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April 6, 2011

Ms. Mary Logan
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U.S. Environmental Protection Agency, Region 5
77 West Jackson
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**Re: Task 2.4 Reach MM In-Channel Island EE/CA, Revision 1-Settlement Agreement No. V-W-10-C-942 for The Tittabawassee River/Saginaw River & Bay Site
Dow Submittal Number 2011-025**

Ms. Logan:

Attached please find the revised Task 2.4 Reach MM In-Channel Island Engineering Evaluation/Cost Analysis (EE/CA) prepared by The Dow Chemical Company (Dow) for the Tittabawassee River/Saginaw River & Bay Site. This submittal has been prepared based upon verbal comments received by the Agency and in accordance with the requirements contained in Administrative Settlement Agreement and Order on Consent (AOC) and Section 2 of the Statement of Work (Attachment A of AOC) (effective January 21, 2010) ("Settlement Agreement"). Please let me know if you have any questions or concerns.

Sincerely,
The Dow Chemical Company

A handwritten signature in black ink that reads "Todd Konechne".

Todd Konechne
Project Coordinator

CC: Al Taylor, MDNRE
Diane Russell, U.S. EPA
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**REACH MM IN-CHANNEL ISLAND ENGINEERING
EVALUATION/COST ANALYSIS
THE TITTABAWASSEE RIVER/SAGINAW RIVER & BAY SITE**



**PREPARED BY:
TITTABAWASSEE & SAGINAW RIVER TEAM**

**PREPARED FOR AND SUBMITTED BY:
THE DOW CHEMICAL COMPANY**

**APRIL 6, 2011
DOW SUBMITTAL NUMBER 2011.025
REVISION 1**

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ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirements
AOC	Administrative Order on Consent
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cy	cubic yard
DNRE	Michigan Department of Natural Resources and Environment
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
HASP	Health and Safety Plan
LWA	layer-weighted average
MIOSHA	Michigan Occupational Safety and Health Administration
NAVD88	North American Vertical Datum 1988
NCP	National Contingency Plan
NTCRA	Non-Time Critical Removal Action
O&M	Operations and Maintenance
ppt	parts per trillion
SCOI	secondary contamination of interest
Site	Tittabawassee River/Saginaw River & Bay Site
SOW	Statement of Work
TEQ	toxicity equivalent

1.0 INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) was prepared to evaluate potential early actions in accordance with Task 2.4 requirements as more specifically described in Section IX (“Work To Be Performed”), Paragraph 29.a. of the Administrative Settlement Agreement and Order on Consent (AOC) for the Site (Settlement Agreement No. V-W-10-C-942), and the associated Statement of Work (SOW; Appendix A of AOC), effective January 21, 2010.

The Task 2.1 Technical Memorandum dated July 16, 2010, which was approved by the U.S. Environmental Protection Agency (EPA) in a letter dated September 16, 2010, identified certain in-channel deposits, in-channel center islands, and bank areas for further evaluation. As described in the Task 2.2 Work Plan, Revision 1, dated September 22, 2010, which was conditionally approved by EPA on November 8, 2010, additional sampling was needed at in-channel center islands and bank areas. Data collection to support these evaluations is currently underway. However, one area, an in-channel center island in Reach MM (Reach MM Island), has been identified to be sequenced directly into the Task 2.4 development of potential mitigation measures. As discussed in the Task 2.1 Technical Memorandum, the Reach MM Island is the subject of this EE/CA to perform an early response in advance of the segment-specific Response Proposal for this area.

1.1 BACKGROUND ON SETTLEMENT AGREEMENT AND TASK 2 PROCESS

The AOC and associated SOW set forth requirements for conducting evaluations of current conditions and assessments of potential mitigation measures at the Site. Task 2 of the SOW is part of the general site wide tasks that characterize and assess potential near term contaminant transport issues in advance of the segment specific Response Proposal required under Task 8.

Task 2 includes six sub-tasks as described below:

- Task 2.1 – Sequence areas
- Task 2.2 – Identify and fill data gaps
- Task 2.3 – Characterize and determine the need for early response action
- Task 2.4 – Develop mitigation measures
- Task 2.5 – Early response action design
- Task 2.6 – Identify new areas of concern

Under Task 2.1, identified areas were sequenced to start in either Task 2.2, 2.3, or 2.4 based upon currently available data. A flow chart depicting the overall Task 2.2 through 2.4 sequencing process, as described in the Settlement Agreement, is shown on Figure 1-1. Task 2.2 is intended for areas where additional data (including sediment stability and/or chemical characterization data) are needed. Task 2.3 provides a vehicle for further characterization and assessment to determine if these areas warrant consideration of early responses ahead of the segment-specific Response Proposals. Task 2.4 (this document) provides for development of mitigation measures, as appropriate, for areas that have been determined to warrant an early response in advance of the respective segment-specific Response Proposal required under Task

8. Task 2.5 will develop a streamlined remedial design when the EPA, in consultation the Michigan Department of Natural Resources and Environment (DNRE), has signed an Action Memorandum for a Non-Time Critical Removal Action (NTCRA). Task 2.6 provides a process for assessing additional areas based on new information, as appropriate.

1.2 BASIS FOR ACTION

As part of a NTCRA Action Memorandum, EPA in consultation with DNRE will review the factors and determine which of the regulatory bases for removal actions apply.

2.0 SITE CHARACTERIZATION

As described in the Final GeoMorph *Site Characterization Report* (Ann Arbor Technical Services [ATS] 2009), Reach MM is located in a moderately sinuous section of the Tittabawassee River (see Figure 2-1). This reach of the river is within Segment 5 of the eight segments delineated at the Site. Reach MM contains four remnant stone piers from a bridge that once existed as an extension of Hospital Road prior to 1937 (the earliest available aerial photograph of the area). The Reach MM Island likely formed in the early 1900s as a result of geomorphic changes to the river following construction of the bridge piers, and relatively high logging- and agriculture-related sediment loads delivered to the river during this period (ATS 2009). A review of historical aerial photographs (at decade-level temporal scales) revealed that the size of the Reach MM Island has decreased since the initial aerial photograph from more than 70 years ago. The current visible Reach MM Island footprint generally starts approximately 250 feet downstream of RMM-903+50 and extends to RMM-904+00. This portion of the island persists above the median water surface (approximate elevation of 580 feet North American Vertical Datum 1988 [NAVD88]) and currently supports some vegetation.

2.1 NATURE AND EXTENT OF CONTAMINATION

TEQ levels are the primary constituents of interest in sediments of the Reach MM Island. To characterize the distribution of TEQ in the river sediments, sampling was initially conducted during 2007 and 2008 as part the Tittabawassee River Site Investigation. Sample locations are presented on Figure 2-2 along with the locations of bed pins used to evaluate changes in bed elevation over time and other survey measurements. Figures 2-3 through 2-6 present cross sections of the bathymetry and available analytical data in the area of the Reach MM Island.

In December 2010, a “grand composite” of sediment was collected along the eroding faces of the Reach MM Island. The TEQ level measured in the grand composite was approximately 6,800 parts-per-trillion (ppt), primarily represented by the 2,3,7,8-tetrachlorodibenzofuran and 2,3,4,7,8-pentachlorodibenzofuran congeners (similar congener patterns have been observed in other areas of the Site). The average TEQ level on the Reach MM Island bank faces (6,800 ppt) is also similar to the calculated layer-weighted average (LWA) TEQ level of 7,850 ppt at core RMM-903+50-IC5, collected in 2007 from the Reach MM Island (the LWA extended from the ground surface to the bottom of the core). The laboratory analytical report is provided in Appendix A. It should be noted, that secondary contaminants of interest (SCOIs) were analyzed

in some cores in the Reach MM Island area. The SCOI data is summarized in Volume 5 of the Site Characterization Report (ATS 2009) in Exhibit 10c (pages 23 and 24 of 32).

3.0 RESPONSE OPTION GOALS AND OBJECTIVES

The objective of this EE/CA is to evaluate response options for early actions to reduce potential near-term contaminant transport potential associated with the in-channel, center island sediments located at river mile 17.1 in Segment 5 of the Tittabawassee River.

3.1 DETERMINATION OF SCOPE

The expedited evaluation performed under Task 2.4 is not intended to represent a comprehensive response to address contaminant transport potential at the Site nor will the evaluations and resulting early actions conducted under Task 2 set precedent for the Task 8 segment-specific response work. The Task 2.4 early actions will be evaluated under Task 8 and will be incorporated into the final Segment 5 response, as appropriate.

3.2 DETERMINATION OF SCHEDULE

Implementation of the Task 2.4 early actions could be completed quickly with an estimated construction schedule of one construction season. In an effort to avoid inclement weather and potential flooding, the construction season typically begins in May and ends in October.

3.3 IDENTIFICATION AND COMPLIANCE WITH ARARS

Any early actions implemented under Task 2.4 shall, to the extent practicable, comply with the substantive elements of applicable or relevant and appropriate requirements (ARARs). A response action performed under formal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) authorities would be exempt from the procedural requirements of federal, state, and local environmental laws.

ARARs may be categorized as: 1) chemical-specific; 2) action-specific; or 3) location-specific. Chemical-, action-, and location-specific ARARs that may be applicable to Task 2.4 early actions are discussed below and identified in Tables 3-1 to 3-3.

3.3.1 Chemical-Specific Requirements

No chemical-specific requirements are applicable for the Task 2.4 activities.

3.3.2 Action-Specific Requirements

Action-specific ARARs that may be applicable to Task 2.4 are summarized in Table 3-2. Clean Water Act – Federal Ambient Water Quality Criteria and Michigan Water Quality Standards may be ARARs for the Reach MM Island early response action if water is discharged to surface water from dewatering areas or if there is turbidity during river bottom work.

3.3.3 Location-Specific Requirements

This group of ARARs typically includes consideration of floodplains, wetlands, navigation features, and historical sites or structures. However, as there are no identified wetlands or historical/archaeological sites near Reach MM Island,, these location-specific ARARs were not considered as part of this EE/CA. It should be noted that if wetland or historical/ archaeological areas are identified in access locations, they will be avoided if possible. If the wetland and/or historical/archaeological areas cannot be avoided, these ARARs will be considered as part of the action. Location-specific ARARs that may be applicable to Task 2.4 are summarized in Table 3-3.

3.4 INTEGRATION WITH ANTICIPATED FUTURE RESPONSE ACTIONS

Task 2.4 early action results will be evaluated under Task 8 and will be incorporated into the final Segment 5 response, as appropriate.

4.0 IDENTIFICATION OF TECHNOLOGIES AND DEVELOPMENT OF RESPONSE ACTION ALTERNATIVES

This section discusses the identification of remedial technologies that were subsequently assembled into response action alternatives for the Reach MM Island. The identification and assembly of response actions/remedial technologies into a focused set of alternatives was performed in accordance with CERCLA guidance (EPA 1988) and EPA's national policy (EPA 2005), consistent with the AOC/SOW, and as detailed in the sections below.

An initial screening of potentially applicable remedial technologies was performed to identify technologies that would be technically feasible and implementable at the Reach MM Island. The following technologies have been identified as potentially applicable to the Reach MM Island:

- **In Situ Containment/Stabilization:** Includes capping, sand cover, and stabilization/deposition.
- **Removal and Disposal/Treatment:** Includes removal of sediment via dredging or excavation followed by subsequent management, such as dewatering and landfill disposal.

These retained technologies were used to develop the response action alternatives presented in this EE/CA. For the purposes of assembling these alternatives, the remedial technologies included in the alternatives have not been defined with respect to remedial process options (e.g., what type of removal method to employ, or the type of cap to be placed). Selection of specific process options depends on the context in which the technology is applied, and will be resolved during remedial design. A description of how each component is applied is provided below.

4.1 ALTERNATIVE 1: STABILIZATION

This alternative would protect the Reach MM Island from further erosion and would stabilize the existing sediments. This would be achieved through installation of energy dissipation and bank or sediment protection features. Examples of stabilization features may include large woody

debris or stone armoring. The configuration of the stabilization features would be determined during the design phase.

The stabilization feature(s) would likely be constructed using mechanical equipment operating from a temporary platform or access road constructed within the river. This alternative would also include monitoring components to verify the effectiveness of the alternative to stabilize existing sediments. Monitoring would generally consist of bathymetry/ topography measurements along the perimeter of the existing Reach MM Island at specific intervals. Details of the monitoring and maintenance plan would be developed during design.

4.2 ALTERNATIVE 2: ABOVE-WATER SEDIMENT REMOVAL AND IN SITU CONTAINMENT

This alternative would consist of removal of sediments located above the water surface during typical low-flow conditions coupled with in situ containment and restoration of island characteristics (e.g., promotion of sediment deposition and natural revegetation).

Sediment Removal of Emergent Portion of Island

This component of Alternative 2 would involve the removal of sediment within the portion of the island that is emergent during typical low-flow conditions (e.g., the visible portion of the island). As part of this removal, sediment located above the water level during low water conditions (approximately elevation 580 feet NAVD88, corresponding to the median low water surface elevation) would be excavated during the construction season. An approximate volume of 500 cubic yards (cy) would be targeted for removal under this alternative.

Excavation of the visible island would be performed under relatively dry conditions using conventional earthwork equipment working from a temporary platform or access road constructed within the river. Removed sediments would be transported for disposal at a suitable landfill.

In Situ Containment

This component of Alternative 2 would involve the installation of an in situ containment cap over the newly exposed areas created from the removal component described above and placement of additional backfill and deposition enhancement materials over the removal area. The cap area may also extend over the adjacent subaqueous areas as needed. The extent and design details of any needed subaqueous cap would be determined based on additional investigation to be conducted as part of the design phase. The cap would be designed to provide isolation and stabilization of existing sediment. The excavation area receiving additional backfill and deposition enhancement materials would be designed to promote natural restoration of a stable island habitat. Following construction, this area would remain an island during typical water flow conditions. Cap placement would most likely be performed using mechanical equipment operating either from a temporary platform or access road constructed within the river.

This alternative would also include a monitoring component to verify the effectiveness of the cap. The monitoring component would generally consist of bathymetry/topography

measurements on pre-determined locations across the cap at specified intervals. Details of the monitoring and maintenance plan would be developed during design.

4.3 ALTERNATIVE 3: REMOVAL OF ALL TARGETED SEDIMENTS

Alternative 3 involves the removal of all targeted sediments within the Reach MM Island. The final limits of removal would be determined based on additional investigations to be performed during the remedial design phase. For cost estimating purposes, a target volume range of approximately 2,000 to 5,100 cy has been assumed for removal under this alternative.

Removal of the targeted sediments may occur both “in the wet” and/or “in the dry.” Removal best management practices (BMPs) would be used to minimize, to the extent practicable, sediment resuspension during construction. Sediment removal would likely be performed using mechanical equipment operating from a temporary access road. Depending on design evaluations and access agreements, removed sediments would either be passively dewatered near the removal area or loaded directly into trucks for transport to an upland passive dewatering and/or staging facility. Following dewatering, dredged sediments would be loaded into trucks for off-site transport and disposal at a suitable landfill.

5.0 ANALYSIS FOR RESPONSE ACTION ALTERNATIVES

The three response action alternatives described in Section 4 were assessed both individually and through a comparative analysis relative to the EE/CA criteria that have been established by EPA to address the overall requirements of CERCLA (EPA 1988) and the National Contingency Plan (NCP). This EE/CA incorporates three main evaluation criteria – effectiveness, implementability, and cost. The three EE/CA criteria (with effectiveness further subdivided into five categories and implementability further subdivided into four categories) used in this evaluation are summarized below:

Effectiveness

- **Overall Protectiveness** Addresses the ability of the proposed alternative to contribute to protection of human health and/or the environment.
- **Compliance with ARARs:** Assesses whether the alternative attains the identified chemical-specific, action-specific, and location-specific ARARs. As discussed in Section 3.3, no chemical-specific ARARs are applicable to Task 2.4 activities and, therefore, will not be discussed in the individual or comparative analyses.
- **Short-term Effectiveness:** Addresses the effects of a proposed alternative during the construction and implementation phase to meet the project goals. This criterion includes the timeframe for the remedy to achieve protectiveness and the potential to create adverse impacts during construction and implementation.
- **Long-term Effectiveness:** Evaluates the alternative for the long-term effectiveness and permanence to meet the project goals. The response action will be constructed and monitored as appropriate to verify effectiveness.
- **Reduction of Toxicity, Mobility, or Volume through Treatment:** Addresses the degree to which an alternative reduces the toxicity, mobility, or volume of chemical constituents

through treatment. Reduction in toxicity, mobility, or volume through treatment would not occur for any of the response action alternatives because none of the alternatives include a treatment component.

Implementability

- **Technical Feasibility:** Assesses the evaluation of construction and operational considerations including whether the response technology has been previously implemented at the Site.
- **Administrative Feasibility:** Assesses the activities needed to coordinate with other local and state offices and agencies (e.g., obtaining permits, site access). All action alternatives will be conducted on-site under CERCLA; therefore, permits will not be required and the substantive technical provisions of any permits will be met.
- **Availability of Services and Materials:** Evaluates the availability of qualified contractors to implement the proposed alternative and access the appropriate resources (e.g., equipment, personnel, and materials).
- **State and Community Acceptance:** Evaluation of community and State acceptance of the alternative will be evaluated by EPA following public review of this EE/CA.

Cost

- **Cost:** Assesses direct and indirect construction costs as well as long-term operation and maintenance. For the purposes of this EE/CA, the proposed alternatives were evaluated based on estimated costs, including labor, equipment, and materials used during installation. Monitoring and maintenance costs (where applicable) were estimated for a 5-year time period for purposes of providing cost estimates. The timeline for monitoring and maintenance for this early action will be established in a future AOC for remediation. Cost estimates were developed for each alternative based on a review of previous Dow project data, similar projects completed at other sites, and initial input from prospective Dow contractors. Consistent with EPA guidance (EPA 2000), the cost estimates for each alternative are anticipated to be accurate within the range of -30 to +50 percent. A future discount rate of 7 percent was used for the present worth calculations of post-construction monitoring costs, as specified by EPA (1988) guidance.

5.1 INDIVIDUAL ANALYSIS OF RESPONSE ACTION ALTERNATIVES

Each response action alternative was evaluated relative to effectiveness, implementability, and cost criteria in the sections below.

Section 4 identified the following three alternatives for evaluation:

- Alternative 1: Stabilization
- Alternative 2: Above-water sediment removal and in situ containment
- Alternative 3: Removal of all targeted sediment

Each of these alternatives is evaluated independently below.

5.1.1 Common Elements

For all alternatives, an area for access would need to be established. A short-term impact for all three alternatives will include a temporary disruption of upland/shoreline areas along the river to construct access points. Following the completion of the early action under any of the three alternatives, the upland/shoreline areas used for access to the river will be restored. Truck transportation accidents for transporting equipment and materials also exist for all three alternatives. Alternatives 2 and 3 include the transport of contaminated sediment to an approved disposal facility. The volume of truck traffic significantly increases with Alternative 3 due to the larger volume of sediment transport to a disposal facility. Measures would be implemented to control the potential for transportation accidents through appropriate traffic controls within and adjacent to the Site. Furthermore, risks to site workers and the community would be controlled through the implementation of appropriate health and safety practices (Michigan Occupational Safety and Health Administration [MIOSHA]) to be documented in a project-specific health and safety plan (HASP).

Several lines of evidence were reviewed as part of this analysis to evaluate contaminant transport potential of the alternatives on downstream deposits. The review included sediment core lithology and sample concentration data, comparisons of successive multibeam surveys and bed pin surveys, and preliminary hydrodynamic model results. Generally, the sediment bed immediately downstream of the Reach MM Island is in a state of dynamic equilibrium, with little or no net deposition or erosion when spatially averaged over the entire bed. Under all alternatives, a hydrodynamic assessment could be performed during remedial design to confirm that the action would not impact sediment stability or transport of other deposits downstream of the Reach MM Island. The hydrodynamic assessment would also help refine the design of the response action.

5.1.2 Alternative 1: Stabilization

This alternative would involve protecting the Reach MM Island from further erosion by stabilizing the existing sediments. This alternative is evaluated below according to each of the EE/CA criteria.

5.1.2.1 Effectiveness

Under Alternative 1, the Reach MM Island would be protected from further erosion and existing sediments would be stabilized.

Implementation of Alternative 1 includes placement of materials to stabilize existing sediments and may need to be evaluated to determine if it would trigger the substantive requirements of action-specific ARARs applying to fill activities (see Table 3-2). However, the limited volume of materials that would be placed as part of this alternative is significantly less than what has eroded from the island, and thus is not likely to affect flooding elevations. Alternative 1 complies with other identified action-specific or location-specific ARARs (see Tables 3-2 and 3-3).

Under Alternative 1, the stabilization features would provide the immediate benefit of controlling contaminant transport. There would be limited potential short-term effects associated with placing stabilization materials into the river during construction, as discussed in Section 5.1.1.

Although Alternative 1 would not result in a reduction in toxicity, mobility, or volume through treatment, Alternative 1 would reduce the mobility of materials by mitigating the continuing erosion of the Reach MM Island and reducing surface sediment exposures in capped areas.

5.1.2.2 Implementability

Dow has successfully completed a number of bank stabilization activities (e.g., Reach J, Reach M, and Reach O) that may provide technologies that could be utilized for this alternative. Based on this prior experience and other stabilization approaches, Alternative 1 is considered technically implementable, although site-specific conditions at Reach MM may likely require refined approaches compared to the previously completed projects. Necessary personnel and materials for the various tasks are readily available.

5.1.2.3 Cost

The estimated present worth of Alternative 1 is approximately \$250,000 (provided in present day [2011] dollars; see Appendix B). The present worth cost analysis was performed assuming that a monitoring program would be conducted during Years 1, 2, and 5 following completion of construction, after which continued monitoring, if appropriate and necessary, would be included in a segment-wide program as part of Task 8.

5.1.3 Alternative 2: Above-Water Sediment Removal, In Situ Containment

This alternative would consist of a combination of remedies including removal of sediments located above the water surface during typical flow conditions followed by placement of a containment cap, additional backfill, and deposition enhancement features to stabilize remaining sediment. This alternative is evaluated below according to each of the EE/CA criteria.

5.1.3.1 Effectiveness

Under Alternative 2, the removal of approximately 500 cy from the Reach MM Island would control contaminant transport by removing targeted sediments from the island and isolating residual deposits with a containment cap. An in situ containment cap would be installed to contain and/or stabilize the remaining island sediment to provide long-term protection. Chemically, the furan congeners detected at the Reach MM Island are hydrophobic with very low solubilities, which limit bioavailability and chemical mass transport potential of TEQ. As reported in the chemical diffusion analysis reported in Dow's September 2007 memorandum "Reach L TEQ Exposure Analysis and Sediment Stability Analysis," chemical diffusion of furans does not contribute to surface sediment conditions. Therefore, a cap or deposition

enhancement feature that stabilizes and physically isolates the remaining contaminated sediments would provide long-term environmental protection.

The removal of sediment from the Reach MM Island will likely more than offset the volume of cap materials placed. Therefore, the placement of cap materials within the river should not trigger the substantive requirements of action-specific ARARs applying to fill activities (see Table 3-2). The final determination will be established during design. Alternative 2 complies with other identified action-specific or location-specific ARARs (see Tables 3-2 and 3-3).

Under Alternative 2, limited potential short-term effects of above-water sediment removal and capping would occur during construction. These short-term effects include those discussed in Section 5.1.1 and could also include localized turbidity from removal of sediments and placement of the capping materials, although the short-term effects of removal “in the dry” should be minimal. The placement of a cap would provide an immediate benefit because it creates an instantaneous clean sediment surface. Positive long term effects of this alternative would be the preservation of island habitat with minimal changes to hydrodynamic flow patterns.

As with Alternative 1, implementation of Alternative 2 would not result in a reduction in toxicity, mobility, or volume through treatment. However, Alternative 2 would reduce the volume and potential mobility of TEQ levels by mitigating the erosion and isolating deposits below the cap, and placing removed sediments in an engineered landfill.

5.1.3.2 Implementability

Dow has successfully completed a number of in situ containment and removal actions in the Tittabawassee River (e.g., in Reaches B, D, and O) and, based on these prior experiences, Alternative 2 is technically implementable. Necessary personnel and equipment for the various tasks are readily available. A combination of removal methods used for Reaches D and O, including mechanical excavation, would be employed under Alternative 2 for the Reach MM Island. Similarly, the placement of a cap would likely use methods similar to those used during the Reach B and D capping activities. Finally, a local permitted landfill would be the primary location for permanent disposal of removed materials.

5.1.3.3 Cost

The estimated present worth of Alternative 2 is approximately \$500,000 (provided in present day [2011] dollars; see Appendix B). The present worth cost analysis was performed assuming that a monitoring program would be conducted during Years 1, 2, and 5 following completion of construction.

5.1.4 Alternative 3: Removal of All Targeted Sediments

Alternative 3 involves the removal of all targeted sediments within the Reach MM Island. For the purposes of this analysis, a target volume range of approximately 2,000 to 5,000 cy has been

assumed for removal under this alternative; the volume would be refined based on additional sampling conducted during remedial design.

This alternative is evaluated below according to each of the EE/CA criteria.

5.1.4.1 Effectiveness

Alternative 3 would remove a greater volume of sediments from the Reach MM Island. Implementation of Alternative 3 would comply with identified action-specific or location-specific ARARs (see Tables 3-2 and 3-3).

Alternative 3 would provide long-term effectiveness by removing contaminated sediments from the river system. Short-term effects under Alternative 3 include those discussed in Section 5.1.1. In addition, Alternative 3 would also induce short-term effects due to subaqueous sediment removal below the low water line including resuspension and release of particulate-phased chemicals from sediments to surface water, as well as localized turbidity impacts. Use of BMPs during removal could reduce, but not eliminate, the transport of particulate-phase chemicals and turbidity, and some amount of downstream transport is anticipated. The short-term effects of release would last for the duration of the in-water construction. The effect of resuspension could persist depending on where resuspended chemicals settle. Removal of sediment is also anticipated to result in residual materials remaining on the sediment surface (including in areas downstream of the removal area) following removal activities.

Alternative 3 would reduce the mobility of TEQ through placement of removed sediments in an engineered landfill, but would not result in reduction in toxicity or volume of TEQ.

5.1.4.2 Implementability

Dow has successfully completed a number of removal actions in the Tittabawassee River (e.g., in Reaches B, D, and O), and based on these prior experiences, Alternative 3 is technically implementable. A local permitted landfill would be the primary location for permanent disposal of removed materials. However, past experience at Reaches D and O show that subaqueous removal can impose unique implementability challenges, including managing river flow conditions, achieving low target sediment concentrations, and conducting the removal work under normal flow conditions. Relative to Alternatives 1 and 2, greater complications are anticipated during the implementation of Alternative 3 due to the presence of buried logs and other debris, along with significantly greater water management and turbidity requirements.

5.1.4.3 Cost

The estimated present worth cost of Alternative 3 ranges from approximately \$1,100,000 to \$2,000,000 (provided in present day [2011] dollars, depending on the final removal footprint determined during design (see Appendix B). The cost estimate range is based on the anticipated construction activities, with no short or long-term monitoring requirements. Short-term monitoring may be necessary, but will be determined during design. Segment-wide monitoring programs will be developed under Tasks 4 and/or 8.

5.2 COMPARATIVE ANALYSIS OF ACTION ALTERNATIVES

Table 5-1 compares the relative advantages and disadvantages of the alternatives according to each EE/CA evaluation criterion (e.g., according to effectiveness, implementability, and cost).

6.0 CONCLUSIONS

According to EPA's (2005) national policy: "The focus of remedy selection should be on selecting the alternative best representing the overall risk reduction strategy for the site according to the NCP remedy selection criteria."

This Task 2.4 EE/CA presents the following three alternatives.

- Alternative 1: Stabilization
- Alternative 2: Above-water sediment removal, in situ containment
- Alternative 3: Removal of all targeted sediment

Based on the evaluations in this Reach MM EE/CA, EPA will select an appropriate technology or combination of technologies that will be effective and implementable at the Reach MM Island site, resulting in a protective and cost-effective approach, consistent with EPA's (2005) national policy.

7.0 REFERENCES

- Ann Arbor Technical Services, Inc. (ATS). 2009. Final GeoMorph Site Characterization Report, Tittabawassee River and Floodplain Soils, Midland, Michigan. June 15, 2009.
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- Dow. 2010. Task 2.1 Technical Memorandum, Revision 2. The Tittabawassee River/Saginaw River & Bay Site. Prepared by The Dow Chemical Company. July 16, 2010.
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- EPA. 2010. Letter to: Todd Konechne, Dow. Regarding: Task 2.1 Technical Memorandum, Revision 2. September 16, 2010.

FIGURES

Figure 1-1: Task 2 Characterization and Sequencing

Figure 2-1: Site Location Map

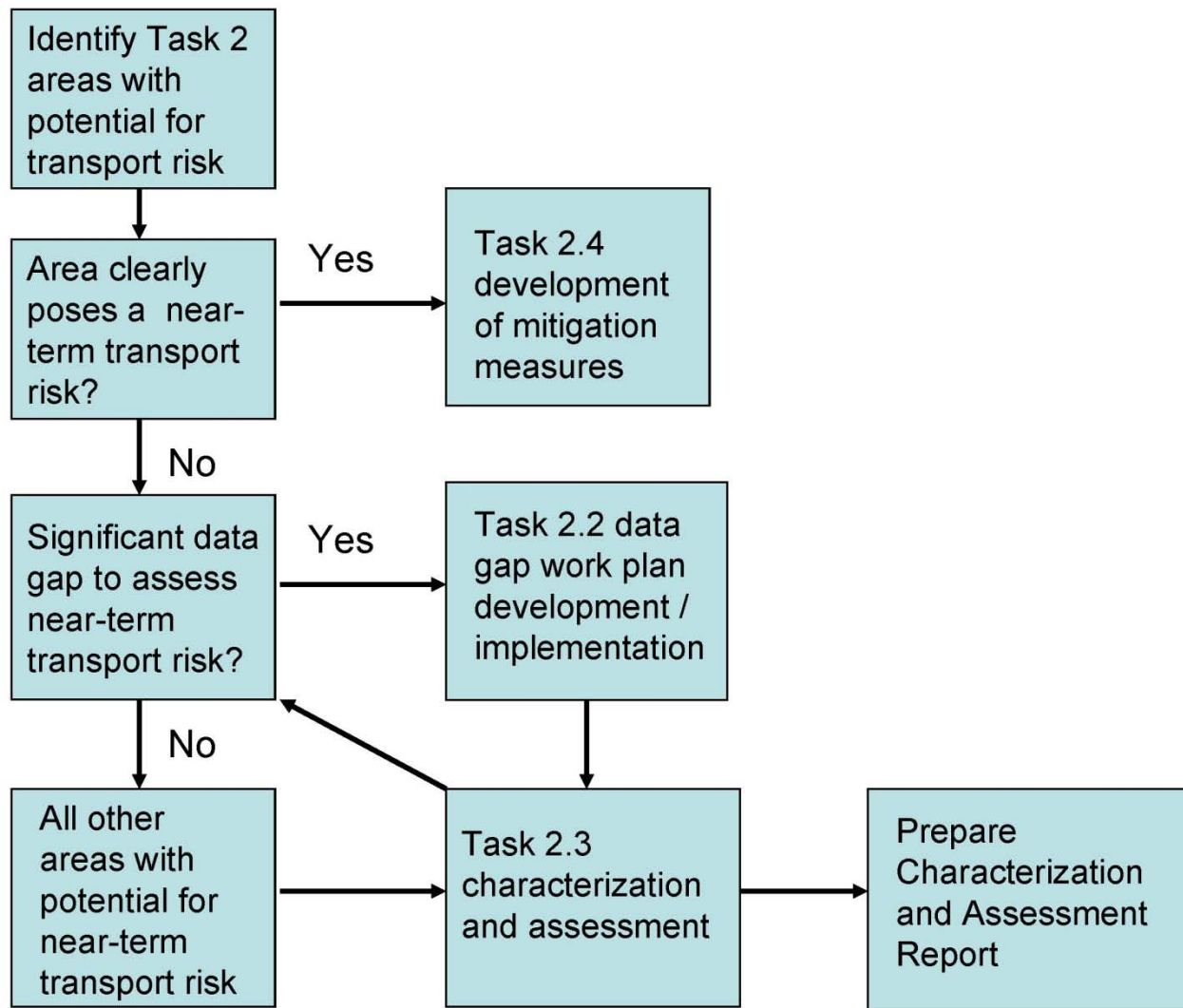
Figure 2-2: Reach MM Island Sample Location Map

Figure 2-3: Cross Section A-A'

Figure 2-4: Cross Section B-B'

Figure 2-5: Cross Section C-C'

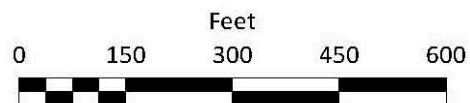
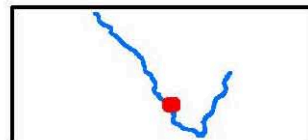
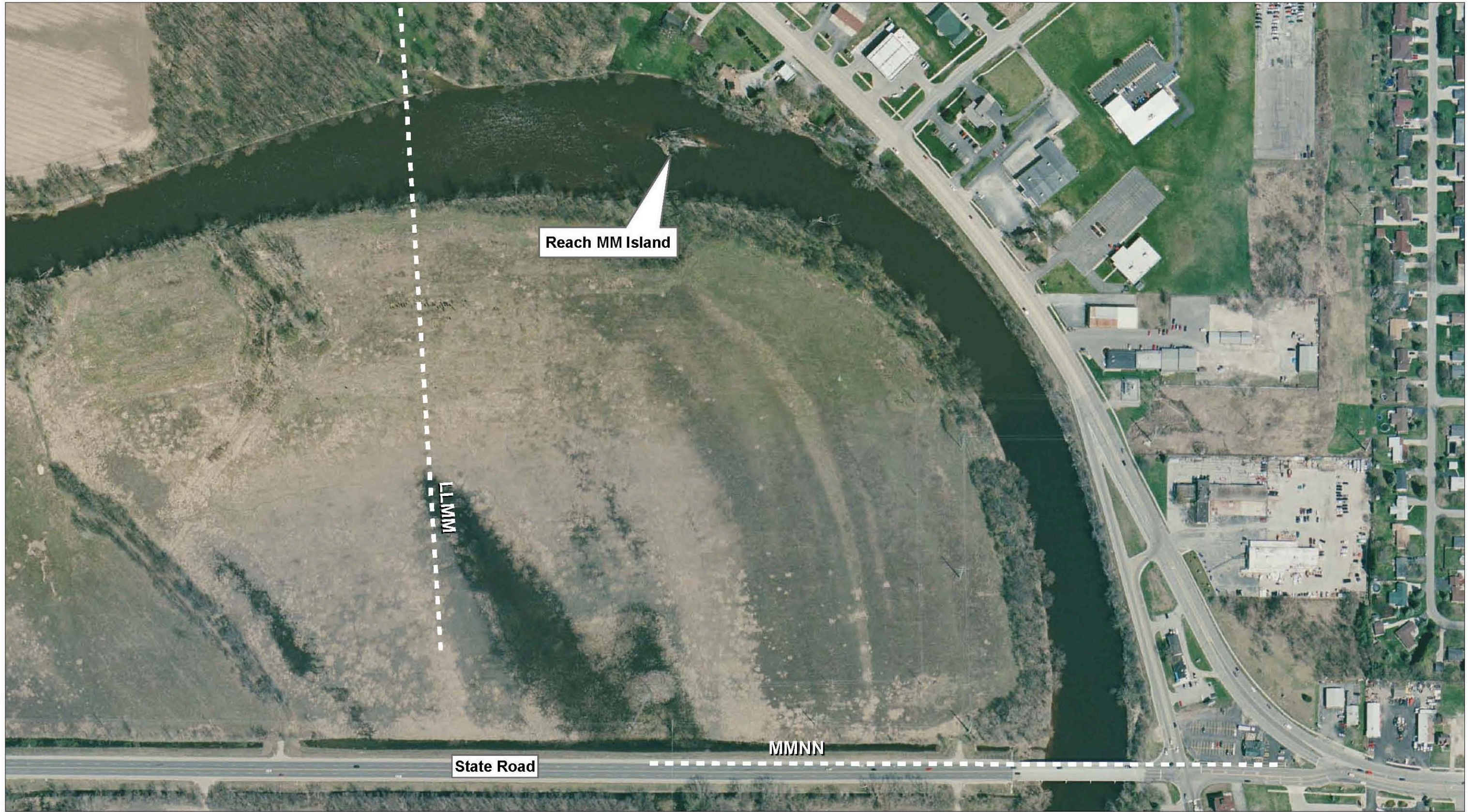
Figure 2-6: Cross Section D-D'



Task 2 Characterization and Sequencing

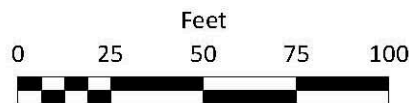
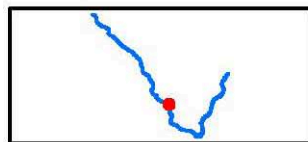
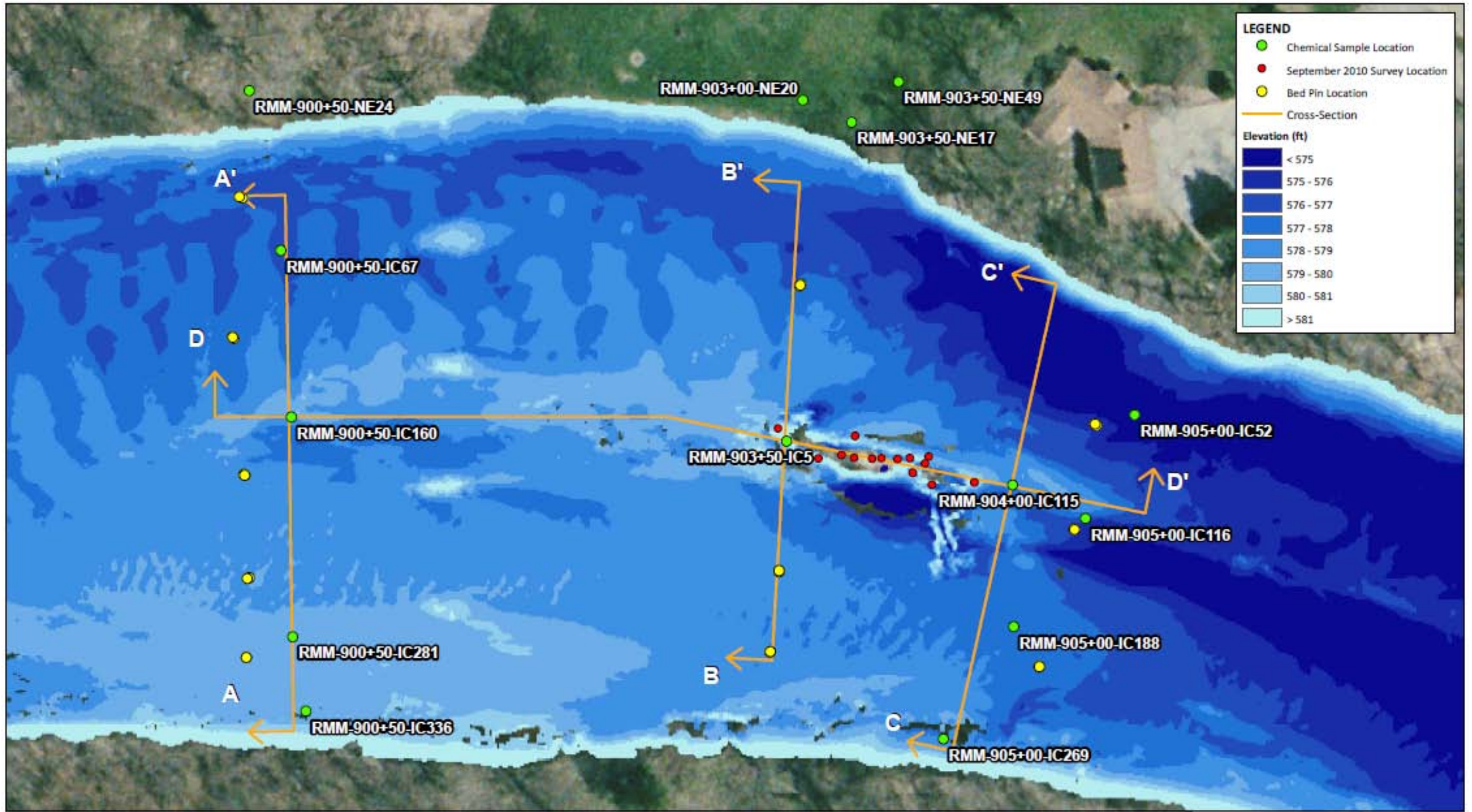
Reach MM In-Channel Island EE/CA

Figure
1-1



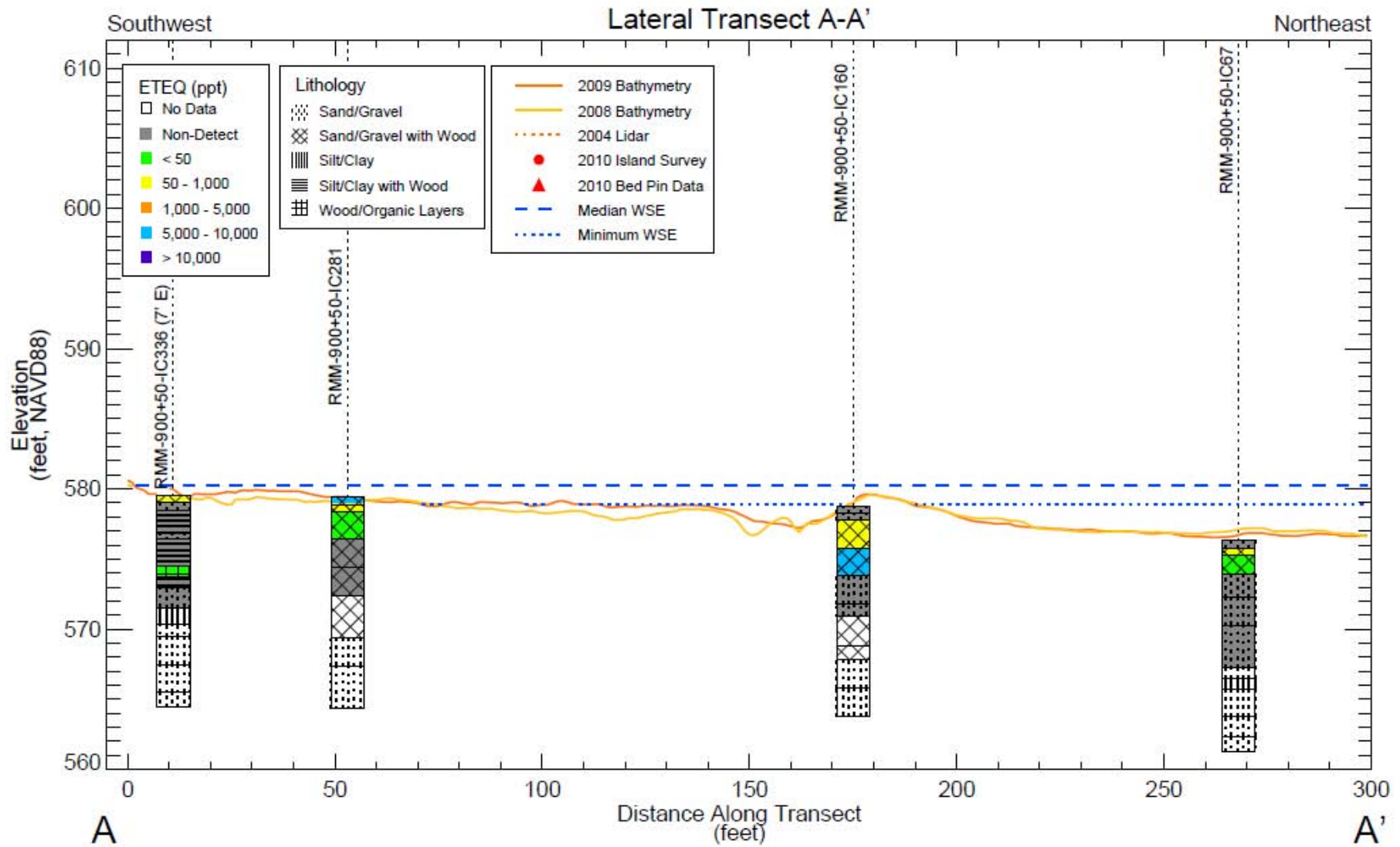
Site Location Map
Reach MM In-Channel Island EE/CA

Figure
2-1



Reach MM Island Sample Location Map
Reach MM In-Channel Island EE/CA

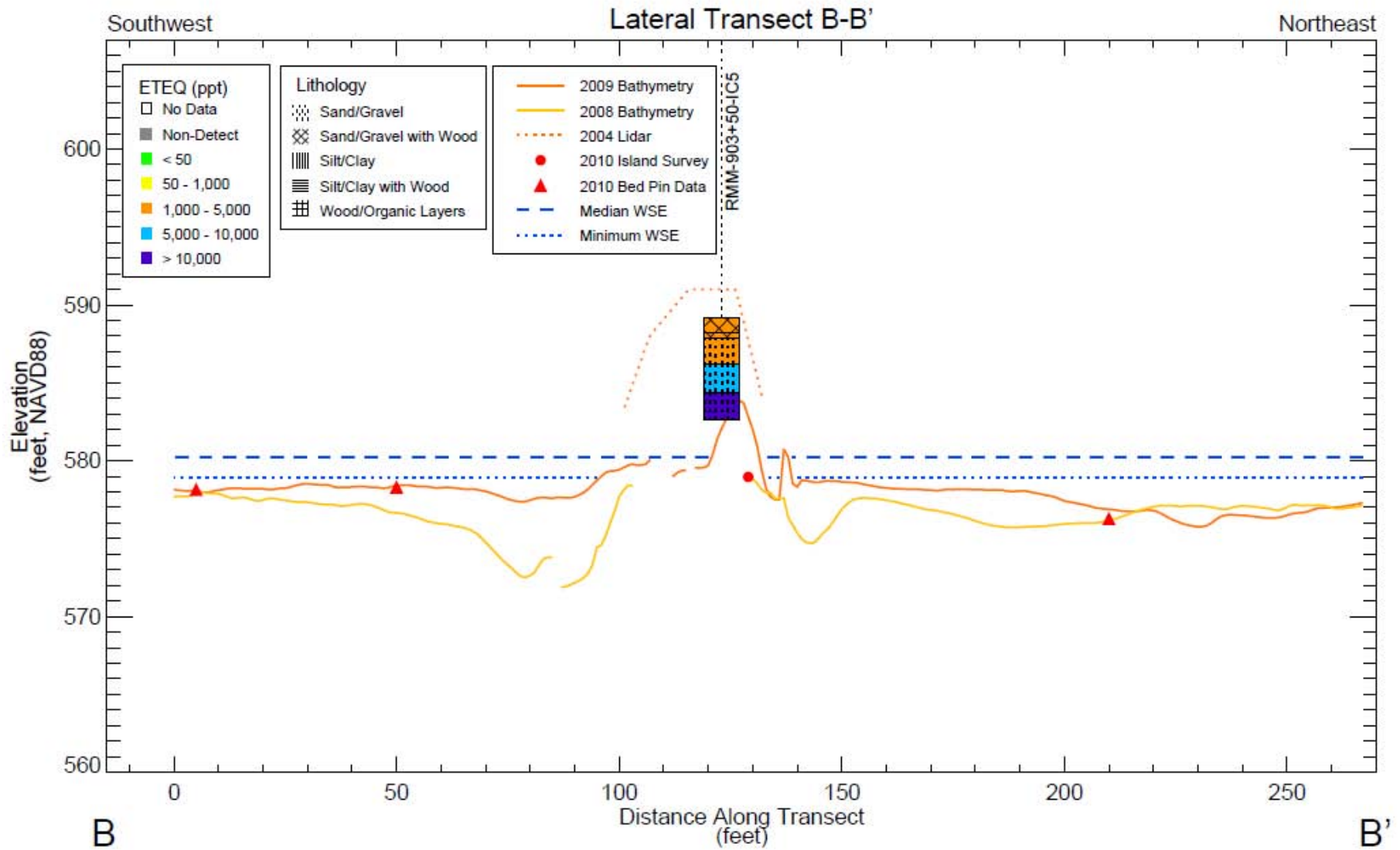
Figure
2-2



Cross Section A-A'
Reach MM In-Channel Island EE/CA

Note: Water surface elevations (WSE) are the minimum and median WSE near the island modeled from June to November of the 2007 - 2009 hydrodynamic model using the floodplain grid. Non-detect values were set equal to half the reporting limit. Core intervals with field duplicates are set as the average of the parent and duplicate sample values. For the September 2010 Reach MM Island survey, only cores within 2.5 ft of the cross-section transect are shown.

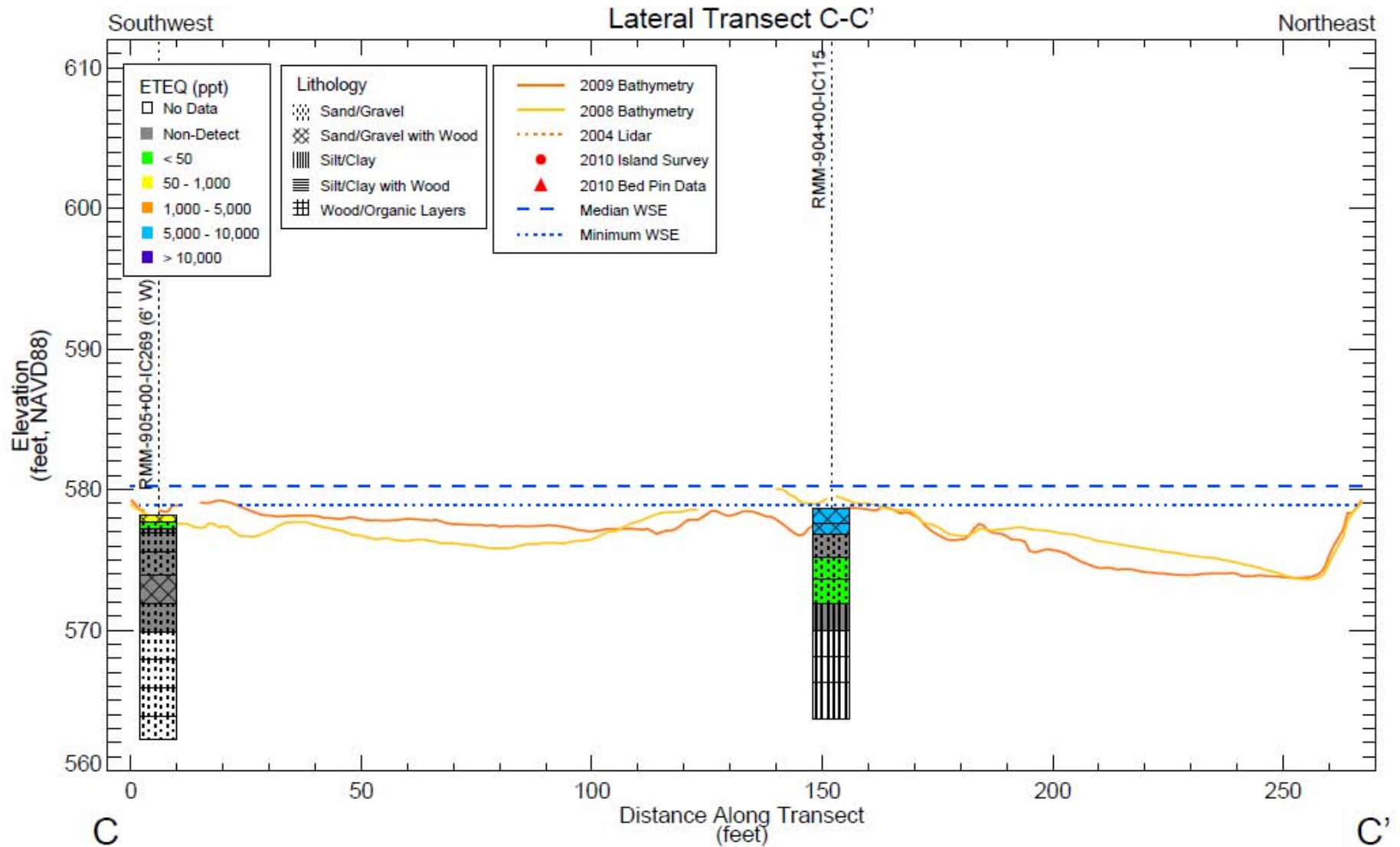
Figure 2-3



Cross Section B-B'
Reach MM In-Channel Island EE/CA

Note: Water surface elevations (WSE) are the minimum and median WSE near the island modeled from June to November of the 2007 - 2009 hydrodynamic model using the floodplain grid. Non-detect values were set equal to half the reporting limit. Core intervals with field duplicates are set as the average of the parent and duplicate sample values. For the September 2010 Reach MM Island survey, only cores within 2.5 ft of the cross-section transect are shown.

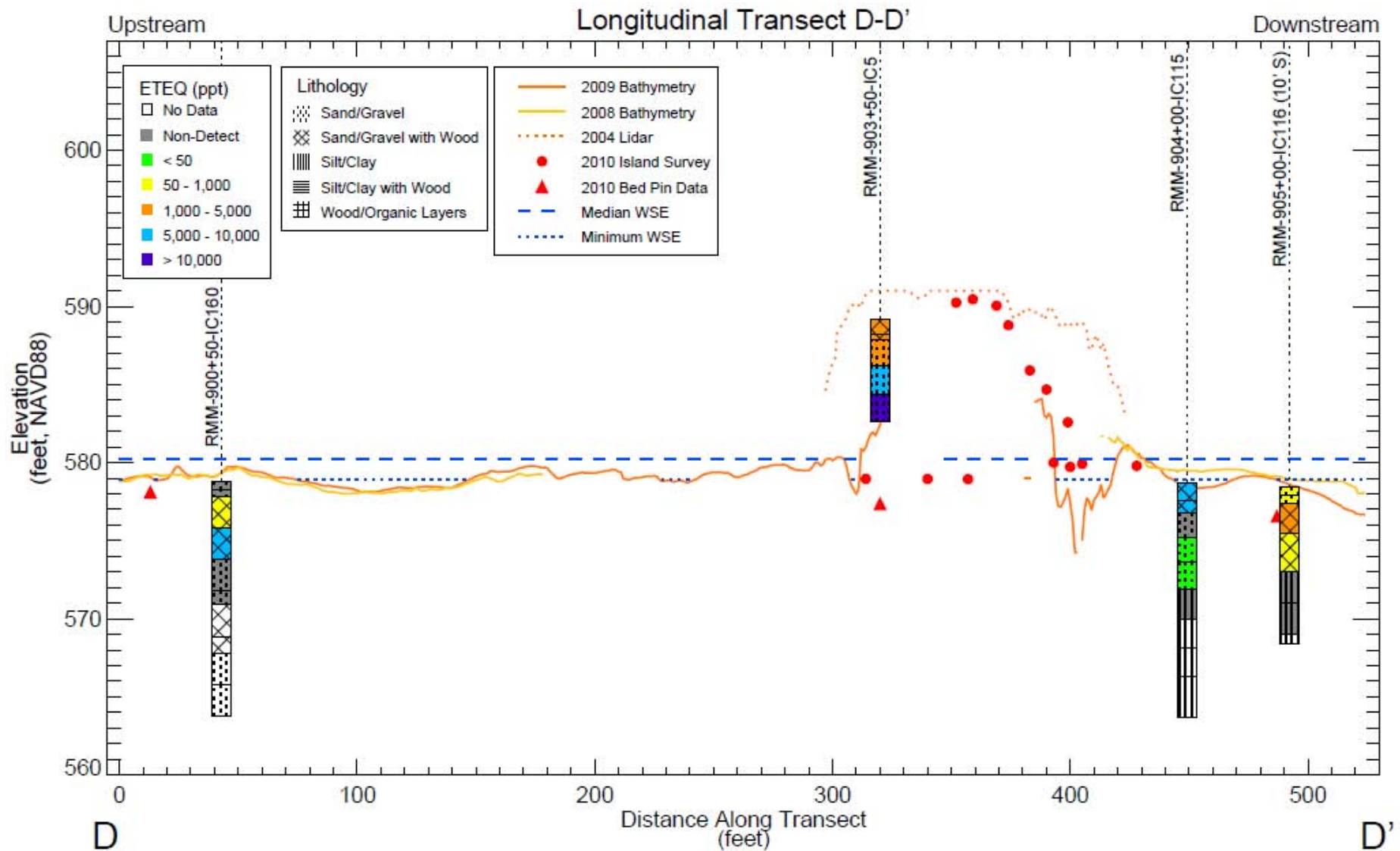
**Figure
2-4**



Cross Section C-C'
Reach MM In-Channel Island EE/CA

Note: Water surface elevations (WSE) are the minimum and median WSE near the island modeled from June to November of the 2007 - 2009 hydrodynamic model using the floodplain grid. Non-detect values were set equal to half the reporting limit. Core intervals with field duplicates are set as the average of the parent and duplicate sample values. For the September 2010 Reach MM Island survey, only cores within 2.5 ft of the cross-section transect are shown.

Figure 2-5



Cross Section D-D' Reach MM In-Channel Island EE/CA

Note: Water surface elevations (WSE) are the minimum and median WSE near the island modeled from June to November of the 2007 - 2009 hydrodynamic model using the floodplain grid. Non-detect values were set equal to half the reporting limit. Core intervals with field duplicates are set as the average of the parent and duplicate sample values. For the September 2010 Reach MM Island survey, only cores within 2.5 ft of the cross-section transect are shown. Bed pin elevations were interpolated to the transect location.

**Figure
2-6**

TABLES

Table 3-1: Potential Chemical-Specific ARARs for Reach MM Island

Table 3-2: Potential Action-Specific ARARs for Reach MM Island

Table 3-3: Potential Location-Specific ARARs for Reach MM Island

Table 5-1: Summary of Reach MM Island Response Alternative Comparative Evaluation

Table 3-1 Potential Chemical-Specific ARARs for Reach MM Island

Medium	Standard or Requirement	Regulatory Citation			Comments
		Federal	State	Local	
Sediments	Sediment cleanup criteria	None	None	None	Site-specific sediment cleanup criteria will be evaluated under Task 8

Notes:

ARAR = applicable or relevant and appropriate requirement; EE/CA = engineering evaluation/cost analysis

Table 3-2 Potential Action-Specific ARARs for Reach MM Island

Action	Standard or Requirement	Regulatory Citation			Comments
		Federal	State	Local	
Dredge/Fill Activities	Requirements for the discharge of dredged/fill material into navigable waters or wetlands	Clean Water Act (33 USC 1251 et seq.; 40 CFR 230 and 231; 33 CFR 320-330) Rivers and Harbors Act (33 USC 401 et seq.)	Part 91 of NREPA (Soil Erosion and Sedimentation Control; MCL 324.9101 et seq.) Part 301 of NREPA (Inland Lakes and Streams; MCL 324.30101 et seq.) Part 303 of NREPA (Wetlands Protection; MCL 324.30301 et seq.)		May be applicable to any remedy that involves dredging or filling
	Design and operating standards for treatment and storage of hazardous waste	Resource Conservation and Recovery Act (42 USC 6901 et seq.; 40 CFR 264)	Part 111 of NREPA (Hazardous Waste Management; MCL 324.11101 et seq.)		May be applicable if excavated sediments are designated as hazardous waste
Capping/Cover/Filling Activities	Requirements for applying cap or cover materials into navigable waters or wetlands	Clean Water Act (33 USC 1251 et seq.; 40 CFR 230 and 231; 33 CFR 320-330) Rivers and Harbors Act (33 USC 401 et seq.)	Part 91 of NREPA (Soil Erosion and Sedimentation Control; MCL 324.9101 et seq.) Part 301 of NREPA (Inland Lakes and Streams; MCL 324.30101 et seq.) Part 303 of NREPA (Wetlands Protection; MCL 324.30301 et seq.)		May be applicable to any remedy that involves capping, covering, or filling

Table 3-2 Potential Action-Specific ARARs for Reach MM Island

Action	Standard or Requirement	Regulatory Citation			Comments
		Federal	State	Local	
Treatment of Excavated Sediments	Requirements for the management of hazardous waste	Resource Conservation and Recovery Act (42 USC 6901 et seq.; 40 CFR 262, 264)	Part 111 of NREPA (Hazardous Waste Management; MCL 324.11101 et seq.)		May be applicable if excavated sediments are designated as hazardous waste
	Requirements for hazardous waste disposal	Resource Conservation and Recovery Act Land Disposal Restrictions (42 USC 6901 et seq.; 40 CFR 268)	Part 111 of NREPA (Hazardous Waste Management; MCL 324.11101 et seq.)		May be applicable to disposal if excavated sediments are designated as hazardous waste
Land Disposal of Excavated Sediments	Requirements for solid waste management and disposal	Solid Waste Disposal Act (42 USC 6901 et seq.; 40 CFR 257, 258)	Part 115 of NREPA (Solid Waste Management; MCL 324.11501 et seq.)		May be applicable to the disposal of non-hazardous solid materials generated during the remedy
	Wastewater treatment prior to discharge		Part 31 of NREPA (Water Resources Protection; MCL 324.3101 et seq.)		May be applicable if the selected remedy involves creation of point source discharges of wastewater to surface waters
Discharges to Surface Water	Surface water quality standards	Ambient Water Quality Criteria established under Section 304(a) of the Clean Water Act (33 USC 1251 et seq.)	Part 31 of NREPA (Water Resources Protection; MCL 324.3101 et seq.)		May be applicable for discharges to surface water, depending on the selected remedy

Notes:

ARAR = applicable or relevant and appropriate requirement; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; CFR = Code of Federal Regulations; EE/CA = engineering evaluation/cost analysis; MCL = Michigan Compiled Laws; NREPA = State of Michigan Natural Resources and Environmental Protection Act; USC = United States Code

Table 3-3 Potential Location-Specific ARARs for Reach MM Island

Location	Standard or Requirement	Regulatory Citation			Comments
		Federal	State	Local	
Within Floodplain	Requirements for design, operation and maintenance of hazardous waste treatment, storage, and disposal facilities	Resource Conservation and Recovery Act (42 USC 6901 et seq.; 40 CFR 264)	Part 111 of NREPA (Hazardous Waste Management, MCL 324.11101 et seq.)		May be applicable if sediments or treatment residuals exceed the criteria for designation as hazardous waste
	Requirements for occupying, filling or grading the floodplain		Part 31 of NREPA (Water Resources Protection, MCL 324.3101 et seq.) Part 91 (Soil Erosion and Sedimentation Control, MCL 324.9101 et seq.)		May be applicable to selected remedy if it involves construction activities within a floodplain.
Within Navigable or State Surface Waters	Standards for dredging and construction	Clean Water Act (33 USC 1251 et seq.)	Part 301 of NREPA (Inland Lakes and Streams, MCL 324.30101 et seq.)		May be applicable to in-water construction activities, including any dredge or fill operations
	Requirements for activities that may obstruct or alter a navigable waterway	Section 10 of the Rivers and Harbors Act (33 USC 403)	Part 301 of NREPA (Inland Lakes and Streams, MCL 324.30101 et seq.)		May be applicable to in-water construction activities
Historic Sites or Structures	Avoidance, minimization, or mitigation of impacts to historic sites or structures	National Historic Preservation Act (16 USC 470f; 36 CFR Parts 60, 63 and 800)			May be applicable if the selected remedy may impact a historical site or structure

Notes:

ARAR= applicable or relevant and appropriate requirement; CFR = Code of Federal Regulations; MCL = Michigan Compiled Laws; EE/CA = engineering evaluation/cost analysis; NREPA = State of Michigan Natural Resources and Environmental Protection Act; USC = United States Code

Table 5-1 Summary of Reach MM Island Response Alternative Comparative Evaluation

Response Alternative	NCP Evaluation Criteria		
	Relative Effectiveness	Relative Implementability	Total Construction and O&M Cost
Alternative 1: Stabilization	Moderate – Stabilization would immediately control sediment transport. Low construction-related impacts	High – Readily implementable	\$250,000
Alternative 2: Non-Subaqueous Sediment Removal and In Situ Containment	High – Removal of sediment above the low water level with placement of an engineered cap would eliminate sediment transport. Low construction-related impacts. An island environment would be restored, enhancing the existing island habitat and the corresponding ecological services of the island.	High - Readily implementable	\$500,000
Alternative 3: Removal of All Targeted Sediments	Moderate to High – Removal would control sediment transport, but residuals could limit effectiveness. Potential construction-related releases and associated impacts, and greater landfill disposal requirements. Island environment would not be restored.	Moderate - Implementable, but potential complications due to debris (e.g., buried logs), turbidity, water management, and subaqueous removal.	\$1,100,000 to \$2,000,000

Notes:

NCP = National Contingency Plan

O&M = Operations and Maintenance

APPENDICES

Appendix A: Laboratory Analytical Report



290 South Wagner Road
 Ann Arbor, Michigan 48103
 Tel. 734/995-0995 Fax. 734/995-3731
 Michigan Laboratory ID: 9604
 Wisconsin Laboratory ID: 998321720

Data Summary
Middle Tittabawassee River
Midland, Michigan

Transect Location/Sample Identification	Collection Date	Depth Interval (ft,bgs)	Geomorphic Setting	Physical Description	USCS	Moisture Content (%)	TOC % (w/w)	2,3,7,8-TCDD (ng/kg)	2,3,7,8-TCDF (ng/kg)	1,2,3,7,8-PeCDF (ng/kg)	2,3,4,7,8-PeCDF (ng/kg)	1,2,3,4,7,8 + 1,2,3,6,7,8-HxCDF (ng/kg)	Aggregate Indicator	Estimated Total TEQ (ppt)	Laboratory
													Congener Concentration (ng/kg)		
RMM-903-904-IC-BFGC (0.0-1.0)	12/13/2010	0.0-1.0	Bank	10YR 3/2 very dark grayish brown fine sand, moist, non-plastic, few fine roots	SW	11.8	1.0	12	24000	9500	9100	6800	50000	6800	Dow / ATS

NOTES:

All concentrations are expressed on a dry weight basis.

"Estimated Total TEQ" is aggregate indicator congener TEQ multiplied by the correlation factor of 1.1x.

A contribution for 1,2,3,7,8-PeCDD has been included based on the concentration of 2,3,7,8-TCDD.

Calculations performed prior to rounding.

DATA FLAGS:

Asterisk (*) indicates estimated concentration.

"LSV" indicates elevated reporting limit due to limited sample volume.

"LISR" indicates elevated reporting limit due to low internal standard recovery.

"MI" indicates elevated reporting limit due to matrix interference.

() indicates sample to be confirmed by USEPA Method 1613B

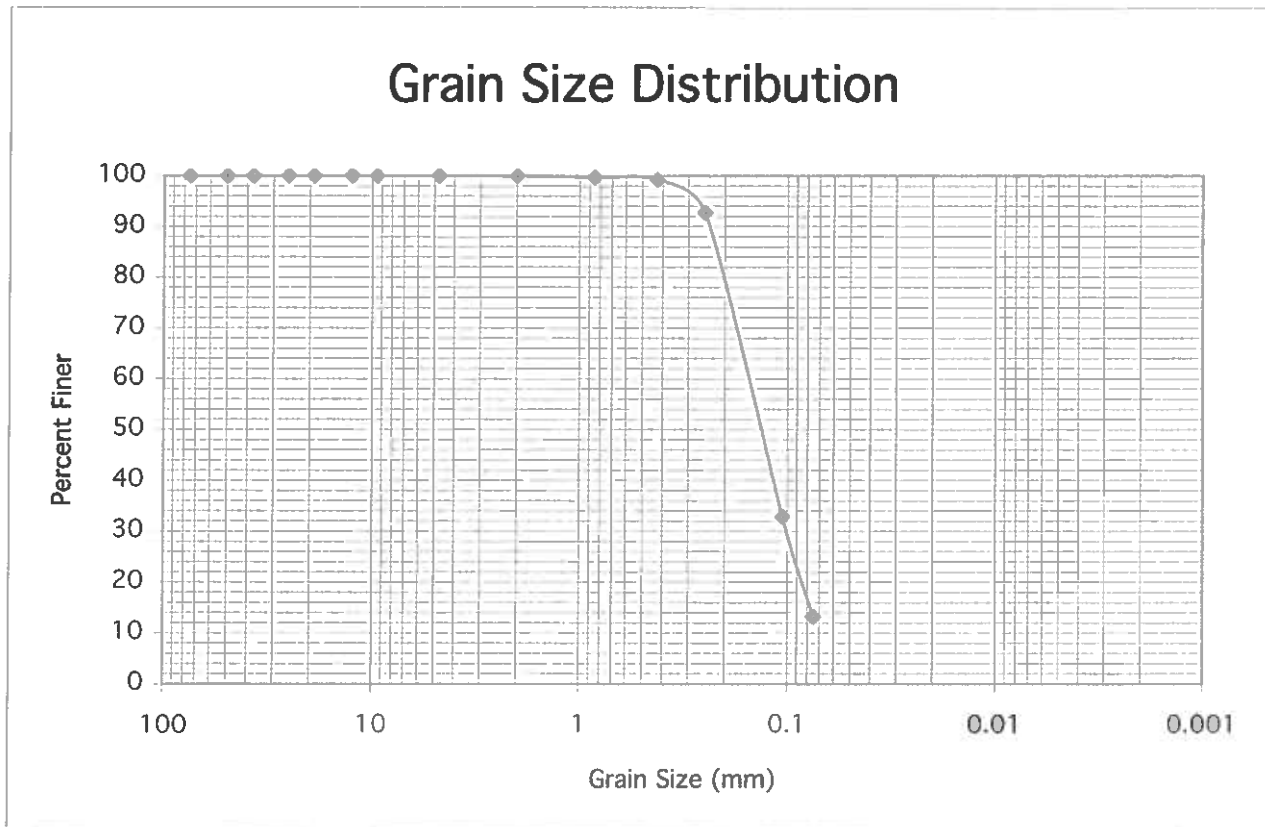
"NS" indicates No Sample

"NR" indicates No Result



Project: DOW/D052-TRP	Project #: 0381256
Client: ATS Inc.	Date Tested: 01/21/10
Date Sampled: 12/13/10	Sample Source: RMM-903-904-IC-BFGC
Sampled by: ATS Inc.	
Description: Fine Sand with fines	

Soil Information:				
% Gravel=	0.0		PI=	n/a
% Sand=	86.8		LL=	n/a
	Coarse	0.1%	PI=	n/a
	Medium	0.7%	USCS:	SP-SM
	Fine	86.0%		Cu=
				Cc=
% Fines=	13.2		Description: Fine Sand with fines	
	Silt	n/a		
	Clay	n/a		



Note: 160.6 g of material was provided for testing purposes

APPENDICES

Appendix B: Cost Estimates

Table A-1

**Preliminary Cost Estimate for Reach MM Island
Alternative 1: Stabilization
Tittabawassee River
Saginaw, Michigan**

	Description	Estimated Cost
1	Mobilization/Demobilization/Site Preparation/ Site Restoration	\$ 45,000
2	Implementation	\$ 115,000
3	Pre-Design Investigation	\$ 10,000
4	Construction Total:	\$ 170,000
5	Engineering Design (15%):	\$ 26,000
6	Construction Contingency (25%):	\$ 43,000
7	Post Construction Monitoring (Present Worth):	\$ 10,000
8	Total:	\$ 250,000

Table A-2

**Preliminary Cost Estimate for Reach MM Island
Alternative 2: Non-Subaqueous Sediment Removal and In situ Containment**

**Tittabawassee River
Saginaw, Michigan**

	Description	Estimated Costs
1	Mobilization/Demobilization/Site Preparation/Site Restoration	\$ 160,000
2	Implementation	\$ 154,000
3	Transport and Disposal at Lanfill (~600 cubic yards)	\$ 26,000
4	Pre-Design Investigation	\$ 10,000
5	Construction Total:	\$ 350,000
6	Engineering Design (15%):	\$ 50,000
7	Construction Contingency (25%):	\$ 90,000
8	Post Construction Monitoring (Present Worth):	\$ 10,000
9	Total:	\$ 500,000

Table A-3

**Preliminary Cost Estimate for Reach MM Island
Alternative 3: Removal of All Targeted Sediments (~ 2,400 Yards)
Tittabawassee River
Saginaw, Michigan**

	Description	Estimated Cost
1	Mobilization/Demobilization/Site Preparation/ Site Restoration	\$ 210,000
2	Implementation	\$ 300,000
3	Sediment Dewatering	\$ 140,000
4	Transport and Disposal at Landfill (~2,400 cubic yards)	\$ 110,000
5	Pre-Design Investigation	\$ 20,000
6	Construction Total:	\$ 780,000
7	Engineering Design (15%):	\$ 120,000
8	Construction Contingency (25%):	\$ 200,000
9	Total:	\$ 1,100,000

**Preliminary Cost Estimate for Reach MM Island
Alternative 3: Removal of All Targeted Sediments (~ 6,000 Yards)
Tittabawassee River
Saginaw, Michigan**

	Description	Estimated Costs
1	Mobilization/Demobilization/Site Preparation/ Site Restoration	\$ 250,000
2	Implementation	\$ 580,000
3	Sediment Dewatering	\$ 350,000
4	Transport and Disposal at Landfill (~6,120 cubic yards)	\$ 270,000
5	Pre-Design Investigation	\$ 30,000
6	Construction Total:	\$ 1,480,000
7	Engineering Design (10%):	\$ 150,000
8	Construction Contingency (25%):	\$ 370,000
9	Total:	\$ 2,000,000