Michigan Family Fish Consumption Guide	31
42	02/01/07	Ann Arbor Technical Services	Dow Chemical Services	GeoMorph Pilot Site Characterization Report for the Upper Tittabawassee River and Floodplain Soils	1233
43	03/08/07	MDEQ	Dow Chemical Company	MDEQ Conditional Permit w/Attachment	14
44	05/31/06	Baker, B., Dow Company/ Ann Arbor Technical Services, Inc.	Bruchmann, G., MDEQ	Geomorph Sampling and Analysis Plan- Upper Tittabawassee River	114
45	4/13/98	U.S. EPA OSWER	U.S. EPA Regions 1 - 10	Directive 9200.4-26: Approach for Addressing Dioxin Soil at CERCLA and RCRA Sites	6
46	4/18/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	Quality Assurance Project Plan for the Tittabawassee River Residential Floodplain Sampling	419
47	3/29/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response	SAP and Cover Sheet (EU001 Areas A, D, E)	10

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50	3/29/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	SAP and Cover Sheet (EU001 Area V)	10
51	3/29/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	SAP and Cover Sheet (EU001 Areas F, G, H)	10
52	3/29/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	SAP and Cover Sheet (EU001 Areas I, J, K)	10
53	3/29/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	SAP and Cover Sheet (EU001 Area M)	10
54	3/29/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	SAP and Cover Sheet (EU001 Areas O and P)	10
55	3/29/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	SAP and Cover Sheet (EU001 Areas Q and R)	10
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57	5/21/08	Weston	U.S. EPA	Map of	1

		Solutions, Inc.	Region 5 Emergency Response Branch	Draft Preliminary Sampling Results EU001
58	5/21/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	Table of Draft Preliminary Sampling Results – TEQs - EU001 1
59	6/3/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	Data validation reports for EU001 SDGs 1070973D, 1070973E, 1070973F, 1071218A, 1071218B, G8D040292, G8D080303, G8D100270, G8D150241, G8D150306, G8D180411, and G8D180412. 1
60	6/3/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	Map of final TEQs to date for EU001 1
61	6/6/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	Data validation reports for EU001 SDGs 1070973D, 1070973E, 1070973F, 1071218A, 1071218B, G8D040292, G8D080303, G8D100270, G8D150241, G8D150306, G8D180411, and G8D180412 1
62	6/6/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	Map of final TEQs to date for EU001 1
63	6/9/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	Level IV data packages for EU001 SDGs 1070973D, 1070973E, 1070973F, 1071218A, 1071218B, G8D040292, G8D080303, G8D100270, G8D150241, G8D150306, G8D180411, and G8D180412. 1
64	6/9/08	Weston Solutions, Inc.	U.S. EPA Region 5 Emergency Response Branch	Data validation reports for EU001 SDGs 1070973D, 1070973E, 1070973F, 1071218A, 1071218B, G8D040292, G8D080303, G8D100270, G8D150241, G8D150306, G8D180411, and G8D180412. 1
65	5/22/08	D. Mackenzie-Taylor	U.S. EPA	Preliminary congener 1

		MDCH	30 Region 5 Emergency Response Branch	profiles, presented at data summit on 5/22/08
66	12/96	U.S. EPA, OSWER	U.S. EPA, Regions 1-10	Directive 9200.4-19: 2 Headquarters Consultation for Dioxin Sites
67	3/3/89	U.S.EPA , OSWER	U.S.EPA , Regions 1-10	Directive 9360.0-10: 9 Guidance on Non-NPL Removal Actions Involving Nationally Significant or Precedent- Setting Issues
68	12/13/07	Bodine, S., U.S.EPA	Gade, M., U.S.EPA	Concurrence and Consultation Requirements for Superfund Removal Actions at Non-National Priority List Sites and for Nationally Significant or Precedent Setting Responses and Sites Involving Dioxin
69	07/07/06	Baker, B., Dow Company/ Ann Arbor Technical Services, Inc.	Bruchmann, G., MDEQ	Geomorph Sampling 114 and Analysis Plan- Upper Tittabawassee River (Revised)
70	9/17/07	Ann Arbor Technical Services	Dow Chemical Company	Remedial Investigation 454 Work Plan for the Tit- tabawassee River and Upper Saginaw River Floodplain Soils Vol. 1 (Revised)
71	12/01/06	Ann Arbor Technical Services	Dow Chemical Company	Remedial Investigation 790 Work Plan for the Tit- tabawassee River and Upper Saginaw River Floodplain Soils Vol. 2
72	10/2007	Baker, B., Dow Company/ Ann Arbor Technical Services, Inc.	Bruchmann, G., MDEQ	Midland Area Soils 204 Remedial Investigation Work Plan
73	10/15/07	Baker, B., Dow Company/ Ann Arbor Technical Services, Inc.	Bruchmann, G., MDEQ	Direct Contact Criteria 124 Report for Midland Soils
74	06/12/06	Exponent	Dow Chemical Company	Pilot Study Report: 152 Oral Bioavailability of Dioxins/ Furans in Midland and Tittabawassee River Floodplain Soils

75	04/2005	U.S.EPA	Public	Study of Dioxin and Other Toxic Pollutants –Midland, Michigan	11
76	03/1987	Dow Chemical Company	U.S. EPA, Region 5	Dow Chemical Building 703 Incinerator Exhaust and Ambient Air Study	322
77	07/1986	Dow Chemical Company	U.S. EPA, Region 5	Dow Chemical Waste-water Characterization Study-Tittabawassee River Sediments and Native Fish	132
78	04/1988	Dow Chemical Company	U.S. EPA, Region 5	Final Risk Assessment for Dioxin Contamination at Midland, Michigan	230
79	03/1988	Dow Chemical Company	U.S. EPA, Region 5	Risk Management Recommendations for Dioxin Contamination at Midland, Michigan	88
76	03/1987	Dow Chemical Company	U.S. EPA, Region 5	Dow Chemical Building 703 Incinerator Exhaust and Ambient Air Study	322
80	9/19/07	Dow Chemical Company	U.S. EPA, Region 5	GeoMorph Data	
81	08/2008	The University of Michigan	Public	Measuring People's Exposure to Dioxin Contamination Along the Tittabawassee River And Surrounding Areas (aka University of Michigan Dioxin Exposure Study ("UMDES"))	110
82	11/5/84	Dow Chemical Company	File	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 the City of Midland, Michigan	110
83	08/08/78	F.Kover., U.S.EPA	J.Merenda., U.S.EPA	Re: Interim Status Report 8EHQ -0778-0209	9
84	07/1981	U.S.EPA	Public	A Report on Polychlorinated Dibenzon-P-Dioxin (PCDDs) and Polychlorinated-O_ Benzo Furan (PCDFs): A Summary of Studies	30

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85	10/24/80	R.Bumb., et al., Science Magazine	Public	Trace Studies of Fire: a Source of Chlorinate Dioxins	4
86	08/29/02	MDEQ	Public	Baseline Chemical 163 Characterization of Saginaw Bay Watershed Sediments	
87	11/01/07	U.S. Dept. of Health and Human Services/ ATSDR	U.S. EPA	Health Consultation: A Pilot Exposure Investigation: Dioxin Exposure in Adults Living in the Tittabawassee River Flood Plain	41
88	04/2004	MDEQ	Public	Baseline Chemical 163 Characterization of Saginaw Bay Watershed Sediments	
89	03/2006	U.S. Dept. of Health and Human Services/ ATSDR	Public	ToxFAQs: CAB TM Chemical Agent Breifing Sheet: Doixins	8
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91	02/1999	U.S. Dept. of Health and Human Services/ ATSDR	Public	Toxilogical Progile for Chlorinated Dibenzo-p-Dioxins	723
92	6/26/08	D. Mackenzie-Taylor MDCH	U.S. EPA Region 5 Emergency Response Branch	Soil DustCongener Distribution	4
93	06/26/08	US.EPA	File	Land Usage Memo for Riverside Boulevard	2

ATTACHMENT 3

Map of EU001 Areas

**Riverside Boulevard Area (Exposure Unit 001)
of the Tittabawassee River Dioxin Spill Site
Saginaw County, Michigan**

July 2008

ATTACHMENT 4

Map of Final TEQs for EU001

**Riverside Boulevard Area (Exposure Unit 001)
of the Tittabawassee River Dioxin Spill Site
Saginaw County, Michigan**

July 2008