Enbridge Line 6B MP 608 Pipeline Release

Marshall, Michigan

Response Plan for Downstream Impacted Areas

August 2, 2010

(Revised August 17, 2010 per U.S. EPA August 17, 2010 letter)

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1.0 Site History

The Enbridge Energy, Limited Partnership (Company) reported a release of crude oil from its petroleum pipeline Line 6B in the vicinity of Marshall, Michigan (Figure 1) on July 26, 2010. Two main areas have been impacted by this release. The Source Area is defined as a lowland area with marshy terrain located approximately 0.4-mile west of US-227 (17 Mile Road), and approximately 0.2 mile south of Division Drive, plus Talmadge Creek and all affected navigable waterways and their shorelines/adjacent up to the confluence of Talmadge Creek with the Kalamazoo River (the "Source Area"). The Downstream Impacted Areas include downstream of the Source Area. Specifically, this includes the Kalamazoo River downstream of the confluence of Talmadge Creek with the Kalamazoo River and all subsequent downstream affected navigable waterways and their shorelines/adjacent affected areas. This work plan titled "Response Plan for Downstream Impacted Areas" (RPDIA) will address the bank and in-river areas, and impacted wetlands, floodplain areas, and marshes (the "Downstream Impacted Areas") in accordance with recommendations made for each individual area by the Shoreline Cleanup Assessment Technique (SCAT) Team. A separate work plan titled the "Source Area Response Plan" (SAR) will address the Source Area.

2.0 Site Description and Location

The Company's pipeline release site is located just west of pipeline mile post 608 in Marshall, Calhoun County, Michigan, (North ½ Section 2, T3S, R6W, Latitude: 42.2395273 Longitude: -84.9662018) in an undeveloped area, south of town. Figure 1 shows the location of the site. The release entered Talmadge Creek and then the Kalamazoo River. These waterways are considered to be navigable waters. Currently, approximately 30 miles of the Kalamazoo River may have been impacted. To date the impacted areas are described as:

- **Division A** - the Spill Release Area (to the constructed Flume where the release entered Talmadge Creek);
- **Division B** - Talmadge Creek from the Flume site to the confluence with the Kalamazoo River);
- **Division C** - The confluence of the Talmadge Creek and the Kalamazoo River to the Angell Street Bridge;
- **Division D** - Angell Street to Kalamazoo County line; and
- **Division E** - Kalamazoo County Line to Morrow Lake Dam.

Figure 2 shows the site division designations A through E. The Source Area is comprised of an approximate 5-acre parcel adjacent to the pipeline release location (Spill Release Area) and the portion of the Talmadge Creek extending from the release site to the confluence with the Kalamazoo river (the Creek) (Figures 3 and 4). The majority of the Spill Release Area is within a wetland between the release site and Talmadge Creek. Most of the surrounding area can be characterized as rural, including undeveloped and agricultural areas. Vegetation in the source area consists of herbaceous emergent wetland plants in low lying areas, as well as brush and trees in upland areas.

This RPDIA Plan addresses the downstream area from the Source Area, which encompasses Divisions C through E (Figures 5 through 7).

3.0 Emergency Response Actions Completed To Date

As of the date of this report, the following key response actions have occurred:

- **Plans:** The Company has prepared and submitted plans for review and comment to be used to control the work and reporting.
- **Security:** Signage at crossings and public notice has been provided to alert the public to the hazards that may be associated with the spill.
- **Oil and Water Containment and Recovery:** Oil containment and recovery operations using up to 1,000 Company and contractor staff, 70,000 feet of booms, 90,000 feet of absorbents, and supporting vacuum trucks along the Kalamazoo River. The Planning Section tracks the staff, equipment, and progress on a spreadsheet that is updated daily (See Figures 5 through 7 for boom location and other containment controls).
- **Initial Receptor Survey:** An initial receptor survey was implemented and will be updated during post-response activities effectively identify potential migration pathways and potential receptors along the Kalamazoo River. The receptor survey is conducted to identify the presence and location of surface waters, water wells, and surface water intakes which could be impacted by the crude oil release.
- **Environmental Sampling and Exposure Reduction:** The Company has performed preliminary sampling of environmental media and potable wells as requested by concerned citizens in order to be protective of human health. Concerned citizens have been provided housing outside of the immediate impacted area.
- **Federal and State Approvals:** The Company has coordinated efforts with all Federal and State level environmental stakeholders identified at the site including:
    - U.S. EPA, U.S. Fish and Wildlife Service (USFWS)
    - Michigan Department of Natural Resources and Environment (MDNRE)
    - U.S. Coast Guard
    - Michigan Department of Agriculture (MDA)
    - Michigan Department of Community Health (MDCH)
    - Calhoun County Public Health Department (CCPHD)
    - Kalamazoo County Health and Community Services Department (KCHCSD)

The Company is obtaining environmental permits for the short-term oil removal in parallel with ongoing response activities. Table 1 contains the permits/approvals obtained to date and submitted

permit applications. The permit expiration dates and conditions are being tracked to maintain compliance. New permits or permit extensions will be acquired as needed during the transition from response to future long-term response actions.

Adaptive Management: Throughout this plan there are various forward looking statements or content. As well, associated text may also indicate that specific details may need to be worked out with relevant agencies as work unfolds. It is understood that the overall Federal On-Scene Coordinator (FOSC) Structure will provide sufficient technical staff to facilitate supplementing or changing parts of the response plan and strategies as such situations arise, and will work with The Company to review and approve alterations.

3.1 Objectives, Endpoints & Metrics

The primary objective of this Response Plan for Downstream Impacted Areas (RPDIA) Plan is to remove and/or abate visible oil and or sheen that is either currently affecting navigable water ways and/or poses the threat of release of a visible oil or sheen discharge to navigable waterways. This objective will be accomplished by meeting the target endpoints for each shoreline type described below. The endpoints are based on visual field screening for the presence of materials capable of producing a release of oil or an oil sheen to navigable water. Visual screening does not include soil that exhibits a petroleum odor and/or organic headspace. These residual impacts will be addressed as part of the long-term assessment and remediation efforts for the site.

3.1.1 Riparian Zones and Stream Banks

1. Shorelines no longer release sheens that affect navigable waterways.
2. Oil no longer rubs off on contact.
3. Oil removal to the point where recovery/re-colonization can occur without causing more harm than leaving the oil in place. Heavy oil generally weathers to a dry coat within weeks.

3.1.2 Soil, Sand and Gravel

1. Oil is no longer visible on surface.
2. No oil layers in test pits dug by inspection teams.

3.1.3 Man-made structures

1. Structure no longer generates liquid oil or sheen.
2. Oil no longer rubs off on contact.

3.2 Response Methods Overview

The Company will develop and coordinate selection of actual response methods in consultation with the agencies and within the FOSC. The response methods will be implemented through a daily Incident Action Plan (IAP). The SCAT Team input will be the overarching mechanism to guide the selection process.

Aggressive response activity measures (versus leaving small amounts of oil which will degrade naturally over time) have the potential to cause greater long-term environmental harm and may delay, rather than accelerate, recovery of impacted shoreline habitats. Therefore, the Company will avoid the use of intrusive disturbance of the river banks unless absolutely necessary. The Company proposes intrusive disturbance of the river banks/beds, floodplains, and/or wetlands only when the potential for adverse affects from the oil poses a greater threat than intrusive removal techniques.

If invasive response activities are required to remove oil-impacted soils/sediments, vegetation and/or debris, best management practices will be employed to minimize adverse impacts to these and surrounding natural resources and/or sensitive habitats. These include:

- Use of low-pressure flushing conducted in such a manner which minimizes erosion and does not dislodge soil/sediment particles from unconsolidated banks leading to the possible incorporation of oil into stream or river sediments. Prevent pushing or mixing oil deeper into the sediment by not directing the stream of water directly into the oil; direct hoses to place stream of water above or behind the surface oil to create a sheet of water to re-mobilize and carry oil down the bank to a containment area for recovery.
- Minimizing the removal of clean soil underlying oiled surface layers being removed.
- Preventing trampling of wetland or upland vegetation by pedestrian or equipment traffic within unoiled areas adjacent to response activity sites.
- Avoiding pedestrian or equipment traffic on soft substrates where oil could be pushed deeper into the substrate.
- Minimizing the removal of clean vegetation when removing oiled vegetation.
- Restrict flushing in marshes from boats or on shore above the high water mark to minimize mixing oil into the sediments or mechanically damaging the marsh plants.

Please refer to Attachment B for further discussion of the Shoreline Cleanup Assessment Team (SCAT) Process and additional information on selecting and recommending response techniques.

4.0 Evaluation of Potential Impact Areas and Select Response Actions

Priority areas will be identified from the SCAT Assessment conducted on the Kalamazoo River (See Attachment B attached for a more detailed description). The SCAT Assessments are compiled and communicated by The Company to Operations to assist development of a daily IAP. Priority areas will be those areas where observed impacts are high and in close proximity to a receptor, or could have future impacts to downstream areas. Receptors may include people, plants, animals and other ecosystem components. Anticipated priority areas may include wetland areas adjacent to the river that contains oil that could become mobilized in the River under different conditions such as a heavy rain event resulting in high water levels. The United States Army Corp of Engineer's (USACE) concrete channel project requirements will be reviewed as possible priority areas.

The need for responses in these defined priority areas will then be determined by balancing response activities while minimizing impacts to other resources. The decision making process is outlined in the decision tree shown as Figures 8 and 9.

Michigan Department of Agriculture (MDA) will be notified within one week if access to a response area will occur through active farmland. Significant impacts from access will be assessed and forwarded to the landowner and the MDA for evaluation of potential long-term impacts to a land that would preclude continued enrollment of the land prior to its contract end.

4.1 Sediments

The presence of oil in the Kalamazoo River creates potential for sediment contamination through several possible mechanisms: direct contact with oil, flushing of oil from banks, and entrainment of sediment or other material, which alone or in combination with weathering processes, causes oil to no longer remain floating. Qualitative assessments will be conducted to characterize sediment oiling conditions by means of visual observations in the Kalamazoo River and Morrow Lake.

4.1.1 Kalamazoo River

Initially, survey locations will be established at depositional areas that are most heavily oiled, as these locations are most likely to contain oil, if present, based on fluvial geomorphic conditions. Transects across the river will be established in areas where heavy oil is observed on both banks. Along transects that span the width of the river, survey locations will be established every 10 to 15 feet.

At each survey location, a dibble or shovel blade will be used to agitate the surficial sediment and/or expose the subsurface sediments for inspection. The type (e.g., free oil, tarballs, sheen) and amount (e.g., percent cover within 3 feet of the survey location) of any observed oil will be documented along with the substrate type. Photographs and GPS coordinates will be taken at each survey location to show the extent of oiling.

If oil is found, the survey procedure will be repeated at additional upstream and downstream locations (not to exceed two locations/transects per river mile).

4.1.2 Morrow Lake

If oil in the sediments is observed in depositional areas at the upstream end of Morrow Lake, subsurface chain drags will be conducted along transects in the lake where deeper water levels are not expected to be conducive to agitation with shovels. Transects will be established perpendicular to the longitudinal axis at half-mile intervals starting at the eastern-most end of the lake.

The chain drag procedure consists of dragging a heavy steel chain and absorbent pompoms across the bottom of the lake along the established transects. The chain drag apparatus is attached to the boat by rope and consists of absorbent pompoms attached to a 10-foot-long steel chain. At each transect, the apparatus will be deployed and dragged the entire length of the transect. At the end of the transect, the apparatus will be retrieved and checked for presence of oil. If no oil is observed, the survey will continue at the next transect with new clean snare. If oil is observed, the transect will be re-surveyed with new clean snare and the apparatus will be retrieved at 500-foot intervals to inspect for the presence of oil.

Each time the chain drag apparatus is retrieved, pictures will be collected and observations will be recorded even if no oil is present. GPS coordinates will be collected and recorded at each retrieval location. If oil is observed (determined by smell and/or appearance), the oiling level (e.g., very light, light, moderate, and heavy) of individual snares will be assessed and recorded on field data sheets. Any oiled snare on the apparatus will be removed and replaced with new clean snares prior to redeployment.

5.0 Kalamazoo River Response and Recovery

The Kalamazoo River is an approximately 50-foot-wide waterbody. During the release, water elevations were high due to recent precipitation. As a result, oil was able to enter floodplain wetlands. Further river shoreline assessment is needed, specifically at locations were wetlands are present adjacent to the river. Wetland area assessments will be completed as part of the shoreline review. As noted earlier, the SCAT Process will guide assessment, prioritization and selection of response activity approaches and methodologies.

5.1 Goals and Objectives for the Kalamazoo River

- Remove remaining free oil.
- Effectively and efficiently remove residual oil on the banks and associated wetland and floodplain areas along the Kalamazoo River to levels that do not produce oil or an oil sheen to navigable waterways.

Conduct response actions in a manner that minimizes further impacts to natural resources and ecosystems by evaluating trade-offs and weighing the benefits of additional response actions against the environmental harm potentially caused by more aggressive techniques.

5.2 Controls to Limit Additional Impacts Downstream

- Maintain and monitor existing downstream control points throughout to protect downstream areas as necessary.
- Utilize localized or "short-term" boom installations to further restrict work areas.
- Minimize foot traffic through oiled areas on non-solid substrates (e.g., sand, gravel, mud, etc.) to reduce the likelihood that oil will be worked into the soil/sediment. Trampling of unoiled wetland vegetation reduces habitat value and may lead to shoreline erosion. Excessive foot traffic through oiled soft substrates potentially drives oil deeper in the sediment potentially increasing the need for future removal or remediation and lengthening the time required for recovery.

Baseline River Conditions: It is not expected that response activities on the Kalamazoo River will cause substantial alterations to baseline fluvial geomorphology of the river. Nonetheless, baseline conditions will be established via existing data as available on topographic conditions, flow channel characteristics, base flow and so on available via the County Commissioner or other local or state resources, as well as USGS or other sources. It will be supplemented as relevant with onsite data collection; for example, to the extent response activities move forward into fluvial deposits or

sediments (see Sediment section later in this report), localized survey data and other documentation will be collected to document baseline conditions. Regarding potential alterations to ecological habitats, baseline conditions are being evaluated and documented as part of the Natural Resource Damage Assessment (NRDA) process currently ongoing with the Trustees. This will include documentation of large woody debris, however, The Company and EPA also held discussions with MDNRE Fisheries staff on this particular issue and also committed to GPS photo documentation of such large woody debris (e.g., downfalls, etc.) prior to removal of oiled material.

The general response activities for the Kalamazoo River will consist of steps to remove free oil, followed by methods to address and remove oily vegetation on the bank, as well as oily debris, bank soils, and sediments in line with SCAT Team recommendations.

6.0 Treatment Recommendations

A quantitative monitoring plan will be developed separately to make judgments on whether natural recovery is occurring without unacceptable adverse effects and will be submitted to the FOSC for approval prior to execution of such as plan.

6.1 Response Methods

Attachment C provides a matrix of approved shoreline clean-up methods developed in conjunction with the U.S. EPA on August 10, 2010. It is expected these will evolve over time by the ongoing SCAT Process and continued agency consultation.

When necessary to access or cross areas of soft substrates, plywood sheets or other appropriate methods will be used to avoid compressing soils.

The outline below provides a brief overview of the anticipated methods of clean-up:

6.1.1 Free Oil Recovery

- Continue free oil recovery as necessary by one of the recommended methodologies identified (which may include pads, skimmers at control points, vac truck).

- Minimally scrape areas (if required) to remove remaining liquid or heavy deposits of crude oil and dispose of resulting material according to waste management plan.

- **Low pressure water wash**—The low pressure water wash will target oiled vegetation and shoreline. Absorbent boom will be used to provide secondary containment. As shoreline washing progresses, localized deployment of boom, sorbent booms and pads, as needed, will occur to contain and recover oil in the immediate area. Throughout all washing or flushing efforts, steps will be taken to avoid impact to un-oiled areas or vegetation. For example, washing will be performed in a manner to move oil down gradient to containment/collection points, not up into clean areas. Such procedures will be communicated and reinforced as part of a daily IAP.

- **Torch residual crude oil smear/stain**—Handheld propane torches will be used to remove crude oil smear and stain on vegetation and soils along shoreline areas. Use of this method will maintain plant root systems and will not result in any self-sustained fires. Prior to any

such burning, it will be approved by the IAP Process. No other thermal treatment of contamination is planned.

6.1.2 Manual Removal

Where practical, manual techniques will be used to remove oil from the streambanks and affected riparian areas. This may consist of shoveling, scraping, raking or digging oil and oil-impacted soils using hand tools. Oily material will be bagged immediately. Removal of clean underlying soils will be minimized. Efforts will be made to avoid destabilizing the streambanks, which could lead to further erosion. Manual removal also applies to removal of oily debris from the streambanks or within the stream channel. Workers will take care to avoid trampling non-oiled vegetation and walking on soft substrates, which has the potential to push oil farther down into the sediments. When necessary to access or cross areas of soft substrates, plywood sheets or other appropriate methods will be used to avoid compressing soils. Backfill of excavated areas will be with clean, weed-free top soil immediately following excavation around tree roots in the riparian zone as necessary to ensure tree survival.

6.1.3 Mechanical Removal

Mechanical removal of heavily oiled bank materials may be proposed, but would be coordinated within the SCAT Process and presented to the agency for approval.

6.1.4 Vegetation Removal

Oiled vegetation will be removed as outlined in Attachment C, which includes shrubs, tree branches and non-persistent grasses and forbs. The cuttings will be collected and disposed of according to Section 2.4 of the Waste Management Plan. Trees larger than 2-inch diameter at breast height (DBH) as outlined in Attachment C.

6.1.5 Debris Removal

Oiled debris will be removed as outlined in Attachment C from the river and banks and disposed of in accordance with Section 2.5 of the Waste Management Plan. To the extent that large woody debris is oiled, it is recognized such debris is an important component of the river habitat for a range of species. Removal of oiled large woody debris has been discussed with EPA and MDNRE, with concurrence that such debris will be inventoried via photo-documentation, and removed as necessary. This will allow assessment and implementation of habitat restoration efforts as needed, and coordinated as appropriate with NRDA processes.

6.1.6 Interim Response Oiled Wildlife Processing Protocol

During implementation of the previously described response activities, live oiled animals will be collected, cleaned, rehabilitated, and released. Oiled wildlife carcasses identified by response staff, regulatory staff, and the public will be called into The Company's Marshall Response 800 number (800.306.6837). A member of the Wildlife Response Facility (WRF) team will be dispatched to collect the carcass. The carcass will be photographed in place, and its location documented (to include either actual lat/long coordinates or coordinates from a nearby known landmark, if available). If, during the course of the response, the appropriate regulatory entity [USFWS (migratory birds) or MDNRE (other species)] has demobilized from the WRF, the collection staff will notify them of the discovery. A record regarding the disposition of wildlife carcasses will be maintained including disposition date, dispositions status, federal band number (if applicable), and intake number.

6.2 Resources and Equipment

The equipment and manpower is dependent on the SCAT Process results. Based on initial assessment, a base level of resources is as follows:

- Trained personnel as described in the earlier section entitled "Resources – Downstream Impacted Areas Section"
- Boats and related water equipment
- Rakes, shovels and other hand tools
- Booms and skimmers as appropriate
- Mechanical excavation equipment (as required)
- Absorbent pads and absorbent booms

7.0 Schedule

Various activities outlined in this work plan have been initiated and are being implemented. Subject to the complications created by weather or other forces outside of the control of the Company, the objectives outlined above will be completed by September 27, 2010. This work plan is being initiated and will be implemented in its entirety upon receiving EPA approval.

8.0 Response and Recovery

After SCAT Team Assessments are complete, and subsequent to mobilization to the site, the following preparatory activities will take place prior to the initiation of response methods:

- **Pre-removal Survey**: The removal contractor personnel will evaluate existing data from the area and familiarize themselves with current site conditions by conducting their own onsite survey of the site to acquire site-specific data.
- **Maintenance of Existing Boom and Skimmer Operations:** Areas to be rinsed will have an existing boom and skimmer system inspection to ensure that freed residual oil will be captured.

8.1 Stabilization and Re-vegetation

Interim restoration activities will occur along the shoreline and other non-aquatic areas of the Kalamazoo River. Restoration activities will include application of a vegetative cover designed to minimize erosion until long-term restoration can be completed. The vegetative cover will include native plant species and/or non-invasive temporary cover crops, such as rye, potentially applied as a hydro-mulch material. Long-term restoration will include, but not be limited to, consideration of the original controls of the site, use of the appropriate soil types, future erosion control, re-vegetation, etc. Long-term monitoring plans with performance criteria including: erosion control, establishment of vegetation, absence of invasive species, etc., will be included as part of the final site restoration plan. The Company recognizes that earth disturbance is subject to Michigan's Permit-by-Rule for construction stormwater; therefore, a detailed restoration plan will be prepared pursuant to Part 301.

8.2 Post Response Assessment

The effectiveness of the response methods will be assessed as the completion of areas progresses downstream. Areas still showing evidence of impacts will be re-assessed, and subsequent recommended response methods will be implemented by the Company. The effectiveness of the response method or methods implemented will be determined by the federal and state SCAT Team members. For those areas, if necessary, continuing to show signs of impact after recommended response methods have been implemented, further investigation, will include sampling and/or monitoring, will be conducted after appropriate site-specific sampling plans are developed by the Company and approved by the assigned MDNRE Project Manager in accordance with applicable MDNRE Part 201 guidelines.

In accordance with the decision tree outlined on Figures 2 and 3, the Company will avoid intrusive disturbance of the river banks unless absolutely necessary. The Company proposes intrusive disturbance of the river banks and beds, only if that SCAT Assessment and the response evaluation process indicate there will be an adverse affect that is more detrimental than intrusive remedial techniques. If additional remedial measures are necessary, such as excavation, appropriate mitigative measures will be employed.

8.3 Long-Term Remediation

Site restoration will be completed in accordance with the requirements of applicable permit requirements including a Joint Permit Application to the MDNRE and USACE for Part 303/301 and Part 31 activities will be sought for the proposed construction. (Application was submitted August 2, 2010.)

Clean-up of the oil spill will require wetland, stream, and floodplain permitting. Pursuant to Part 303 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), any project involving placing fill in a wetland, dredging or removing soil from a wetland, constructing, operating or maintaining use or development in a wetland, or draining surface water from a wetland requires a Part 303 permit from the MDNRE Land and Water Management Division. Part 301, Inland Lakes and Streams of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), involves any project concerning the natural resources and the public trust waters of Michigan's inland lakes and streams including activities related to dredging, filling, constructing or placing a structure on bottomlands, constructing or operating a marina, interfering with natural flow of water or connecting a ditch or canal to an inland lake or stream. The State of Michigan Floodplain Regulatory Authority, found in Part 31, Water Resources Protection, NREPA requires that a permit be obtained prior to any alteration or occupation of the 100-year floodplain of a river, stream or drain. The Floodplain Regulatory Authority deals with the floodplains of rivers, streams, or drains which have a drainage area that is two square miles or greater and requires a permit from the MDNRE for alterations within such floodplains.

A Joint Permit Application to the MDNRE and USACE for Part 303/301 and Part 31 activities will be sought for the proposed construction. In pursuing this permit we will demonstrate that they have taken all reasonable actions to avoid impacts to waters, minimize impacts that cannot be avoided, and provide compensatory mitigation for all remaining impacts. Restoration and proper seeding of impacted wetlands, streams, and floodplain will be conducted in accordance with these MDNRE regulations.

A wetland/stream/floodplain restoration plan will be implemented with the goal of restoring the wetland/stream/floodplain area to a condition as good as what previously existed, with a similar plant community and similar hydrologic regime, at the same finished grade as pre-existing conditions. Plantings will incorporate native plant species along with non-invasive temporary cover crops. Use straw mulch in level areas and mulch blankets for slopes will be used. The MDNRE may require monitoring of the restored wetland/steam/floodplain areas annually in the fall of each year for three years after the project is complete. For each monitoring visit, documentation will be taken of the establishing plant community, compared to seeding treatments, and an assessment of the results will be conducted. Any observed wildlife use of the area will be reported in addition to hydrology, and photos documentation of each area.

After river bank and sediment removal operations have been completed, the following river and bank restoration activities will be implemented in accordance with the approved wetland/stream/floodplain restoration plan in accordance with the Part 301/303 and Part 31 joint permit.

8.4 Post Response

If additional investigation/remedial action beyond those response methods recommended by the SCAT Team is warranted, any necessary site-specific action plan or work plan will be developed and submitted to U.S. EPA and MDNRE for review and approval.

If additional intrusive response is required, Company will work with the MDNRE and appropriate parties to determine location and frequency of soil and/or ground water samples to be collected and analyzed. The samples will be collected and analyzed according to the Sampling and Analysis Plan.

9.0 Contingency Planning

The current controls to limit downstream impacts consist of containment points located along the Kalamazoo River from Talmadge creek downstream to Morrow Lake. The containment points consist of deflection, collection and absorbent boom. The containment points are monitored daily for boom integrity, performance and absorbent saturation. Contingency operations at each containment point are initiated by the Operations Lead. Contingency resources are mobilized as needed and may consist of crew and or equipment to handle the contingency and inspect potential upstream source locations if warranted.

The Company will maintain a program of inspection and mitigation to control and capture any visible oil that threatens navigable waterways after the initial oil removal actions are complete. In addition to observations by the project team members involved in sampling and other surveys and the public, the initial inspections will comprise weekly trips by boat by a SCAT Team who will assess the conditions along the River. If river conditions preclude the use of a boat, the SCAT Team will complete assessments from river access points. The SCAT Team inspection frequency will be reduced by mutual agreement with the FOSC. Booms will remain in the River until agreed-upon endpoints have been reached and FOSC approval for their removal is obtained. It is considered that booms at primary control points will remain in place after the initial removal as a precautionary measure for as long as the weather permits in 2010. In the event visible oil re-emerges, booms and/or absorbents will be re-deployed and maintained as needed until the endpoint is again attained.

10.0 Plan Modifications

If the Company wishes to propose an action, revision or change that is not identified in this Plan, the Company will request approval of the action, revision or change from the FOSC. To initiate the process, a written request will be submitted by the Company to the FOSC outlining the proposed action, revision or change to be utilized and the benefits to be derived from its execution. FOSC will then approve or disapprove in writing or discuss potential alternatives.

References

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Shoreline Assessment Manual, Third Edition, Office of Response and Restoration, Hazardous Materials Response Division, National Ocean Service, National Oceanic and Atmospheric Administration, HAZMAT Report No. 2000-1, August 2000.

Tables

Table 1

Summary of Agency, Workplans, Permits and Approvals

U.S. EPA Work Plans

Work Plan	Dated	Status
Pipeline Repair	7/29/10	Approved
Oil Recovery and Containment	8/2/10; rev. 8/5/10	Approved
Health and Safety Plan	8/4/10	Approved
Waste Treatment, Transportation, and Disposal Supplement #1 – Frac Tank Secondary Containment Design Supplement #2 – Frac Tank Secondary Containment Plan	8/2/10; rev. 8/8/10 8/6/10 8/11/10	Approved Pending Pending
Quality Assurance Project Plan	8/2/10	Pending
Sampling and Analysis	8/2/10	Pending
Source Area Remediation	8/2/10	Pending
Downstream Remediation	8/2/10	Pending

Additional Permits/Approvals

Permit/Approval	Dated	Status
DNRE/USACE Joint Permit Application	8/2/10	Pending
Dewatering Discharge Work Plan (General Permit MIG080000)	8/4/10	Approved
Battle Creek POTW – Special Discharge Authorization	8/11/10	POTW - Approved EPA - Pending
Wetland Impacts – Temporary Alterations (General Permit)	NA	In progress

Figures

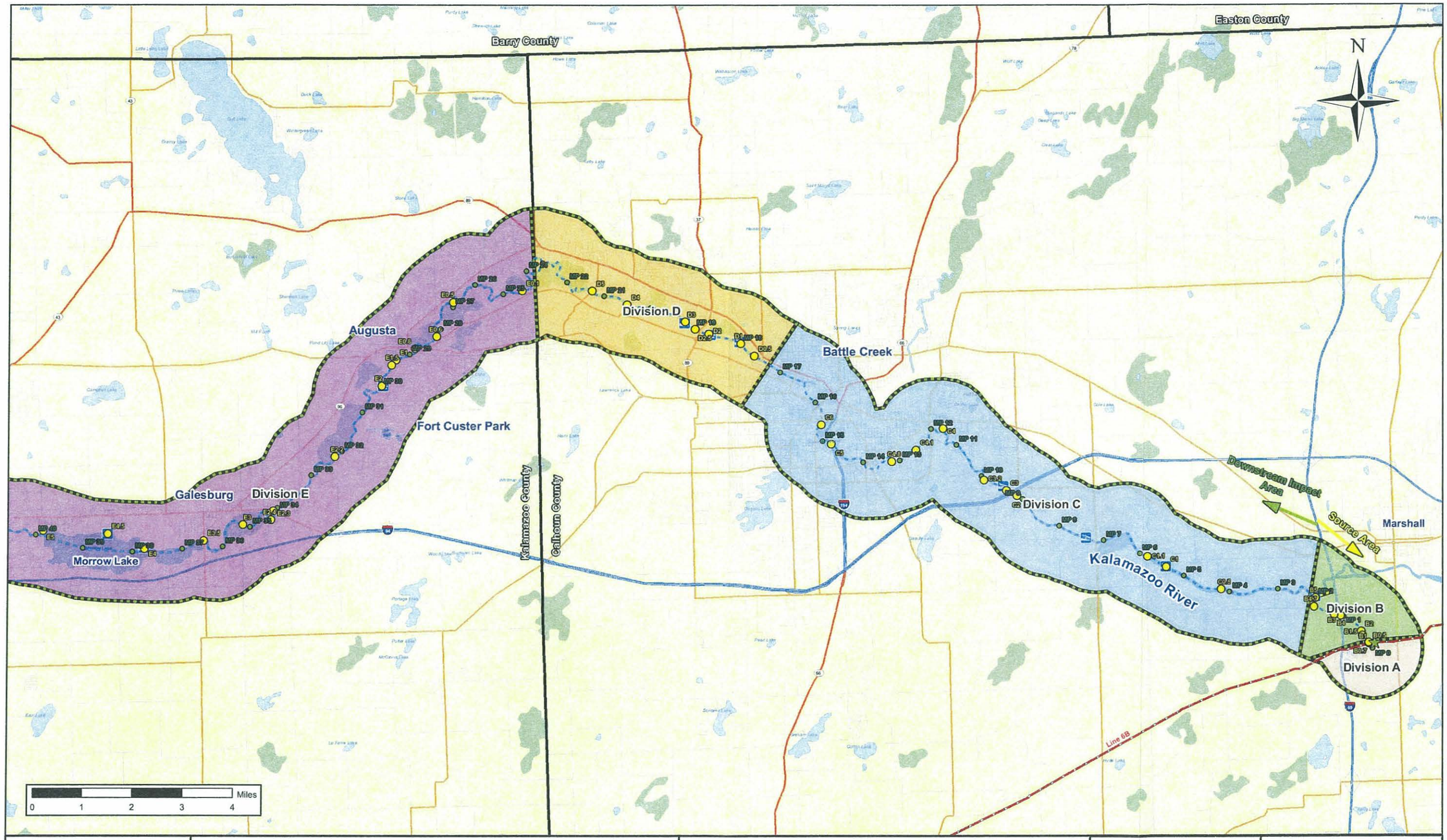
ENBRIDGE

0 50 100 150 200 Miles

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Downstream Impact Area Response Plan
Figure 1: Site Location

DATE ISSUED:	Aug 11, 2010
DATE REVISED:	
SCALE:	1:1,500,000
DRAWN BY:	NMS/JPM
SERIES:	1 of 7

Natural Resources Engineering Co.
715-395-5680



ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Containment Site
- Water Access
- Release Location
- Downstream Milepost

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Downstream Impact Area Response Plan
Figure 2: Division Designation Map

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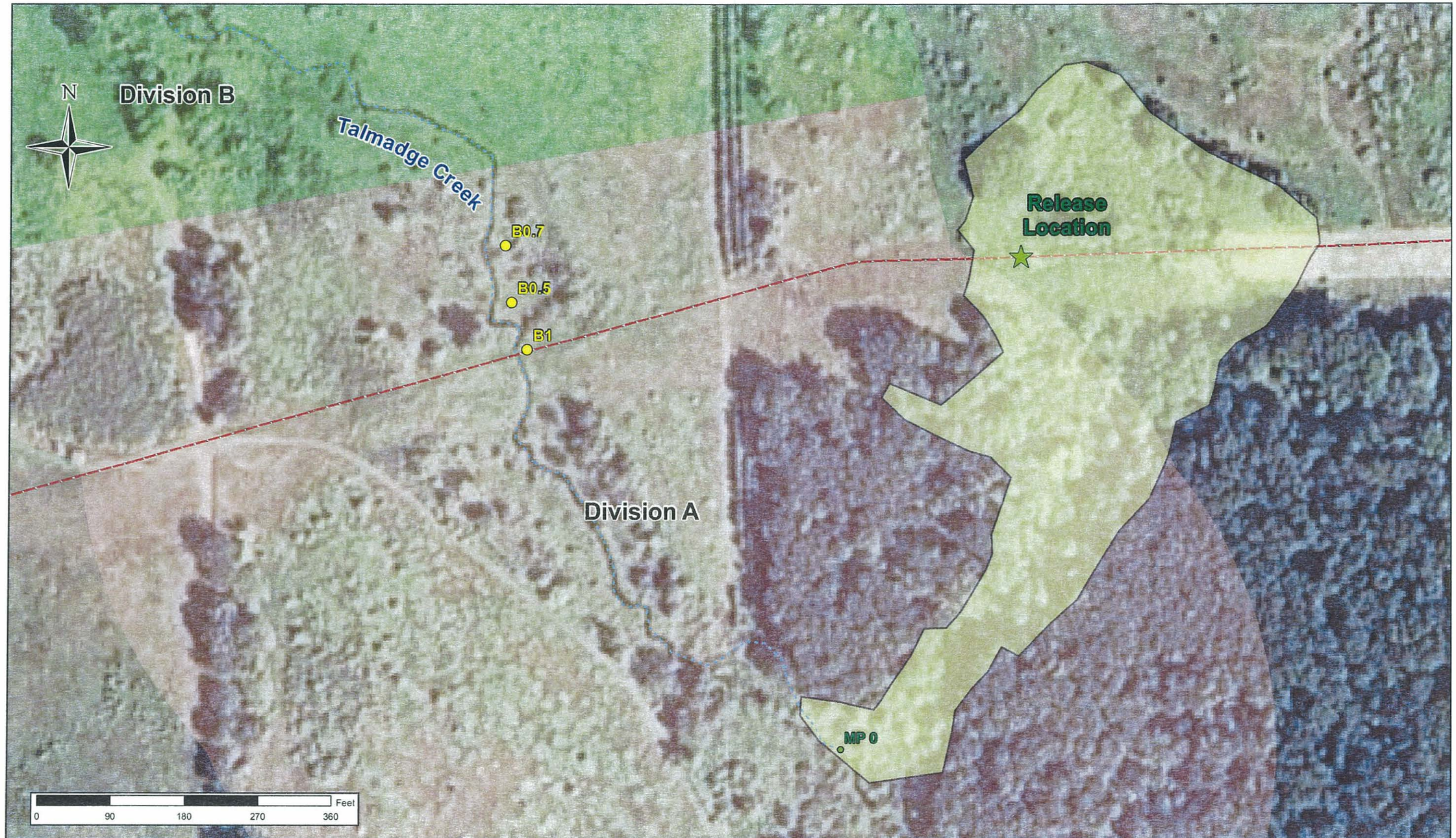

ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Release Location
- Containment Site
- Downstream Milepost
- Approximate Extent Of Oil

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Downstream Impact Area Response Plan
Figure 3: Source Area - Spill Release Area

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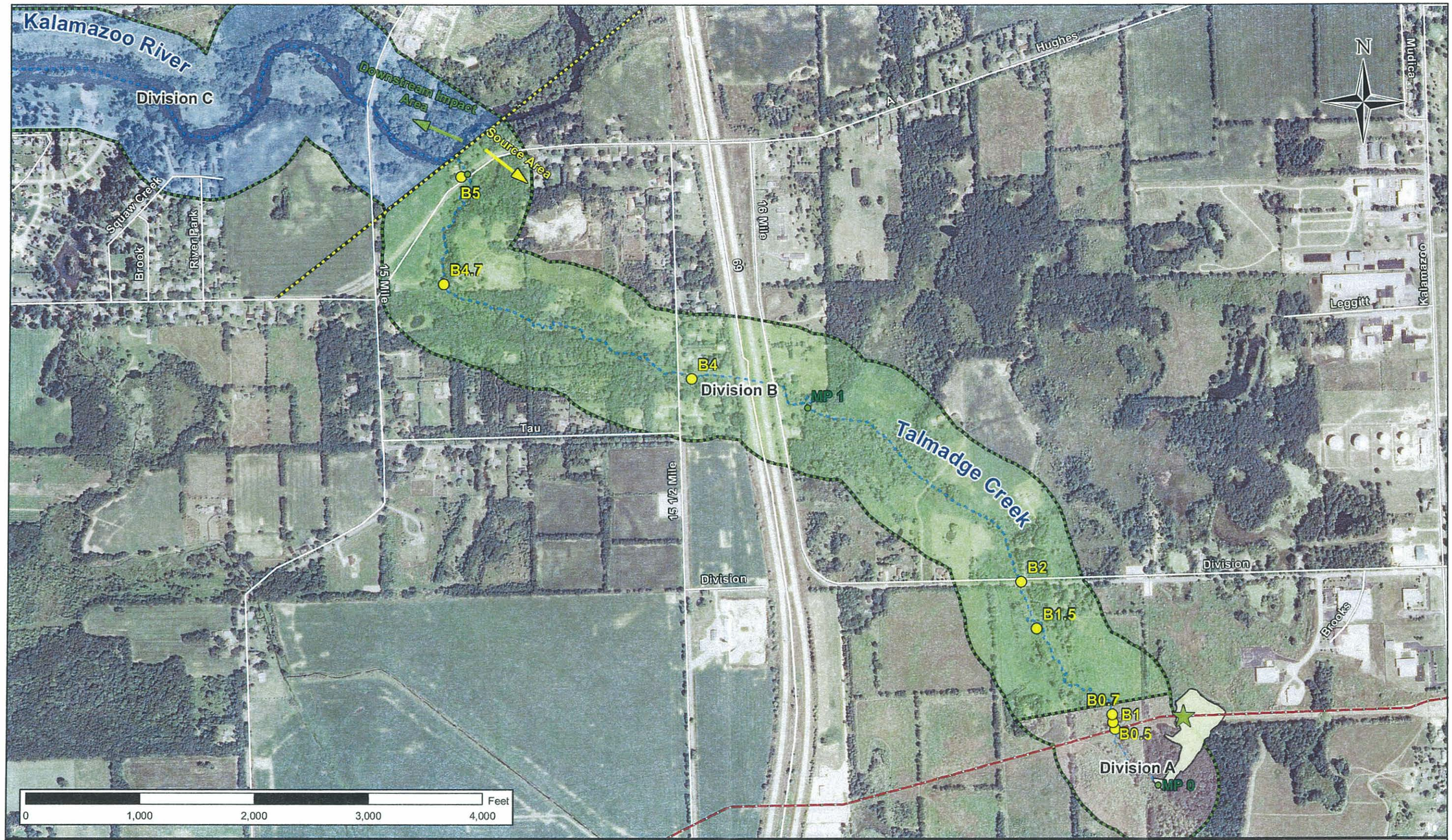

ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Source Area
- Release Location
- Downstream Milepost
- Approximate Extent Of Oil

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Downstream Impact Area Response Plan
Figure 4: Division B Map

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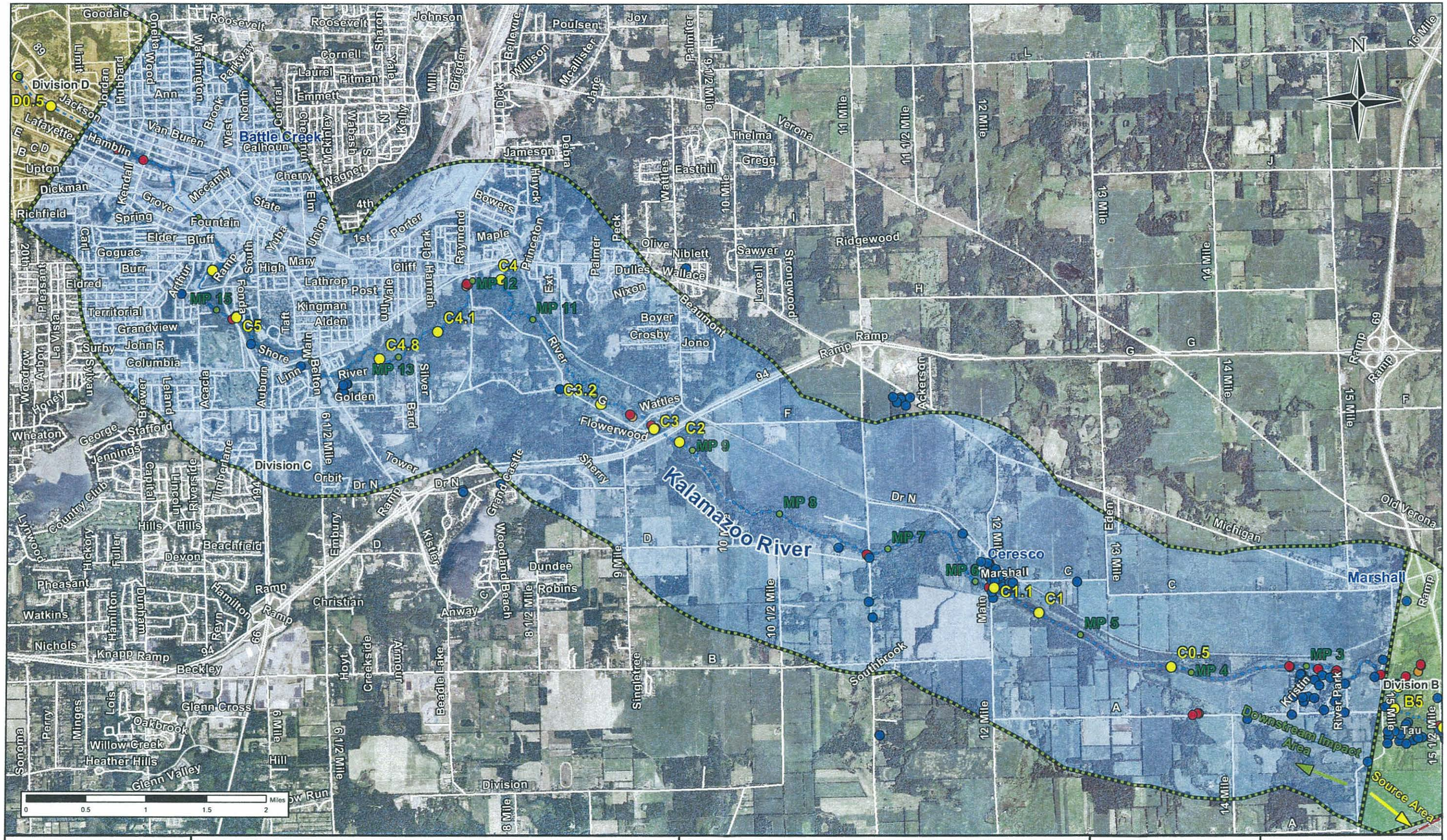

ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Downstream Milepost
- Containment Site (Boom)
- Surface Water Sample
- Potable Well
- Sediment Sample
- Soil Sample
- Water Access

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Downstream Impact Area Response Plan
Figure 5: Division C Map With Sample Locations

DATE ISSUED:	Aug 11, 2010
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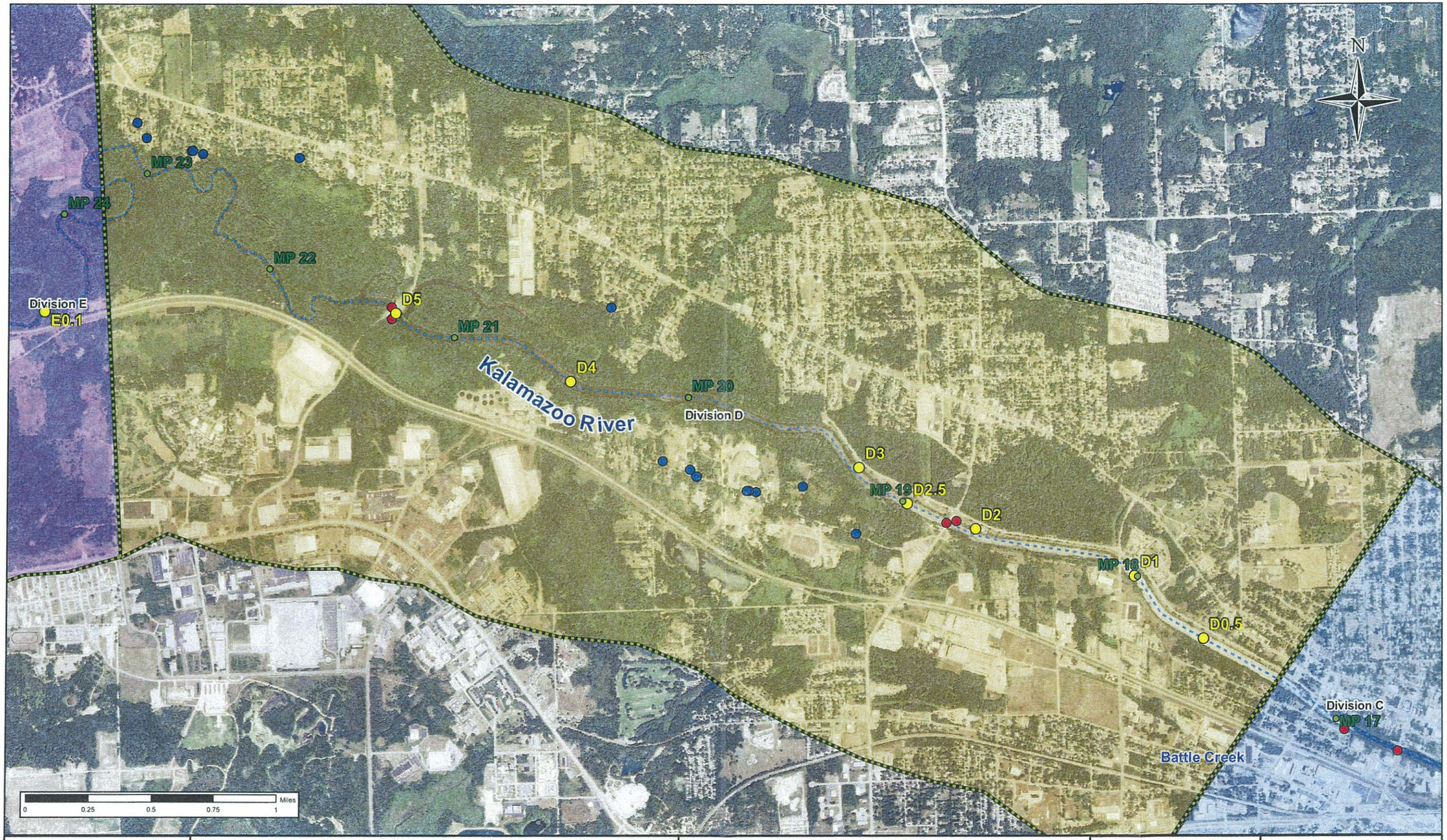

ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Downstream Milepost
- Containment Site (Boom)
- Surface Water Sample
- Potable Well
- Sediment Sample
- Soil Sample
- Water Access

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Downstream Impact Area Response Plan
Figure 6: Division D Map With Sample Locations

DATE ISSUED:	Aug 11, 2010
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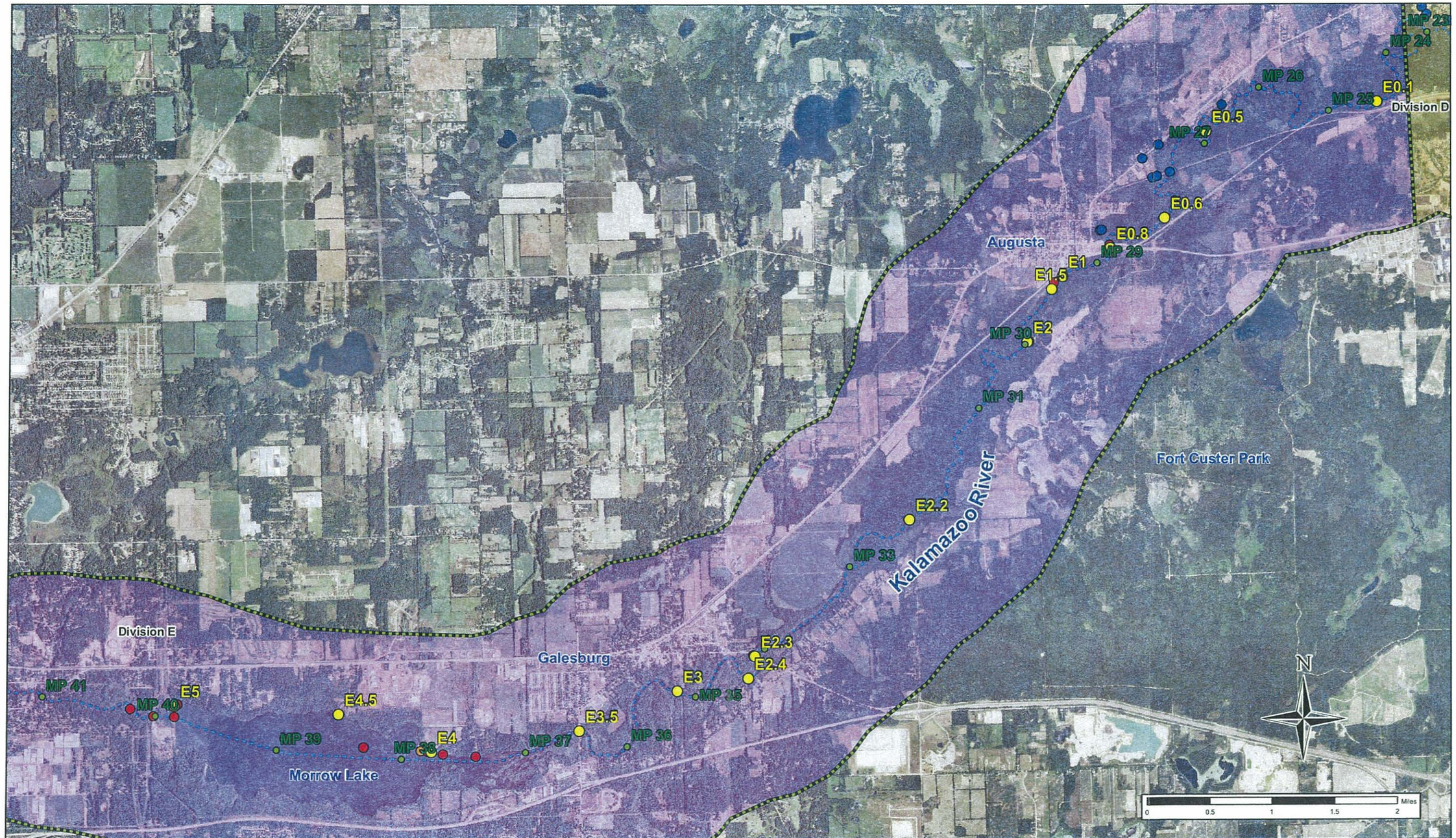

ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Downstream Milepost
- Containment Site (Boom)
- Surface Water Sample
- Potable Well
- Sediment Sample
- Soil Sample
- Water Access

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Downstream Impact Area Response Plan
Figure 7: Division E Map With Sample Locations

DATE ISSUED:	Aug 11, 2010
DATE REVISED:	
SCALE:	1:24,000
DRAWN BY:	NMS/JPM
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715-395-5680

Attachments

Attachment A

Acronyms and Definitions

Attachment A
Acronyms and Definitions

Company – Enbridge Energy, Limited Partnership

DNAPL – Dense Non-Aqueous Phase Liquid – A with a Specific Gravity > 1.0

DBH – Diameter at Breast Height – a forestry term for the measurement of trees

Low-Pressure Water Wash – Water cleaning by spray or flow that does not cause removal of live foliage or erosion of soils. Ambient water is sprayed at low pressures (<50 psi), usually from hand-held hoses to lift oil from the substrate and direct it to the water's edge for pickup.

Floodplain - The flat or nearly flat land along a river or stream or in a tidal area that is covered by water in a flood.

FOSC – Federal On-Scene Coordinator

IAP – Incident Action Plan – prepared by the Environment Unit and Planning Section daily and used to support preparation of the shoreline response plan to be implemented by Operations.

LNAPL – Light Non-Aqueous Phase Liquid – A with a Specific Gravity <1.0

MDA – Michigan Department of Agriculture

MDNRE – Michigan Department of Natural Resources and Environment

Minimal Scraping – Minimal scraping is defined as manual removal of the oil and immediate surface, but typically removal of less than 1" of surficial soil. No mechanized equipment will be used for minimal scraping.

NCRS – National Resources Conservation Service

NOAA – National Oceanographic and Atmospheric Administration

NRDA - Natural Resources Damage Assessment

NREPA – Natural Resources and Environmental Protection Act

Operations – Personnel, both Company employees and contractors, under the purview of the Company, that is engaged in the response activities.

Primary Oiled Area – The area with visible oil and/or sheen that is either currently affecting navigable waterways and/or poses a threat of release of a visible oil or sheen discharge to navigable waterways.

Priority Activity – A response activity performed in a priority area.

Priority Area – Area where observed impacts are high, that are in close proximity to a receptor, or could have future impacts to downstream areas.

Response Actions – Those actions undertaken in the short term by the Company to remove and/or abate visible oil and/or sheen that is either currently affecting navigable waterways and/or poses the threat of release of a visible oil or sheen discharge to navigable waterways.

RPDIA – Response Plan for Downstream Impacted Area

Remediation – Those interim response actions undertaken to remove visible oil and petroleum products from media affected by the spill and located downstream of the spill source area. Specifically, this includes response actions to remove and/or abate visible oil and or sheen that is currently affecting navigable waterways or poses the threat or release of a visible oil or sheen discharge to navigable waterways.

Riparian – Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant species relative to nearby uplands.

River – The Kalamazoo River

SAP – Sampling and Analysis Plan

SCAT - Shoreline Cleanup Assessment Technique also known as **SCAT Assessment or SCAT Process** – A systematic approach that uses standard terminology to collect data on impacted areas, support decision-making for cleanup; reference HAZMAT Report No. 2000-1; Office of Response and Restoration, Hazardous Materials Response Division, National Ocean Service, National Oceanic & Atmospheric Administration, Shoreline Assessment Manual – Third Edition, August 2000.

SCAT Team –A team of qualified individuals using SCAT, organized and reporting to the FOSC and comprised of representatives from U.S. EPA (as the FOSC), MDNRE (as the SOSC and state NRDA trustee), NOAA or USFWS (as federal NRDA trustees) and Company (both responsible party Operations and NRDA) to assess impacted areas and recommend cleanup methods and priorities. At least one member should have sufficient expertise in wetland and aquatic ecology to evaluate the sensitivity of impacted areas.

SOSC – State On-Scene Coordinator

Trustees – Government officials who act on behalf of the public when there is injury to, destruction of, loss of, or threat to natural resources as a result of a release of a hazardous substance or a discharge of oil. Trustees include the U.S. Departments of Commerce, Interior, Defense, Agriculture, and Energy; state agencies; and Native American tribes. NOAA is the lead federal trustee for coastal and marine resources. MDNRE is the lead trustee for the State of Michigan.

USACE - United States Army Corps of Engineers

U.S. EPA – Unites States Environmental Protection Agency

U.S. FWS – United States Fish and Wildlife Service

Attachment B

Shoreline Cleanup Assessment Technique (SCAT)Team

Attachment B

Shoreline Cleanup Assessment Team

Downstream Impacted Areas will be assessed by the Shoreline Cleanup Assessment Team ("SCAT Team") and then recommended, approved remedial responses will be implemented. Aerial photography and visual surveys will be conducted on a regular basis during the product recovery efforts to document impacted areas downstream of the Source Release Area.

The sequencing and scheduling of the recommended response methods, including bank and sediment removal processes, if necessary, will be determined after the SCAT Team Assessment and SCAT Team recommendations are completed. A summary of the SCAT Team Assessment for this spill is described below.

SCAT Team Assessment

SCAT Teams will access downstream impacted areas, including river banks, wetlands, flood plains, and marsh areas, and other areas as appropriate and make recommendations on clean-up methods to be used, including priorities. In addition to the methods and techniques identified in Tables 17, 23, and 25 in the "Inland Oil Spills, Options for Minimizing Environmental Impacts of Freshwater Spill Response" (June 1994), any available new technologies, best practices, and lessons learned from completed or on-going SCAT Team recommended response methods will be assessed for specific environments or habitats similar to those partially or completely remediated. It is anticipated that the following techniques in conjunction with response methods recommended by the SCAT Teams will be the main methods used: low pressure rinsing, vegetation removal, vegetation and soil removal, and sediment removal.

The objective of the SCAT Team Assessment is to conduct a detailed assessment of downstream areas and document downstream conditions to facilitate clean-up and identify response methods, and efficiently and effectively deploy clean-up crews, evaluate and document shoreline conditions and provide clean-up recommendations and priorities to Operations. The SCAT Team Assessment will provide guidance to Operations to complete recommended response methods in an expedited manner to minimize the time oil remains present on the land and water.

The primary objective of the SCAT Process is to provide operational support. The SCAT Process is a systematic approach that uses standard terminology to collect data on Downstream Impacted Areas and support decision-making for Downstream Impacted Area response activities. SCAT Team surveys are also used for:

- Development of treatment or response activities recommendations;

- Development of treatment or endpoint criteria;
- Net environmental benefit analysis;
- Post-treatment inspection and evaluation;
- Provision of long-term monitoring; and,
- Natural Resource Damage Assessment.

The SCAT Teams will provide information in accordance with recognized shoreline assessment forms for the bank and in-river areas, wetlands, floodplain areas, and marshes. Information will include, if applicable, but may not be limited to: development of response methods and endpoint criteria. Data collected by SCAT Team will be used to develop downstream impacted area cleanup plans intended to maximize the recovery of impacted habitats and resources, while minimizing the risk of injury from response efforts. Consideration will always be given to:

- Extent and duration of environmental impacts if the oil is not removed;
- Natural removal rates;
- Potential for remobilized oil to affect other sensitive resources; and
- Likelihood of response activities to cause greater harm than the oil alone.

As part of the process SCAT Teams shall consider state and federal threatened and endangered species during oil removal response actions, as well as species and habitats of special concern or management interest by MDNRE or the U.S. Fish and Wildlife Service. SCAT Teams shall be alert to new occurrences of species and habitats of special concern and shall immediately notify the U.S. Fish and Wildlife Service upon discovery. U.S. FWS has sensitive environment GIS data available for use to assist in the effort.

The SCAT Team assessment segments are expected to align with the existing boom deployment segments currently used by Operations (Figures 3, 4, 5, 6, and 7). The area to be assessed extends from the Source Release Area (Figure 3) to the entry of the Kalamazoo River into Morrow Lake (Figure 7). The SCAT Team Assessment segments are expected to be aligned with the existing segments as follows:

Existing Segments	Segment Length in Miles (Shoreline)
Division A – MP- 0	N/A
Division B – MP 0.0 -1.8	1.8 (3.6)
Division C – MP 1.8 – 16.6	14.8 (29.6)
Division D – MP 16.6 – 22.5	5.9 (11.8)
Division E – MP 22.5 – 38.5	16 (32)

Further assessments may be required

Based-on the SCAT Team Assessments, along with the recovery phase aerial photo documentation and visual inspections, those areas showing where free oil or sheen is evident will be prioritized based on location and volume, and then addressed. The SCAT Team will recommend priority and determine appropriateness of disturbance impact as a result of recommended response methods.

Phased Approach:

SCAT Team Assessment of Downstream Impacted Areas will be conducted to document extent of impact and determine appropriate response activity and will follow a phased approach. Phase 1 will target assessment of potentially impacted areas that are accessible by boat. Phase 2 will target assessment of those areas such as floodplains where impacts cannot be fully delineated and characterized through boat-based surveys alone.

The geographic extent of Phase 1 surveys will include the river banks and associated emergent marshes and other wetlands along the Kalamazoo River from the confluence of Tallmadge Creek downstream to the head of Lake Morrow. If necessary, the extent of Phase 1 SCAT Team surveys will be extended downstream until the maximum extent of shoreline impact has been delineated. Specific methodology for conducting Phase 1 is detailed below.

During the conduct of Phase 1 surveys, floodplains, forested wetlands and other habitats for which the inland extent of oiling cannot be completely ascertained from water-based surveys will be identified for follow-up surveys conducted in Phase 2. Specific methods for Phase 2 floodplain response activities assessment surveys are currently under development; however, it is anticipated that Phase 2 surveys will be performed on foot.

Team Composition:

A SCAT Team Coordinator will be designated to manage SCAT Teams and coordinate synthesis of field data and information flow for use by the Environmental Unit and Planning Section to support the daily Incident Action Plan (IAP). The information and response recommendations generated will be used by the Planning Section to develop one or more shoreline cleanup plans, which in turn will be implemented by the Operations Section.

Each shoreline assessment team will be comprised of representatives from U.S. EPA (as the FOSC), MDNRE (as the SOSC & state NRDA trustee), NOAA or USFWS (as federal NRDA trustees) and Company (both responsible party Operations and NRDA). Every effort will be made to keep the composition of each team consistent to insure continuity in descriptions of the extent and degree of impacts and reporting.

The Company will be using ENTRIX, Inc. personnel as the company's representatives on SCAT Teams. Qualifications of these individuals regarding wetland and aquatic expertise will be provided to the U.S. EPA.

Number of Teams:

SCAT Team Assessments will initially be performed by two teams working opposite sides of the river. Each team will contain the representatives identified above. Due to the size of watercraft dictated by river conditions, it is anticipated that each team will require two flat-bottom boats in the 12- to 16-foot range. Phase 1 SCAT Team Assessments will progress from upstream to downstream.

Personnel Resources:

Each primary group (Company, U.S. EPA, MDNRE, NOAA and USFWS) will designate a SCAT leader who will acquire and coordinate the necessary staff resources from their agency/group. In addition, the SCAT leaders will meet daily with the SCAT Coordinator to identify the next day's SCAT Team plan.

Schedule:

Phase 1 SCAT Team surveys began on Sunday, August 1, 2010. An informal training and calibration session will be conducted in the field prior to beginning actual surveys. It is presently anticipated that Phase 1 SCAT Team surveys will require 2-3 days for completion. Phase 2 surveys will be initiated upon completion of Phase 1 and approval of a floodplain assessment plan.

Methodology:

Phase 1 SCAT Team surveys will be performed by boat. Each river bank will be assigned to one team. As the shoreline is viewed from the boat, visual observations related to oiling will be recorded on the shoreline assessment form as the teams work downstream. The forms are designed to record oiling information by zone. For purposes of this assessment, a zone is defined by a visual change in the degree or extent of oiling or habitat type, or the presence of a side channel or island (see below). This approach will result in the delineation of unique combinations of habitat type and oiling characteristics. Primary and secondary habitat types will be noted on the assessment form (using "P" or "S", accordingly). Information collected on degree of oiling will apply to the entire primary habitat area. Waypoints will be recorded at the beginning and end of each zone, and a track log will

be continuously recorded. Horizontal distance of oiling measured perpendicular to the shoreline will be recorded. If the horizontal distance of oiling from the shoreline is greater than can be visually ascertained, the zone will be flagged for further investigation during Phase 2.

Islands and side channels will be treated as a separate zone. As such, waypoints will be recorded at the beginning and end of a side channel, prior to and after circumnavigating an island, or at a change in habitat type or degree of oiling.

In order to estimate the extent and degree of shoreline oiling the following informational components will be collected:

Areal extent of oiling. The aerial extent of shoreline will be estimated based on the polygon defined by shoreline length of the zone (calculated from the shoreline length between the zone waypoints collected in the field) and the field estimate of the distance (width) of horizontal oiling perpendicular to the shoreline.

Degree of oiling – Degree of oiling will be determined by:

- visually estimating the percentage of the areal extent of shoreline that is covered with oil and the thickness of that oil (film, stain, coat, or cover), and
- visually estimating the height of oiling on vegetation and the percentage of the area below maximum height that is oiled.

In addition to this information on shoreline oiling, information will be collected on oil or sheens observed on water, including the percentage of area covered within a zone and a characterization of the oil or sheen (biological sheen, silver, rainbow, brown, black, tarballs).

Equipment:

Each team will be equipped with the following:

- Two flat-bottom jon boats (12- to 16-foot range) with outboard motors and operators
- Personal protective equipment, including personal flotation devices.
- SCAT Assessment forms and ink writing utensil
- GPS unit
- Digital camera with date and time stamp for photo documentation
- Opportunistic sampling equipment
    - Wooden pole or stick
    - Biota sampling jar or aluminum foil and plastic Ziploc bags
    - Powder-free nitrile gloves

- Cooler with wet or blue ice
- Paper towels
- Trash bag
- Teflon tape
- Permanent marker

Impacted Area Preparation

Those downstream mpacted areas found to be adversely impacted may require a single method or a combination of techniques and methods, as recommended by the SCAT Team, including but not limited to, those identified in Tables 17, 22, 23, and/or 25 of the "Inland Oil Spills, Options for Minimizing Environmental Impacts of Freshwater Spill Response" (June 1994). SCAT Team recommendations may include:

Response Method – Heavy Oils	Small Rivers & Streams	Gravel Habitats	Wetland Habitats
Booming – Deflection/Exclusion	A	NA	
Skimming	A	NA	
Booming – Containment	A	NA	
Vacuum	A	B	
Sorbents	A	B	A
Barriers/Berms	A	NA	NA
Physical Herding	B	NA	NA
Natural Recovery	C	B	B
Debris Removal	B	A	B
Vegetation Removal *	B	NA	C
In-Situ Thermal Treatment **	B	B	B
Manual Oil Removal/Cleaning	B	A	C
Mechanical Oil Removal	C	C	D
Low-Pressure, Cold Water Flushing		B	B

A = May cause the least adverse habitat impact.

B = May cause some adverse habitat impact.

C = May cause significant habitat impact.

* Any vegetation removed will be managed as required by the approved Waste Treatment, Transportation, and Disposal Plan.

** In-Situ Thermal Treatment is not intended to result in the burning or incineration of soils.

[Table modified from Table 17. "Relative environmental impact from response methods for SMALL RIVER and STREAM environments."]

At this time no other response methods beyond those provided in the above table are anticipated, for example, the use of dispersants and other chemical agents.

Other resources will be consulted through the SCAT Process to best determine response and clean-up strategies, for example, on options to treat wetland soils and vegetation. This will include the document: NRCS Interim Conservation Practice Standard 772 Guidance "Organic Sorbents for the Remediation of Oil-Contaminated Soils".

In addition to the methods and techniques identified in the table, any available new technologies, best practices, and lessons learned from completed or on-going SCAT Team recommended response methods will be assessed for specific environments or habitats similar to those partially or completely cleaned-up.

The sequencing and scheduling of the bank and sediment removal process will be driven by decisions made in the field based-on information to be available after SCAT Team Assessment and SCAT Team recommendations, and existing site conditions as they are identified during the SCAT Team assessment described in this work plan.

Attachment C

Phase I Shoreline Cleanup Methods

Attachment C

Phase I Shoreline Cleanup Methods

Kalamazoo River/The Company Spill

Phase I Shoreline Cleanup Methods

Date: August 10, 2010 (May be revised/updated, and new date provided)

The Company Contact: Joe McGaver (218-390-9254)

NOTE: This does not represent final clean up

Habitat Type or feature	**Cleanup Recommendation:** **Do not touch un-oiled vegetation**	**Phase 1 Cleanup Objective**
Low hanging limbs extending over and into the water	• Cut and bag branches 2" above oiling level	No oil observed on branches hanging over or into the water
Vegetated Bank	• Remove oiled vegetation leaving roots intact up to 50' from waterline; • Do not remove woody plants great than 2" diameter (as measured one foot above ground surface)	**Primary oil removal;**
Grasses, reeds, cattails, wetlands	• Remove oiled vegetation leaving roots intact up to 50 feet from waterline; • On soft surfaces, use pallets/plywood or other methods to distribute weight and minimize number of walk ways to reach oiled vegetation away from the river's edge; • **Do not tear out roots** • Area should be boomed during removal process • Use snares/pompoms for small pockets; • Low pressure/high volume rinse to direct oil to boom for collection	**Primary oil removal;** • If free oil extends beyond 50' from waterline contact SCAT Team for guidance. Do not enter. • SCAT Team will visit following removal to assess next steps

Habitat Type or feature	Cleanup Recommendation: Do not touch un-oiled vegetation	Phase 1 Cleanup Objective
Oiled debris	• Mobilize oil and capture w. boom or sorbent material before and during moving debris; • Manual removal of oiled debris • For large woody debris remove all visibly oiled material	**Primary oil removal** • Un-oiled large woody debris will remain undisturbed
Oiled Manmade Structures	• Manual removal using scraping or wiping with sorbents, • High pressure cold water wash	**Primary oil removal**
Aquatic vegetation holding floating oil [water lilies, grasses, etc.]	• Boom prior to cutting • Cut vegetation below water's surface, leaving roots; • Use snares to collect released oil; • Bag vegetation	**Primary oil removal**
Oiled mixed sand and gravel	• Boom prior to cutting • Low pressure/high volume flushing	**Primary oil removal**

Definitions:

Primary oil removal: removal of pooled oil and major sources of sheening

Phase 2: Additional cleaning to remove sources of sheen

Attachment D

U.S. EPA Comment Response Verification
(per U.S. EPA August 15, 2010 letter)

Attachment D

U.S. EPA Comment Response Verification
Enbridge Line 6 MP608
RPDIA
Marshall, Michigan
(per U.S EPA August 15, 2010 letter)

RPDIA Plan-Specific Comments

1. Section 8.3 has been modified to include that planting will incorporate native plant species along with non-invasive temporary cover crops.
2. Section 6.1.2 was revised to add "when necessary to access or cross areas of soft substrates, plywood sheets or other appropriate methods will be used to avoid compressing soils".
3. Section 3.1.1 was renamed from "Marshes" to "Riparian Zones and Stream Banks", as requested.
4. Section 6.0 has been revised to state that a quantitative monitoring plan will be submitted to the FOSC for approval prior to execution of such a plan.
5. Section 6.1.2 was revised to state that backfill of excavated areas will be with clean, weed-free top soil immediately following excavation around tree roots in the riparian zone.
6. Section 6.1.4 has been revised to state that trees larger than 2 inches diameter DBH will be preserved.
7. Section 6.1.6 has been amended to include the collection, cleaning, rehabilitation and release of live oiled animals.
8. The word "within" was removed from the first sentence of Section 8.1 as requested.
9. The definition of NREPA has been corrected in Attachment A as requested.
10. The reference to Table 22 in the third paragraph of Attachment B, page B-6, has been corrected to reference Table 23.
11. References to the Unified Command (UC) and/or Incident Commander (IC) in the RPDIA have been changed to reference FOSC.

Enbridge Line 6B MP 608 Pipeline Release

Marshall, Michigan

Source Area Response Plan

August 2, 2010

(Revised August 17, 2010 per U.S. EPA August 17, 2010 letter)

Enbridge Line 6B MP 608 Pipeline Release
Marshall, Michigan
Source Area Response Plan

August 2, 2010
(Revised August 17, 2010 per U.S. EPA August 17, 2010 letter)

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Attachment A	U.S. EPA Comment Response Verification (as requested per U.S. EPA August 15, 2010 letter to Enbridge Energy, Limited Partnership)
Attachment B	Cleanup Plan for Talmadge Creek (Division B), August 6, 2010
Attachment C	Joint Permit Application to MDNRE and USACE for Part 303/301 and Part 31
Attachment D	Preliminary Threatened and Endangered Species Survey

List of Acronyms/Definitions

Calhoun County Drain Commissioner (CCDC)

Company – Enbridge Energy, Limited Partnership

RPDIA – Response Plan for Downstream Impacted Area

DNAPL – Dense Non-Aqueous Phase Liquid – A liquid with a Specific Gravity > 1.0

Drain –The word "drain" shall include the main stream or trunk and all tributaries or branches of any creek or river, any watercourse or ditch, either open or closed, any covered drain, any sanitary or any combined sanitary and storm sewer or storm sewer or conduit composed of tile, brick, concrete, or other material, any structures or mechanical devices, that will properly purify the flow of such drains, any pumping equipment necessary to assist or relieve the flow of such drains and any levee, dike, barrier, or a combination of any or all of the same constructed, or proposed to be constructed, for the purpose of drainage or for the purification of the flow of such drains, but shall not include any dam and flowage rights used in connection therewith which is used for the generation of power by a public utility subject to regulation by the public service commission.

FOSC – Federal On-Scene Coordinator

LNAPL – Light Non-Aqueous Phase Liquid – A liquid with a Specific Gravity < 1.0

MDNRE – Michigan Department of Natural Resources and Environment

NREPA – Natural Resources and Environmental Protection Act

Oil Saturated Soil – Soils containing free-phase product capable of flowing or migrating as an oil and/or a sheen, either of which is affecting or threatens to affect navigable waterways.

Remediation – Future long term corrective actions beyond those included as an initial response

Residual Impacts – Soils exhibiting oil staining, petroleum odor, and/or organic headspace, none of which are affecting or threaten to affect navigable waterways.

Response – The initial response to remove oil affected-media and/or sheen affecting and/or posing a risk to navigable water bodies

SAP – Sampling and Analysis Plan

SCAT – Shoreline Cleanup Assessment Technique also known as **SCAT Assessment or SCAT Process** – A systematic approach that uses standard terminology to collect data on impacted areas, support decision-making for cleanup; reference HAZMAT Report No. 2000-1; Office of Response and Restoration, Hazardous Materials Response Division, National Ocean Service, National Oceanic & Atmospheric Administration, Shoreline Assessment Manual – Third Edition, August 2000.

SCAT Team - A team of qualified individuals using SCAT, organized and reporting to the FOSC and comprised of representatives from U.S. EPA as the (FOSC), MDNRE (as the SOSC and state

NRDA trustee), NOAA or U.S. FWS (as federal NRDA trustees) and Company to assess impacted areas and recommend cleanup methods and priorities. At least one member should have sufficient expertise in wetland and aquatic ecology to evaluate the sensitivity of impacted areas.

Source Area - The primary locations impacted by the crude oil release, includes Division A (i.e. the wetland area impacted by the release due to overland flow of oil) referred to herein as the Spill Release Area and, Division B (i.e., the portion of Talmadge Creek impacted by the oil spill) referred to herein as the Creek

SAR – Source Area Response Plan - A workplan describing interim response actions designed to protect navigable waters from the crude oil release

Spill Release Area (Division A) – Area of primary spill release into wetland

Talmadge Creek (Division B) – Initial navigable water body impacted by release

USACE - United States Army Corps of Engineers

U.S. EPA – Unites States Environmental Protection Agency

USFWS – United States Fish and Wildlife Service

1.0 Introduction

1.1 Overview

The purpose of this Source Area Response Plan (SAR Plan) is to present initial response actions that will be taken to address the Source Area for the Enbridge Energy, Limited Partnership (Company), Marshall, Michigan, Line 6B M.P. 608 as a result of the crude oil release. The Plan is prepared in response to the United States Environmental Protection Agency (U.S. EPA) Administrative Removal Order (ARO) dated July 27, 2010.

1.2 Site History

On July 26, 2010, a release of heavy crude from the Company's 30-inch pipeline (referred to as "Line 6B") was discovered. The Company's pipeline release site is located just west of pipeline mile post 608 in Marshall, Calhoun County, Michigan, (North ½ Section 2, T3S, R6W, Latitude: 42.2395273 Longitude: -84.9662018) in an undeveloped area, south of town. Figure 1 shows the location of the site. The release entered Talmadge Creek and then the Kalamazoo River. These waterways are considered to be navigable waters. Currently, approximately 30 miles of the Kalamazoo River may have been impacted. To date the impacted areas are described as:

- Division A – the Spill Release Area to the constructed Flume where the release entered Talmadge Creek;
- Division B – Talmadge Creek from the Flume site to the confluence with the Kalamazoo River;
- Division C – The confluence of the Talmadge Creek and the Kalamazoo River to the Angell Street Bridge;
- Division D – The Angell Street Bridge to Kalamazoo County line; and
- Division E – Kalamazoo County Line to Morrow Lake Dam.

Figure 2 shows the site division designations A through E. This SAR Plan addresses Division A, referred to as the Spill Release Area, and Division B, referred to as the Creek.

Following the release, the U.S. EPA, issued a Removal Administrative Order (RAO) signed July 27, 2010. The RAO established actions and timeframes for responding to the release.

In conjunction with the SAR plan, the following Work Plans were requested by the RAO and are submitted as separate documents:

- Health and Safety Plan (HSP);
- Pipeline Repair Work Plan (PRWP);
- Sampling and Analysis Plan (SAP);
- Quality Assurance Project Plan (QAPP);
- Oil Recovery and Containment Plan (ORCP);
- Response Plan for Downstream Impacted Area (RPDIA) Plan; and,
- Waste Treatment, Transportation, and Disposal Plan (WTTDP).

Draft Work Plans requested in the RAO were submitted to the U.S. EPA on July 29, 2010. Comments on draft work plans were received on July 31, 2010 and are incorporated into this revision. Additional comments on this SAR Plan were received on August 10, 2010 and are addressed in this submittal. Attachment A provides a numerical tracking of the responses to the specific comments provided by the U.S. EPA in their August 10, 2010 letter.

1.3 Site Description and Location

The Source Area is comprised of an approximate 5-acre parcel adjacent to the pipeline release location (Spill Release Area) and the portion of the Talmadge creek extending from the release site to the confluence with the Kalamazoo river (the Creek) (Figures 3 and 4). The majority of the Spill Release Area is within a wetland between the release site and Talmadge Creek. Most of the surrounding area can be characterized as rural, including undeveloped and agricultural areas. Vegetation in the source area consists of herbaceous emergent wetland plants in low lying areas, as well as brush and trees in upland areas.

1.4 General Site Geology/Hydrogeology and Baseline Conditions

The surficial deposits in the area of the release site consist of glacial outwash sand and gravel and post-glacial alluvium with occasional thin clay lenses overlain by surficial peat material. The glacial deposits are generally underlain by the Mississippian Marshall Sandstone and Coldwater Shale in Calhoun County and Coldwater Shale in Kalamazoo County. The bedrock surface mapped as 50 feet

below ground surface (bgs) in much of Calhoun County and up to 200 feet in Kalamazoo County based on the State of Michigan Department of Conservation, Geological Survey Division, Drift Thickness Map, 1938. Baseline conditions within the source area will be established and will include fluvial geomorphology, baseline topographic conditions and fluid flow channel physical dimensions/survey and ecological habitats. A wetland delineation establishing jurisdictional boundaries and the type and distribution of wetland communities will also be performed within the Source Area.

It is our understanding that the Talmadge Creek is a legally established "drain"; therefore, the Company will contact and consult with the Calhoun County Drain Commissioner (CCDC) concerning work on the Creek, including interim and long-term restoration of the drain, and hydraulic capacity and drainage function.

1.5 Source Area Actions to Date

As of the date of this report, the following key remedial actions have occurred:

- **Security:** Access to the Source Area is restricted by fencing and twenty-four hour security. Access to surface water is being limited by security control measures at crossings, signs, and fencing at creek access points. These measures address unauthorized access to the source areas.

- **Temporary Access Road:** An access road, primarily timber mats, was constructed to the site from Division Drive. Safety turn-around areas were created and grading of the site has been completed to allow for heavy equipment traffic related to response activities and pipeline repair. Timber mat access roads are also being constructed adjacent to Talmadge Creek.

- **Site Clearing and Grubbing:** Clearing and grubbing of site trees and vegetation has been performed as necessary to allow construction of access roads and removal of soils impacted by the overland flow of oil. The trees and brush will be chipped and the material mixed with excavated soil for offsite disposal.

- **Shallow Soil Excavation:** Shallow soil in the Spill Release Area (primarily peat) impacted by the overland flow of crude oil is being excavated and staged for offsite disposal. The objective associated with shallow soil excavation is to prevent further migration of oil to surface water. Spill Release Area excavation activities involve the use of a long reach

backhoe staged on the access road to remove the top 6-inches to 1-foot of impacted soil/peat material. The material is direct loaded into off-road trucks and transported to the staging area where it is allowed to dewater prior to disposal. Creek area excavation (i.e., along the banks of the Talmadge Creek) involve removal of primarily oil impacted vegetation and shallow soil/root zone material as described in the Shoreline Cleanup Assessment Team (SCAT) Plan for Talmadge Creek (Attachment B). At the time this document was prepared, approximately 80 percent of the Spill Release Area excavation has been completed and 25 percent of Creek area has been mechanically cleaned.

- **Staging Area Construction:** An approximate 2.3 acre staging area was constructed at the boundary of the exclusion zone to the north of the Spill Release Area. The staging area was constructed using Class 5 gravel to allow heavy equipment access and minimize erosion. Silt fencing and other stormwater control measures were implemented as needed. Material from the Spill Release Area and the Creek is currently being transported to the main staging area using off-road trucks.

- **Berms:** Three temporary soil berms have been constructed to remove the migration pathway for crude oil from the Spill Release Area to Talmadge Creek. The basic design of the temporary soil berms is an elongated earthen mound used to prevent the flow of water and oil. Clean on-site soils and clean granular soils were used to construct the berms. The length and height of the berms correspond with the volume of flow and drainage area required to be controlled in the Spill Release Area. All berm heights are less than five feet from the toe of the berm to the upstream bottom elevation. This berm height will ensure that the berms are not considered "dams" under Part 315 Dam Safety, of the Natural Resources and Environment Protection Act (NREPA), 1994 PA 451, as amended. As of July 30, 2010, flow of crude oil to Talmadge Creek from the Spill Release Area has not been observed.

- **Flumes:** Numerous flumes (i.e. underflow weirs) were constructed downgradient of the Spill Release Area to minimize further migration of crude oil. The basic design of a flume is a pipe, or series of pipes, that extend through a temporary flow control structure such as a berm or dam. For a crude oil release to surface water, the pipe intakes are submerged on the upstream side of the berm to allow oil-free water to flow through the pipe. This prevents the crude oil floating on top of the water from migrating further downstream. Crude oil pools on the upstream side of the berm or dam and is captured and containerized using sorbent booms, pads and vacuum trucks.

- **Oil and Water Containment and Recovery:** Oil containment and recovery operations using flumes, berms and vacuum trucks is operating in the Source Area.

- **Initial Receptor Survey:** An initial receptor survey was implemented and will be updated during post response activities to effectively identify potential migration pathways and potential receptors within the Source Area. The receptor survey is conducted to identify the presence and location of surface waters, water wells and surface water intakes which could be impacted by the crude oil release.

- **Federal and State Approvals:** Company has coordinated efforts with all Federal and State level environmental stakeholders identified at the site including:

    - U.S. EPA, U.S. Fish and Wildlife Service (USFWS)
    - Michigan Department of Natural Resources and Environment (MDNRE)
    - U.S. Coast Guard
    - Michigan Department of Agriculture (MDA)
    - Michigan Department of Community Health (MDCH)
    - Calhoun County Public Health Department (CCPHD)
    - Kalamazoo County Health and Community Services Department (KCHCSD)

A Joint Permit Application to MDNRE and USACE for Part 303/301 and Part 31 has been submitted for activities within the Source Area (Attachment C).

1.6 Interim Response Scope of Work

This SAR Plan addresses the ARO requirements for the Site. The response objectives under the SAR Plan will consist of: 1) removal of free phase crude oil and heavily impacted crude oil media (oil saturated soil and vegetation) from the overall Source Area; and 2) removal and/or abate visible oil and/or sheen that is currently affecting navigable water ways and/or poses a threat of a visible oil or sheen discharge to navigable waterways. Heavily impacted soil will be excavated and staged prior to transport for off-site disposal. Free phase oil and oil/water mixtures will be recovered for beneficial re-use. The remaining contaminated water will be containerized for proper offsite disposal of in accordance with applicable rules and regulations.

Post-SAR activities will be conducted in accordance with all applicable Parts of NREPA.

2.0 Response Action Plan

2.1 Interim Response - Spill Release Area

Response actions within the Spill Release Area will include the following:

- Berming of the Spill Release Area to prevent flow of oil to the Creek;
- Installation of temporary collection trenches for the containment and recovery of crude oil ;
- Site clearing and grubbing of trees and vegetation to allow completion of free phase crude oil removal activities;
- Removal, staging, transportation and disposal of crude oil impacted soil; Stormwater management and erosion control.

On-site personnel will follow their respective Health and Safety Plans. Odors and dust generated by on-site activities will be controlled by wetting to acceptable conditions as provided by air monitoring.

2.1.1 Construction of Temporary Berms

Temporary berms will be constructed, as necessary, to prevent the migration of oil to and within Talmadge Creek. Figure 5 shows the location of the temporary berms.

Berms will be constructed of clean on-site and granular soil. Berms will be less than five-feet in height to satisfy MDNRE requirements. Given the shallow nature of the temporary berms, significant hydraulic head will not develop that could create subsurface water flow or channeling under the berms. Groundwater flow patterns within the wetland system will be further evaluated as part of long-term corrective remedial actions.

Berm removal will be conducted during future site restoration activities in accordance with an approved site restoration plan. Additional information pertaining to berm construction is also presented in the Oil Recovery and Containment Plan (Section 6.0) for the site.

2.1.2 Construction of Temporary Receptor/Collection Trenches

Temporary receptor/collection trenches will be constructed to enhance the recovery of oil within the Spill Release Area. The location of currently installed trenches is shown on Figure 5. One to two foot shallow depressions will be excavated adjacent to berm areas to allow for recovery of crude via

skimmer pumps and/or pump trucks. Trenches will be appropriately filled during final site restoration activities. Recovered crude oil will be managed in accordance with Section 6.0 of the Oil Recovery and Containment Plan.

2.1.3 Site Clearing and Grubbing

Site clearing and grubbing in the Spill Area will be accomplished using manual and mechanized methods to gain access for site response activities. Prior to removal of mature trees, the U.S. Fish and Wildlife Service (USFWS) will be consulted as to the potential to affect Indiana bats. Jack Dingeldine of the USFWS will be contacted to determine if the trees affected by the interim response actions would provide adequate habitat for the bats. Trees and other vegetation removed for the purpose of interim response activities will be shredded/chipped on-site and mixed with oil saturated soil in the staging area as described in 2.1.4. Shredded vegetation and woodchips will not be piled on-site to avoid adverse impacts on the local habitat.

Crude oil impacted vegetation will be cleared and handled in accordance with the Waste Treatment, Transportation and Disposal Plan (Section 2.4). Mature trees will be preserved and used for future restoration purposes if feasible and in accordance with a final restoration yet to be completed. Work within wetland areas and streams will be conducted in accordance with the Joint Permit MDNRE and USACE for Part 303/301 and Part 31. Timber matting will be used in wetlands for access and to minimize soil erosion. Additional information regarding soil erosion control is provided in Section 2.6. USFWS and MDNRE will be consulted for compliance with Threatened and Endangered (T&E) species regulation. A preliminary T&E survey has been conducted and is included as Attachment D. If additional information is collected, it will be provided at a later date.

2.1.4 Removal, Staging, Transportation and Disposal of Oil Saturated Soil

Soil containing free-phase product (oil saturated soil) within the Spill Release Area will be excavated based on visual field screening. If visible oil is evident in the native soils, scraping of the soil will continue until it is removed. Peat will be squeezed for any visible evidence of free-phase product (oil). If oil is present, it will be excavated. Excavation activities will be conducted within wetland areas using timber mats to allow equipment access to the area and to minimize soil erosion. The Company will balance the need to invasively remove oil while minimizing adverse impact to the natural environment and/or sensitive habitats by limiting the horizontal and vertical extent of excavation to only oil saturated material. For example, wooded habitats take longer to return to baseline conditions than emergent marshes or grasslands, therefore, consideration will be given to the use of alternate techniques, such as natural attenuation, to minimize impacts to the natural

environment. The estimated areal extent of oil saturated soil requiring excavation is shown on Figure 5.

Future remedial activities will include SCAT Team recommendations that must be approved by FOSC.

Impacted soil will be placed in a soil staging area and allowed to drain. The soil staging areas will be constructed with a series of berms preventing stormwater run-on and/or run-off. The bermed staging areas will be lined with polyethylene sheeting to prevent infiltration and/or contact with native soils. Soil staging will occur only within the constructed/lined staging areas in order to contain and recovery residual oil. Staged soil will be sampled and analyzed in accordance with Section 4.6 of the Sample and Analysis Plan (SAP) and disposed of in accordance with Section 2.2. of the Waste Treatment, Transportation and Disposal Plan (WTTDP). Soil pretreatment options may include the addition of solidification enhancing material such as kiln dust, wood chips, sawdust, native soils, etc. This will be conducted to support live loading of waste material directly to trucks for offsite disposition, or to stabilize material prior to transport to a staging pile if needed.

Wastewater generated during soil excavation activities will be managed in accordance with the Waste Treatment, Transportation and Disposal Plan (Section 2.1).

Air monitoring will be conducted during excavation activities in the Spill Release Area. Air monitoring will include, a) on-site monitoring for worker safety and b) perimeter monitoring for the protection of public health. Worker exposure is measured through real time monitoring of benzene, carbon monoxide (CO), and hydrogen sulfide (H_2S). On-site personnel monitoring will be conducted in accordance with the approved Health and Safety Plan (Section 2.03). Field perimeter air monitoring stations are located along Division Drive as shown on Figure 6. Additional locations may be added in consultation with FOSC as work progresses. Roving real time air monitoring occurs 24 hours per day, traveling along public roadways in and around the Spill Release Area. Air monitoring and sampling will be conducted in accordance with the approved Air Sampling and Monitoring Plan (Sections 2 and 3).

2.2 Interim Response – Talmadge Creek

Response action within Talmadge Creek will include:

- Installation of flumes to prevent flow of oil to Talmadge Creek

- Site Clearing and Grubbing
- Removal, Staging, Transportation and Disposal of Oil Saturated Vegetation and Soil

2.2.1 Flume Installation

Temporary flumes will be installed within berms and other flow prevention structures to prevent further downstream migration of crude oil in Talmadge Creek. Flumes will be constructed of steel or corrugated pipe appropriately designed for water flow and load bearing requirements. The constructed flume elevation will be designed to maintain appropriate flow of water concurrent with the collection/separation of oil. The primary flume locations will be downgradient of the Spill Release Area.

2.2.2 Site Clearing and Grubbing

Site clearing and grubbing in the Creek area will be accomplished using manual and mechanized methods to gain access for site response activities. Crude oil impacted vegetation will be cleared and handled in accordance with the Waste Treatment, Transportation and Disposal Plan (Section 2.4). Mature trees, if removed, will be preserved for future restoration purposes if feasible and in accordance with the final site restoration plan.

As previously described in Section 2.1.4, shredded trees and vegetation will not be piled on-site and will be incorporated into oil saturated soil for off-site disposal.

USFWS will be consulted regarding the potential to affect the Indiana bat as previously described in Section 2.1.4.

2.2.3 Removal, Staging, Transportation and Disposal of Oil Saturated Soil

Soil containing free-phase product (oil saturated soil) along the banks of Talmadge Creek will be excavated based on visual field screening in accordance with the cleanup plan for Talmadge Creek (Attachment B). Excavation activities will be conducted from timber mats placed parallel to the Creek to allow equipment access to the area and to minimize soil erosion and wetland disturbance. Excavation will involve primarily oil impacted vegetation and shallow soil/root zone material along the banks of the Creek. The Company will balance the need to invasively remove oil while minimizing adverse impacts to the natural environment and/or sensitive habitats by limiting the horizontal and vertical extent of excavation to only oil saturated materials. As previously described in Section 2.1.4, consideration will be given to the use of techniques other than excavation, such as

natural attenuation, to minimize impacts to the natural environment. Oil saturated soil/vegetation will be placed in a lined soil staging area as previously described in Section 2.1.4.

As described in Section 2.1.4, on-site air monitoring is performed for worker safety and for the protection of public health. Fixed air monitoring sampling stations are located on each side of the Creek and on 16-Mile Road north of the Creek (see Figure 6). Additional locations may be added in consultation with FOSC as work progresses downstream towards the Kalamazoo River.

2.3 Interim Methods and Confirmatory Metrics

Methods to remove oil saturated soil (i.e. posing a risk of release to navigable water) were described in Section 2.1 and 2.2 and are based on visible field screening. This does not necessarily include soil exhibiting oil staining/sheen, petroleum odor, organic headspace, etc.

Riparian Zones and Steam Banks

1. Shorelines no longer release sheens that affect navigable waterways.
2. Oil no longer rubs off on contact.
3. Oil removal to the point where recovery/re-colonization can occur without causing more harm than leaving the oil in place. Heavy oil generally weathers to a dry coat within weeks.

Soil, Sand and Gravel

1. Oil is no longer visible on surface.
2. No oil layers in test pits dug by inspection teams.

Man-made structures

1. Structure no longer generates liquid oil or sheen.
2. Oil no longer rubs off on contact.

The horizontal extent of the Source Area impacts will be verified following interim response actions based on collection and analysis of soil samples. As described in the SAP, samples will be field screened for the presence of petroleum impacts using odor, oil sheen test, and organic headspace. Samples will also be laboratory analyzed for total petroleum hydrocarbons (TPH), diesel range organics (DRO) (with silica gel cleanup), TPH gasoline range organics (GRO) and benzene, toluene, ethyl benzene, and xylenes (collectively as BTEX) as an indicator of clean soil conditions. A positive laboratory detection will not necessarily indicate the need for additional interim corrective action; however, these data will be evaluated as part of future assessment and remediation activities.

Sampling locations and frequency for delineation of the horizontal extent will be further discussed with FOSC prior to implementation.

The Talmadge Creek streambed consists primarily of rock and granular material. To date, no oil impacts (i.e., dense non-aqueous phase liquids (DNAPLs)) have been observed within this creek bed. Given the age and conditions associated with the release, a DNAPL component is not anticipated to exist in the streambed. However, during these Source Area interim response activities, a visual inspection of the streambed will be completed to inspect for the presence of oil/DNAPL. As outlined in the SAP, sediments will be disturbed at regular intervals (e.g., 50') from the Spill Release Area through the affected waterways of Talmadge Creek using a rod, stick, or similar implement to evaluate if a visible oil/sheen is present.

The post-response activities will be further evaluated as part of the long-term remedial actions for the site. As part of the RPDIA Plan, submitted under a separate cover, the potential for DNAPL impacts associated with the release will be evaluated with respect to product that may have sunk to the river bottom of the Kalamazoo River or Morrow Lake.

2.4 Interim Response Oiled Wildlife Processing Protocol

During implementation of the previously described response activities, all live oiled animals will be collected, cleaned, rehabilitated and released. Oiled wildlife carcasses identified by response staff, regulatory staff, and the public shall be called into Enbridge's Marshall Response 800 number (800.306.6837). A member of the Wildlife Response Facility (WRF) team will be dispatched to collect the carcass. The carcass will be photographed in place, and its location documented (to include either actual lat/long coordinates or coordinates from a nearby known landmark, if available). If, during the course of the response, the appropriate regulatory entity [USFWS (migratory birds) or MDNRE (other species)] has demobilized from the WRF, the collection staff shall notify them of the discovery. A record regarding the disposition of wildlife carcasses will be maintained including disposition date, dispositions status, federal band number (if applicable), and intake number.

2.5 Source Area Access and Security

During the removal action of the Source Area, access will be made via construction of a temporary road off of Division Drive. Efforts will be made to limit heavy trucks to minimize public disturbance. Support facilities (e.g. field trailers, etc.) will be located to the north of the Source Area and other appropriate locations near the site.

Security guards will be posted at the entrance road to the site off of Division Drive. The site is located on private property and in a rural setting. Air monitoring stations or regularly scheduled air monitoring readings for fugitive emissions will be conducted as referenced in Section 2.1.4.

2.6 Storm Water Management and Erosion Control

Silt fencing, flow control structures and other engineered devices will be used in the Source Area for stormwater management around construction areas consistent with Part 91 of NREPA. No erosion control will be placed near the creek prior to removal of oily soil and vegetation.

Natural fiber erosion control materials, or equivalent, will be placed and staked at the water's edge along the entire length of Talmadge Creek after the response action is implemented to protect the creek.

Other actions will be conducted in compliance with the Joint Permit MDNRE and USACE for Part 303/301 and Part 31 (application submitted) for the Source Area. As response activities are completed, site drainage will be returned to pre-existing flow patterns and/or those specified in the approved final restoration plan.

2.7 Source Area Interim Restoration Activities

Source Area interim restoration activities will occur within the Spill Release Area and along the shoreline and other non-aquatic areas of Talmadge Creek. Restoration activities will include backfilling and application of a vegetative cover designed to minimize erosion until long term restoration can be completed. Backfilling near the pipeline subsurface will include placement of clean granular material and then surface organic soils to match the pre-existing conditions. Backfilling in the creek, where necessary, will include placement of organic soils. Details of stream and wetland restoration will be fully determined through consultation with all appropriate regulatory agencies. The vegetative cover will include native plant species and/or non-invasive temporary cover crops, such as rye, potentially applied as a hydro-mulch material. Long term restoration will include, but not be limited to, consideration of the original controls of the site, use of the appropriate soil types, future erosion control, re-vegetation, etc. Long term monitoring plans with performance criteria including: erosion control, establishment of vegetation, absence of invasive species, etc. will be included as part of the final site restoration plan.

The Company recognizes that earth disturbance is subject to Michigan's Permit-by-Rule for construction stormwater; therefore, a detailed restoration plan will be prepared pursuant to Part 301for both the Spill Release Area and the Creek.

2.8 Initial Response Action Decontamination

Personnel decontamination and equipment decontamination areas will be established on-site for the duration of the initial response actions. The decontamination areas will be constructed to be strategically near work areas for personnel and equipment.

2.8.1 Personnel Decontamination

Entrance and egress from the hot zones will require donning and doffing personnel protective equipment. A decontamination station will be established nearby for areas where the potential for personnel contamination exists. Such stations shall be set up to accommodate individuals entering under their own power or in the event that they become disabled. Contaminated clothing will be removed from the outermost layer and turned inside out while removing. Skin surfaces will be rinsed with a mild detergent and rinsed thoroughly. Gloves will be removed last. Contaminated clothing and debris will be collected and bagged for proper disposal.

2.8.2 Equipment Decontamination

Decontamination units within the decontamination areas will be constructed to periodically clean equipment during response actions and upon egress from the area. Cleaning systems for skimmers, hand tools, and heavy machinery will be established for each decontamination area.

The equipment decontamination area will consist of a lined diked impoundment for cleaning equipment and a frac tank for capture of any spilled material and storage of liquids.

The decontamination process will involve using hot-water pressure washing and a citrus based soap with a water rinse. This process will be repeated until visible contamination is removed. Expendable equipment (e. g., rope mops, brushes, tarps, etc.) will not be decontaminated but will be drummed and disposed as waste.

A decontamination area and decontamination station will be established near the Source Area, along the access road prior to departing the work area. A personnel decontamination area will be setup at the boundary of the Source Area exclusion zone in accordance with Section 3.07 of the HSP.

2.8.3 Additional Decontamination Requirements

In addition to work personnel and equipment decontamination, additional infrastructure such as MDOT culvert Interstate 69, will be decontaminated as part of the interim response activities. The proposed decontamination method will be consulted with and approved by the appropriate regulatory agency or jurisdiction prior to implementation. Oil material resulting as part of the decontamination process will be contained and collected for proper disposal.

2.9 Contingency Plan

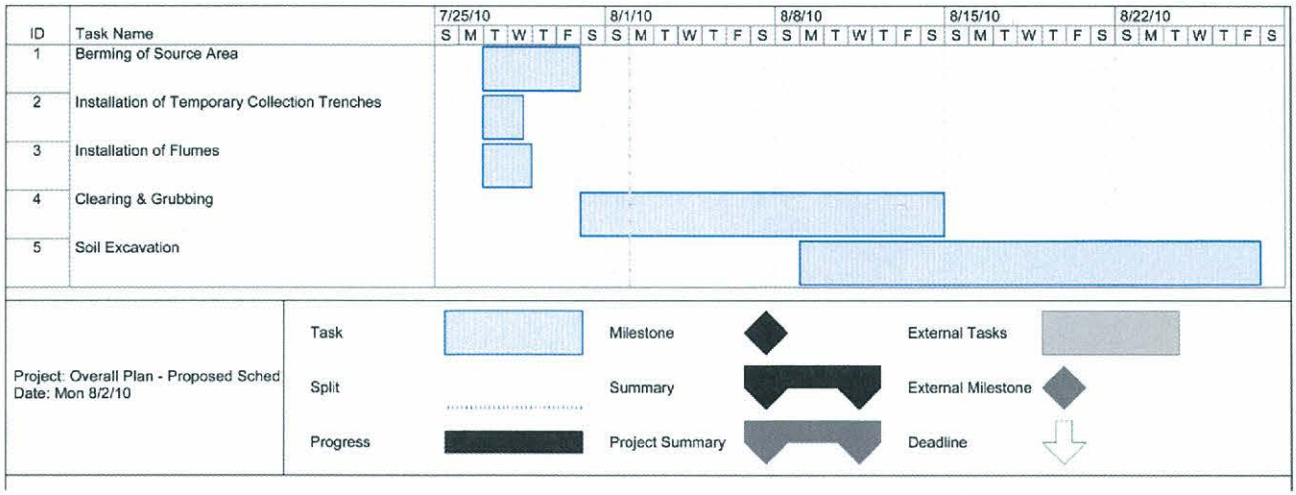
If the Company wishes to propose an action, revision or change that is not identified in this Plan, the Company shall request approval of the action, revision or change from the FOSC. To initiate the process, a written request will be submitted by Company to the FOSC outlining the proposed action, revision or change to be used and the benefits to be derived from its execution. FOSC shall then approve or disapprove in writing or discuss potential alternatives.

In addition, the Company will continue to monitor site conditions daily for the presence of visible oil on navigable water, or with the potential to threaten navigable waterways until the FOSC approves an alternate monitoring plan. Should such oil be observed, the Company will re-initiate the approved Oil Recovery and Containment Plan (Section 6.1 and 6.2) which may include the re-deployment of absorbent boom material, etc. as necessary to contain the observed oil. It is also the Company's intention to maintain the berms and flumes after initial response actions are complete to further limit the potential of future oil migration prior to final site remediation and restoration. Water discharges to the Creek during interim response actions are not anticipated to occur; however, if necessary, the SAR Plan would be re-initiated as described above.

The Company does not anticipate the need to provide a drainage contingency to adjacent landowners, due to the fact that dams will not be constructed in the Creek and the flumes put in place to allow underflow while capturing potential oil if present. In addition, no pumping or water diversion of the Creek will be performed during oil removal activities; therefore, we do not anticipate needing to meet a 50-year flood design volume.

3.0 Schedule And Resources

Various activities outlined in this SAR Plan have been implemented and are being implemented. Subject to the complications created by weather or other forces outside of the control of the Company, the objectives outlined above will be completed by August 27, 2010. This SAR Plan is being implemented and will be implemented in its entirety upon receiving U.S. EPA approval. A proposed schedule for SAR Plan tasks is provided below.



As of August 1, 2010 over 800 trained personnel are engaged in recovery activities. The existing complement of personnel and equipment will be adjusted to facilitate aggressive cleanup work at the release site by the approved deadlines. Cleanup activities will include removal of product and impacted material such as organics and vegetation. Any additional personnel required to facilitate this activity will be determined in part by the completion of a cleanup assessment. Variables that can impact resource loading are approval timelines, permitting and weather. The existing complement of trained personnel will be adjusted based on actual needs and assessment. Any changes, especially downsizing in resources, will be conducted only after discussions with and agreement by the FOSC. Increases in resources can be conducted as needed with notification during or subsequent to the change to the FOSC. This can be facilitated via coordination with the Operations Section Chief for U.S. EPA.

The additional personnel required to facilitate cleanup will be determined in part by the completion of shoreline assessments, specifically the completion of the SCAT and/or other assessment activity. Other variables that can impact resource loading are approval timelines, permitting and weather. The existing complement of trained personnel will be adjusted based on actual needs and assessment.

The number of crews and personnel in each crew will be dependent on many variables and is subject to areas that may impact the process, such as the final assessment process, the determination of response standards for all areas, the comments of other agencies such as the MDNRE, the number of crews that are acceptable to be on the river at one time, as examples. The plan will also require some adjustment based on the effectiveness of the technique used and the potential flushing of petroleum products into the river that will occur due to wave action and precipitation. The resourcing component of the plan will require adjustments to reflect these variables while generally requiring the appropriate number of crews and staff required to meet established deadlines.

Crews will consist of appropriately trained personnel, including supervision, clean up personnel, safety personnel, supply and waste transport and environmental monitors. The number of personnel will also be dependent on the area being remediated, level of contamination, access to the water or existing roads, denseness of vegetation, etc. and may require or limit total personnel in each area. With the appropriateness of crew structure approved, the crew size and crew numbers will determine total personnel required to complete this SAR Plan.

Figures

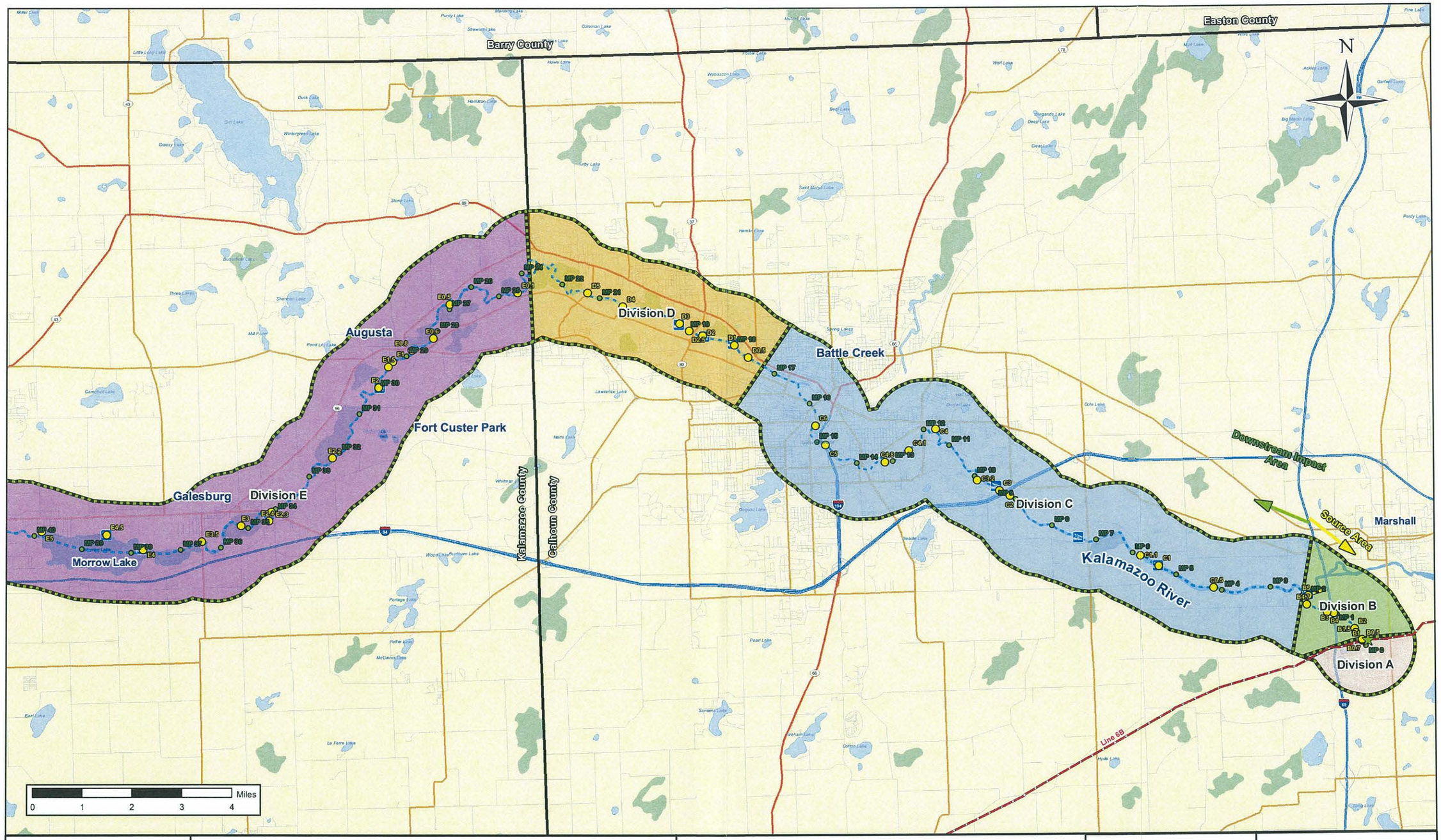
ENBRIDGE™

0 50 100 150 200 Miles

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Source Area Response Plan
Figure 1: Site Location

DATE ISSUED:	Aug 11, 2010
DATE REVISED:	
SCALE:	1:1,500,000
DRAWN BY:	NMS/JPM
SERIES:	1 of 6

Natural Resources Engineering Co.
715-395-5680



ENBRIDGE

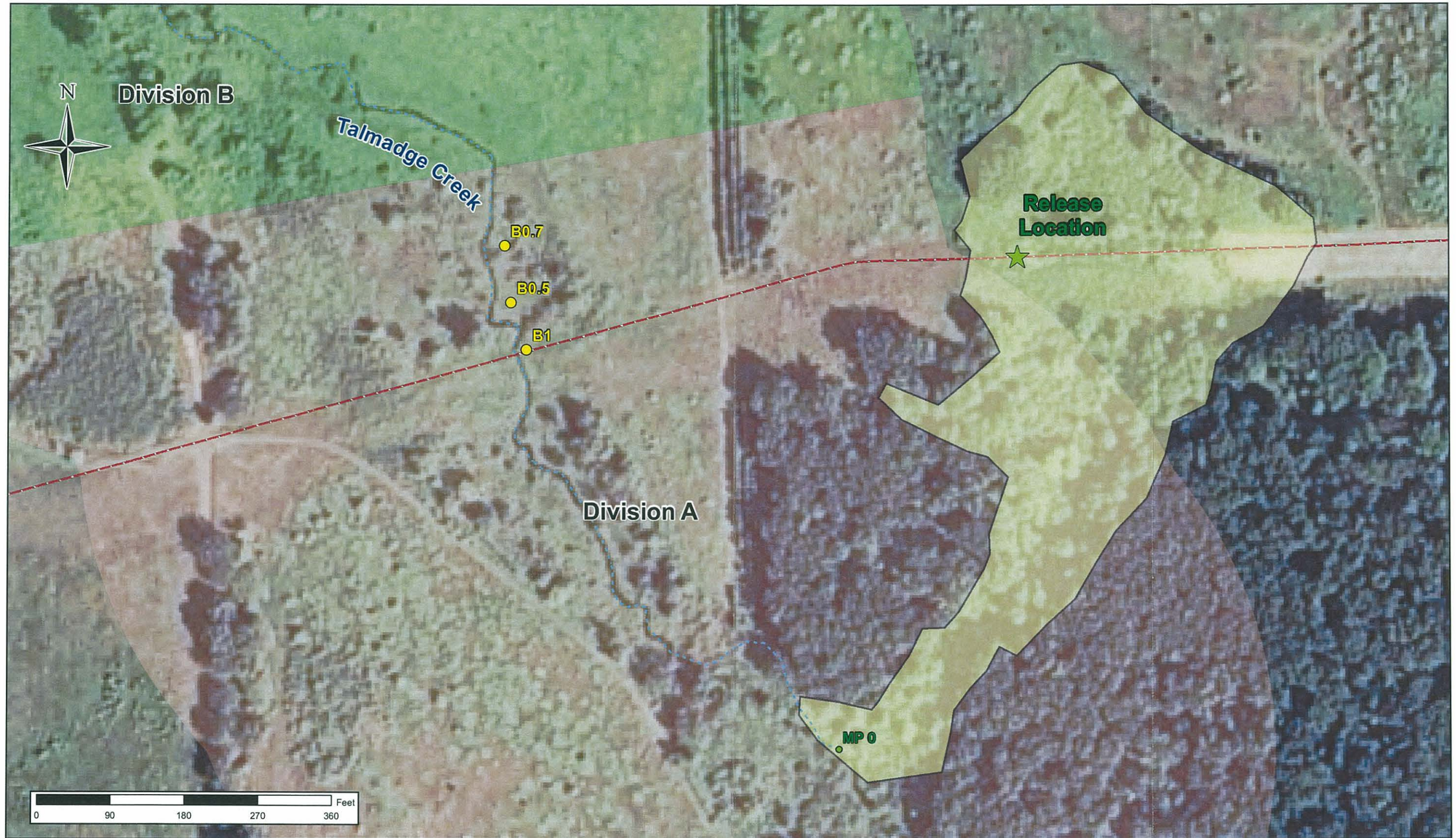
Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Containment Site
- Water Access
- Release Location
- Downstream Milepost

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Source Area Response Plan
Figure 2: Division Designation Map

DATE ISSUED:	Aug 11, 2010
DATE REVISED:	
SCALE:	1:60,000
DRAWN BY:	NMS/JPM
SERIES:	2 of 6

Natural Resources Engineering Co.
715-395-5680



ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Approximate Extent Of Oil
- Release Location
- Containment Site
- Downstream Milepost

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Source Area Response Plan
Figure 3: Spill Release Location

DATE ISSUED:	Aug 11, 2010
DATE REVISED:	
SCALE:	1:700
DRAWN BY:	NMS/JPM
SERIES:	3 of 6

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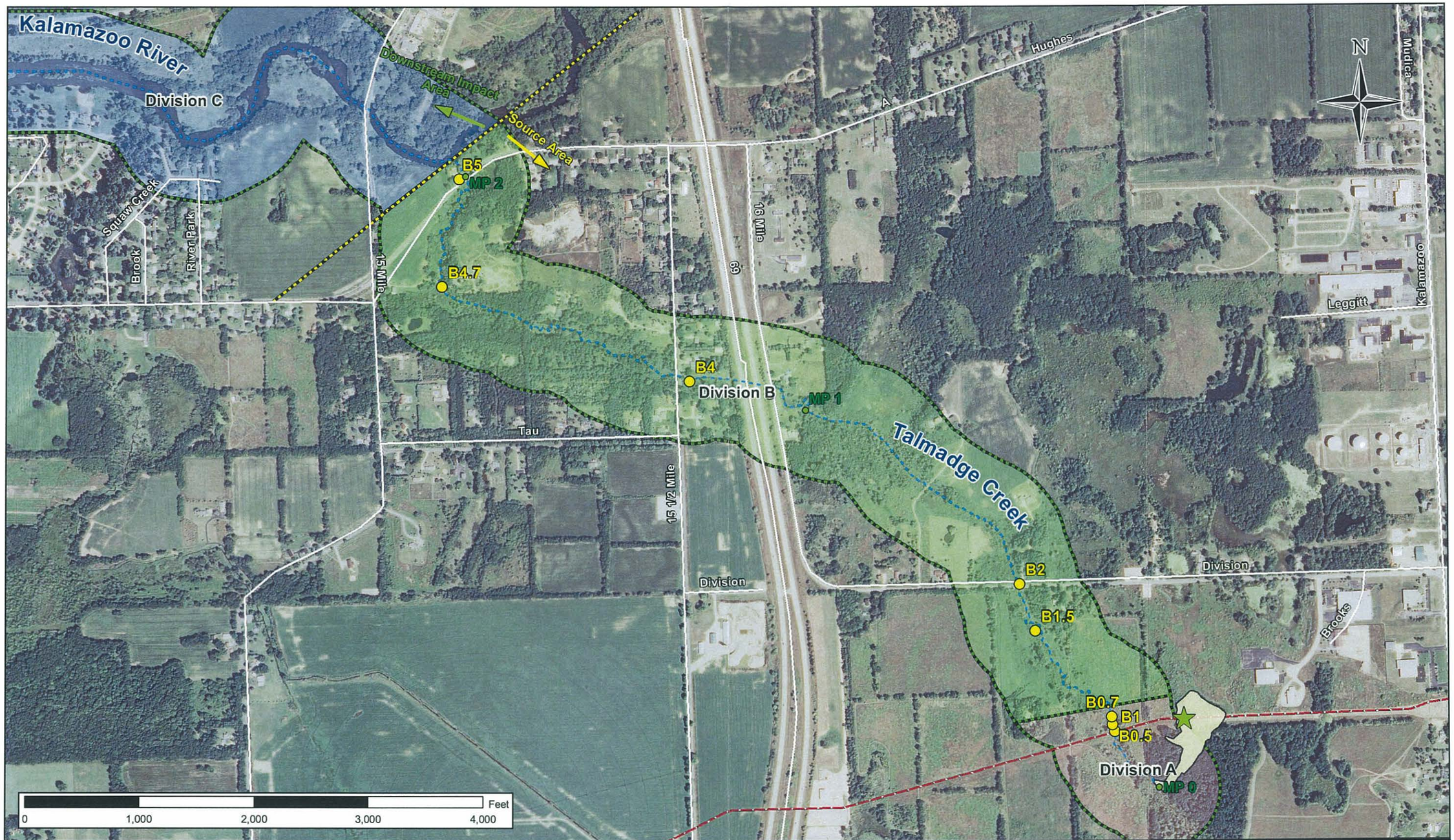
715-395-5680



ENBRIDGE

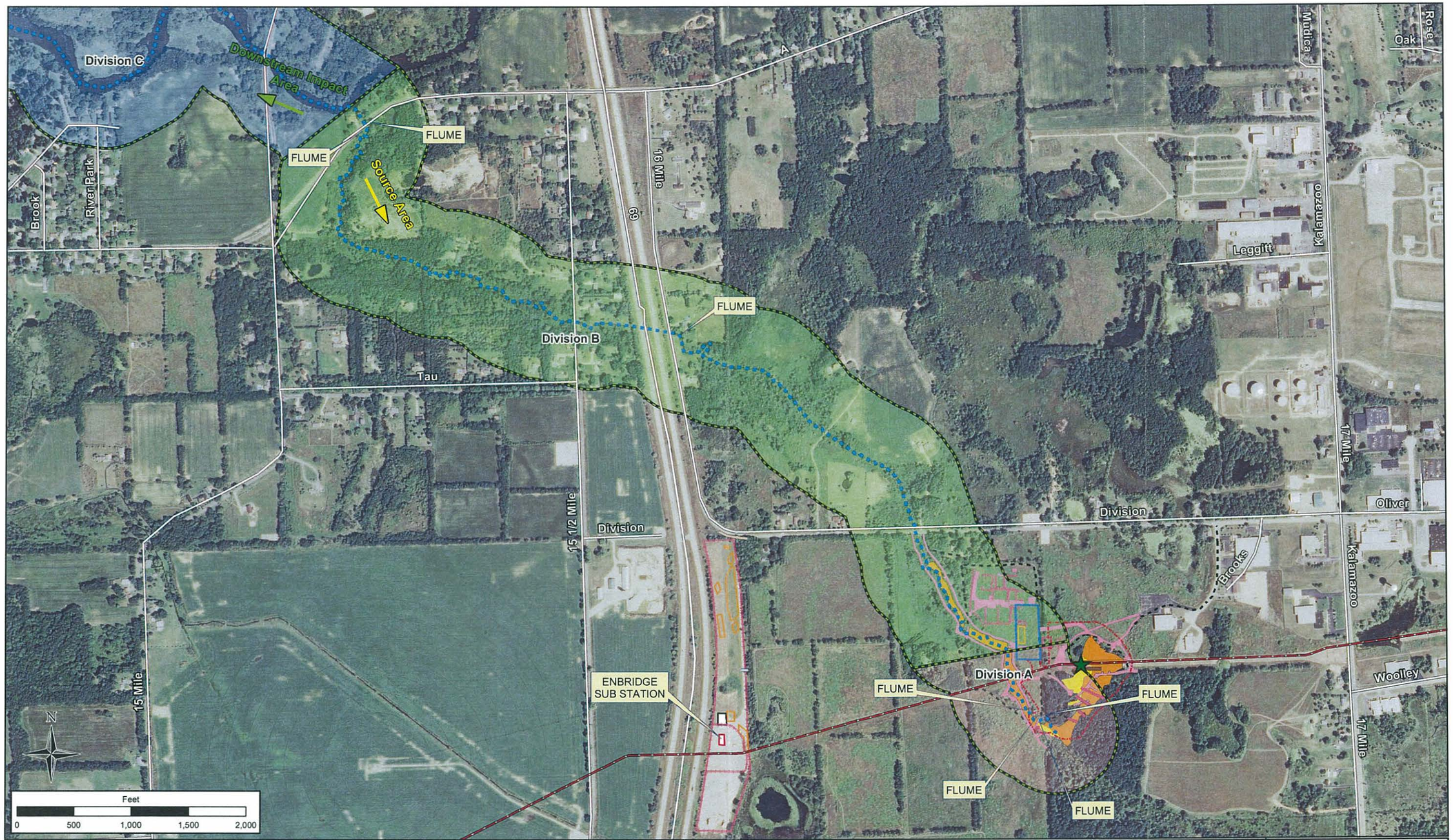
Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Containment Site
- Release Location
- Downstream Milepost
- Approximate Extent Of Oil

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Source Area Response Plan
Figure 4: Talmadge Creek

DATE ISSUED:	Aug 11, 2010
DATE REVISED:	
SCALE:	1:5,000
DRAWN BY:	NMS/JPM
SERIES:	4 of 6

Natural Resources Engineering Co.
715-395-5680



ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Access Road
- Major Road
- Fence
- Berm
- Trench
- Ditch
- Culvert
- Release Location
- Work Zone
- Contamination
- Contamination Scraped
- Staging
- Decon
- Mats
- Frac Tanks

Enbridge Energy, Limited Partnership

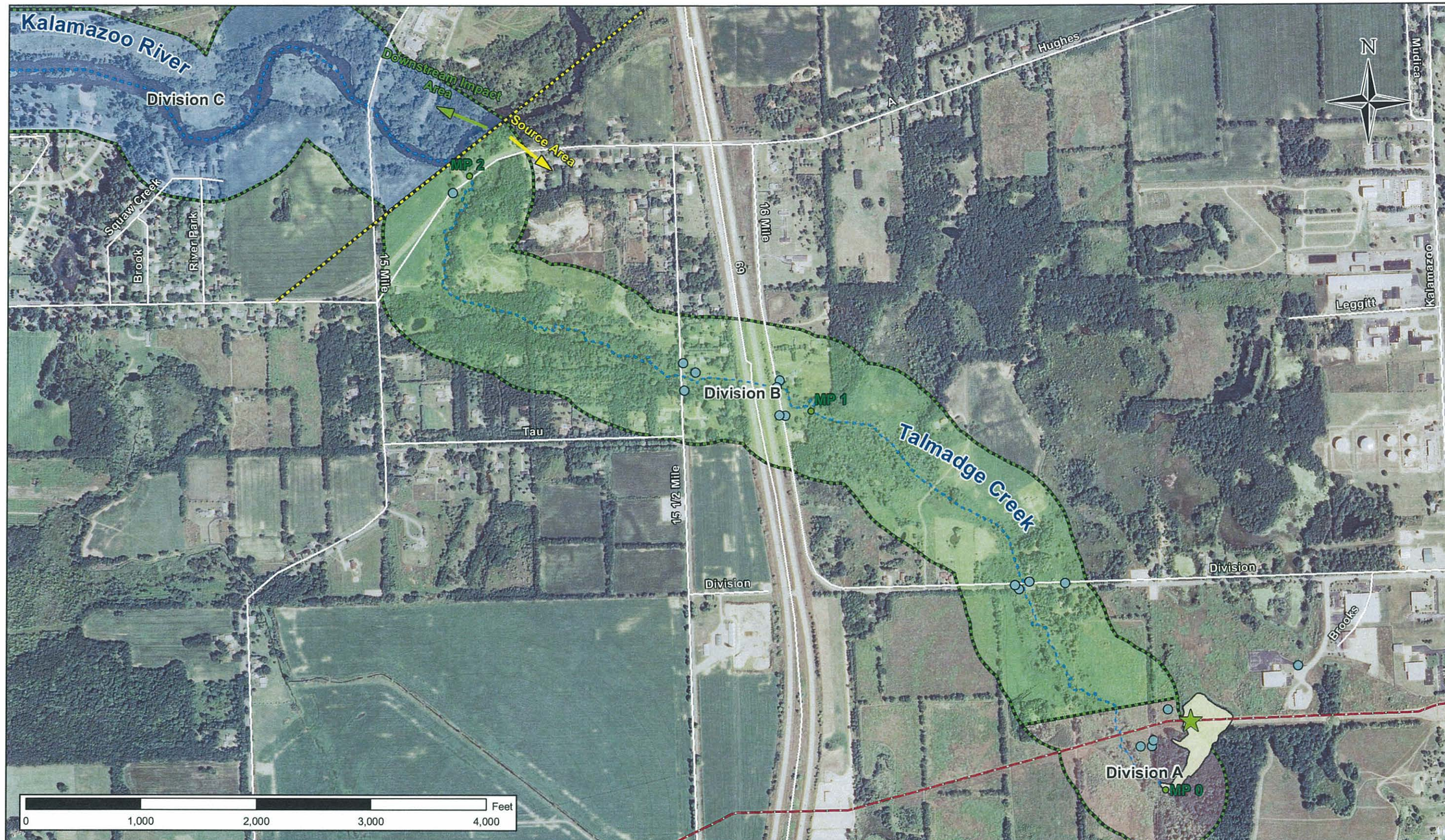
Enbridge Line 6B MP 608 - Marshall, MI

Source Area Response Plan

Figure 5: Source Area Site Base Map

DATE ISSUED:	Aug 11, 2010
DATE REVISED:	
SCALE:	1:5,000
DRAWN BY:	NMS/JPM
SERIES:	5 of 6

Natural Resources Engineering Co.
715-395-5680



ENBRIDGE

Legend

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Air Sample Location
- Downstream Impact Area
- Containment Site
- Release Location
- Downstream Milepost
- Approximate Extent Of Oil

Enbridge Energy, Limited Partnership
Enbridge Line 6B MP 608 - Marshall, MI
Source Area Response Plan
Figure 6: Source Area Air Monitoring Station Locations

DATE ISSUED:	Aug 11, 2010
DATE REVISED:	
SCALE:	1:5,000
DRAWN BY:	NMS/JPM
SERIES:	6 of 6

Natural Resources Engineering Co.
715-395-5680

Attachments

Attachment A

U.S. EPA Comment Response Verification

Attachment A

U.S. EPA Comment Response Verification
Enbridge Line 6 MP 608
SAR
Marshall, Michigan
(per U.S EPA August 15, 2010 letter)

SAR Plan-Specific Comments

1. The acronym table has been revised as requested.
2. Detailed information regarding how different soil types will be evaluated has been added to Section 2.1.4.
3. The sentence has been revised as requested in Section 2.3.
4. A proposed plan to investigate Talmadge Creek bottoms/sediments has been added to Section 2.3.
5. The frequency and duration for the proposed monitoring has been added to Section 2.9.
6. Details regarding backfilling and/or regarding of impacted areas has been added to Section 2.7.
7. The SAR has been revised to state that proposed decontamination techniques of man-made structures must be approved by the regulatory agency with the appropriate jurisdiction (Section 2.8.3).
8. The reference to Section 2.1.5 has been corrected to read 2.1.4.
9. The phrase "Part 201 (Environmental Remediation) of..." has been replaced to say that the work will be conducted in accordance with all applicable parts of the NREPA.
10. Results of the preliminary Threatened and Endangered species survey have been resubmitted.
11. Language has been added to state that the SCAT Team will include recommendations for remediation that must be approved by FOSC.
12. Section 2.3 has been amended to include a reference that collection and analysis of samples will conform to the SAP.
13. Section 2.4 has been amended to include the collection, cleaning rehabilitation and release of live oiled animals.
14. In Section 2.6, the phrase "consistent with Part 91 of the NREPA" has been added to the end of the first sentence of the first paragraph. The second sentence has been clarified.
15. The SAR has been amended to include text regarding metrics from Sections 3.1, 3.1.1, 3.1.2 and 3.1.3 of the Response Plan for Downstream Impacted Areas.
16. All references from the Unified Command (UC) and/or Incident Commander (IC) in the SAR have been changed to reference the FOSC.

Attachment B

Cleanup Plan for Talmadge Creek

Cleanup Plan for Talmadge Creek (Division B)
August 6, 2010

Cleanup within Division B (Talmadge Creek) will be conducted per the recommendations of the shoreline cleanup assessment teams (SCAT). Initial SCAT surveys of Talmadge Creek were performed on 6 August 2010 by a team comprised of representatives of the Federal and state on-scene coordinators, Federal and state NRDA Trustees, and the Responsible Party (Enbridge). Accessible portions of the creek were surveyed on foot by walking along the banks of the affected reaches and also from bridge crossing or other vantage points.

In general, oiling conditions were found to be moderate to heavy within the areas observed. Vegetation growing on the banks and/or overhanging the channel was often heavily oiled and frequently contained varying amounts of free product (e.g., mobile oil) stranded above the water line. Bank soils were heavily coated or saturated with oil in many locations. Heavy sheen and floating free product were present on the water's surface, especially in natural accumulation areas or in association with instream deposits of woody debris.

Cleanup will utilize a variety of techniques tailored to the conditions present at specific locations with Division B. As a general rule, the least invasive cleanup methods will be applied in order to accomplish the following objectives:

- Remove free product capable of being remobilized and contaminating other areas,
- Preventing secondary oiling of wildlife, and
- Minimizing potential threats to human health or other nuisance conditions.

The benefits of cleanup actions relative to these objectives will be weighted against the potential environmental impacts. It is recognized that there is a point where the negative environmental consequences of further cleanup/more aggressive methods outweigh the incremental benefits of removing additional oil from the environment.

The following cleanup techniques will be applied as appropriate:

- **Low-pressure, high-volume ambient water flushing**. Ambient water from Talmage Creek will be pumped to mobilize oil trapped in streambank or overhanging vegetation back into the creek where it will be collected with sorbents and/or skimmers. Adequate containment in the form of hard boom or underflow (siphon) dams will be established within a reasonable distance downstream of active work zones to facilitate collection and recovery of remobilized oil and to prevent additional oiling of downstream reaches. Flushing will not be conducted where the movement of water causes erosion of unconsolidated bank sediments. Water streams shall

be directed at low angles parallel to the slope to facilitate the downgradient movement of oil, while minimizing incorporation of oil into stream channel sediments. Use of a perforated header pipe or manifold at the top of the bank to flush oil towards the creek may be used where appropriate and feasible.

- **Vegetation Cutting.** Oiled herbaceous and shrub vegetation along the streambanks and overhanging the channel will be removed by cutting. Only oiled vegetation will be targeted for removal. Removal of unoiled vegetation will be minimized. All cut oiled vegetation will be bagged immediately and segregated from other types of oily wastes (e.g., sorbents, soil, etc.). Trees with oiled bark on their trunks will not be cut. However, oil on tree bark may be removed by using sorbents and/or flushing. Only the above-ground portion of vegetation will be removed; efforts will be made to limit disturbance of the root systems of plants to help maintain bank stabilization/erosion control functions to the greatest degree possible. Removal of above-ground vegetation will also improve the chances of natural recovery from the root stock next in subsequent growing seasons.

- **Manual Removal.** Where practical, manual techniques will be used to remove oil from the streambanks and affected riparian areas. This may consist of shoveling, scraping, raking or digging oil and oil-impacted soils using hand tools. Oily material will be bagged immediately. Removal of clean underlying soils will be minimized. Efforts will be made to avoid destabilizing the streambanks, which could lead to further erosion. Manual removal also applies to removal of oily debris from the streambanks or within the stream channel. Workers will take care to avoid trampling non-oiled vegetation and walking on sift substrates, which has the potential to push oil farther down into the sediments.

- **Mechanical Removal.** In areas where bank soils are saturated with oil and manual removal is impractical or unsafe, mechanical removal will be performed using heavy equipment. Removal of clean underlying soils will be minimized. To the degree possible, channel morphology will be maintained. Impacted soils will be loaded into lined roll-off containers for proper disposal. Equipment shall be positioned in locations where it causes the least harm to surrounding environments and risk to workers. To the degree possible, equipment will not transit through oiled areas.

This plan may be adapted during the course of cleanup to use modified or alternative approaches based on conditions encountered in the field and lessons learned throughout implementation.

Attachment C

Joint Permit Application to MDNRE and USACE Part 303/301 and Part 31

URS

August 2, 2010

Mr. Kameron Jordan
Michigan Department of Natural Resources and Environment
Land & Water Management Division
Kalamazoo District Office
7953 Adobe Road
Kalamazoo, Mi 49009-5026

Re: Enbridge Pipelines, Inc. Talmadge Creek Oil Spill
MDNRE/USACE Joint Permit Application
Fredonia Township, Calhoun County, Michigan

Dear Mr. Kameron Jordan:

Please find enclosed a Joint Permit Application for wetland, stream, and floodplain impacts associated with the Enbridge Line 6B spill clean-up in Talmadge Creek in Fredonia Township, Calhoun County, Michigan. The Line 6B spill is located at T03S, S2, R06W within Calhoun County. URS, on behalf of Enbridge Pipelines, Inc. is seeking a General Permit for Minor Activities in Wetlands in the State of Michigan under Category N. Emergency Spill Cleanup.

The proposed clean up is location in wetland, stream and floodplain areas where the initial Line 6B oil spill occurred. The area of wetland impacted is an emergent and forested wetland where contaminated soil and wetland vegetation have been removed in clean up efforts. The clean up will impact approximately 2.84 acres of regulated wetland. Of the impacted wetland area 0.76 acre is emergent wetland and 2.09 acres of impact is forested wetland. Additionally, the proposed excavation will impact 2.61 acres of floodplain. Stream impacts are being cleaned up through the use of vacuum trucks and skimmers, however a complete stream assessment and survey is not possible at this time due to health and safety concerns. Further survey will be completed for the stream impacts below the OHWM.

Once the proposed clean-up is complete, the remaining wetland and floodplain in the project area will be restored to its natural condition per the enclosed restoration plan following Best Management Practices (BMP) from Enbridge's Environmental Guidelines for Construction and MDNRE's Guidebook of Best Management Practices for Michigan Watersheds. Impacts to wetlands, streams and floodplain have been minimized as much as possible.

Due to safety concerns the wetland delineation of approximately 6.61 acres conducted by URS Corporation on July 30, 2010, was limited as access to the impact area was restricted. Consequently this delineated wetland line and impacts may vary at a later date and impact quantities are approximate. A more detailed survey will be completed when conditions at the site improve.

Enclosed you will find the MDNRE joint permit application, a permit addendum, a site location map, a site plan, plan/profile drawings, a wetland/stream/floodplain restoration plan, BMPs, a photolog, an adjacent land owner reference map, table and mailing address labels, a wetland delineation report, and the credit card transaction authorization form. Please feel free to contact me, Ms. Sherry Slocum, at (616) 560-5245 with any questions or if additional information is needed.

URS Corporation
3950 Sparks Drive, SE
Grand Rapids, MI 49546
Tel: 616.574.8500
Fax: 616.574.8542

URS

Sincerely,

URS Corporation Great Lakes

for

Sherry Slocum
Manager, Ecological Services Group

URS Corporation
3950 Sparks Drive, SE
Grand Rapids, MI 49546
Tel: 616.574.8500
Fax: 616.574.8542

AGENCY USE				
	Previous USACE Permit or File Number	Date Received	Land and Water Management Division, MDEQ File Number	
	USACE File Number		Pre-application Number or Marina Operating Permit Number	
	District Office		Fee received $	

Read Instructions pages i - iii. All of the following boxes below must be checked and information provided for the application to be processed:

- ☐ **All items in Sections 1 through 9 are completed**
- ☐ **Items in Sections 10 through 21 that apply to the project are completed**
- ☐ **Dimensions, volumes and calculations are provided**
- ☐ **Date project was staked**
- ☐ **Application fee is attached**
- ☐ **All requested supplementary attachments (➡) are included**
- ☐ **Reproducible location map, site plan(s), cross sections and photographs are provided, one set must be black and white on 8 ½ by 11 inch paper.**
- ☐ **List any additional attachments, tables, etc.:**

1 PROJECT LOCATION INFORMATION

- Refer to your property's legal description for the Township, Range, and Section information, and your property tax bill for your Property Tax Identification Number(s).

Site location Address (road, if no street address)	Zip Code	Township Name(s)	Township(s)	Range(s)	Section(s)
Division and Old US 27	*49068*	*Fredonia Township*	*03S*	*06W*	*2*

City/Village	County(ies)	Property Tax Identification Number(s)
City of Marshall	*Calhoun County*	

Name of Waterbody	Project Name or Job Number	Subdivision/Plat	Lot Number	Private Claim
Talmadge Creek	*Enbridge Pipelines, Inc. Talmadge Creek Oil Spill*			

Project types (check all that apply): ☒ private ☐ public/government ☐ industrial ☐ commercial ☐ multi-family ☐ building addition ☐ new building or structure ☐ building renovation or restoration ☐ river restoration ☐ single-family ☐ project is receiving federal transportation funds ☐ other (explain)

The proposed project is on, within, or involves (check all that apply) ☐ a legally established County Drain (date established) (M/D/Y) / /

☒ a stream ☐ a pond (less than 5 acres) ☐ a Great Lake or Section 10 Waters ☐ a natural river ☐ a new marina
☐ a river ☐ a channel/canal ☐ a designated high risk erosion area ☐ a dam ☐ a structure removal
☐ a ditch or drain ☐ an inland lake (5 acres or more) ☐ a designated critical dune area ☒ a wetland ☐ a utility crossing
☐ floodway area ☒ a 100-year floodplain ☐ a designated environmental area ☐ 500 feet of an existing waterbody

2 DESCRIBE PROPOSED PROJECT AND ASSOCIATED ACTIVITIES, AND THE CONSTRUCTION SEQUENCE AND METHODS (attached additional sheets)

Written Summary of All Proposed Activities. *See Addendum*

Construction Sequence and Methods. *See Addendum*

3 APPLICANT, AGENT/CONTRACTOR, AND PROPERTY OWNER INFORMATION

Owner/Applicant (individual or corporate name)	Agent/Contractor (firm name and contact person)
Endbridge Pipelines, Inc. - Tom Fridel	*URS Corporation - Sherry Slocum*
Mailing Address *1500 Main St*	Address *3950 Sparks Drive, SE*
City *Griffith* State *IN* Zip Code *46319-2662*	City *Grand Rapids* State *MI* Zip Code *49546*
Daytime Phone Number with Area Code *219-922-3133* Cell Phone Number - -	Daytime Phone Number with Area Code *616-560-5245* Cell Phone Number *616-560-5245*
Fax - - E-mail	Fax *616-574-8542* E-mail *Sherry_Slocum@URSCorp.com*

☒ No ☐ Yes Is the applicant the sole owner of all property on which this project is to be constructed and all property involved or impacted by this project?
➡ If no, attach letter(s) of authorization from all owners. A letter signed by each property owner authorizing the agent/contractor/other owner to act on his or her behalf or a copy of easements or right-of-ways must be provided. If multiple property owners, also attach a list of all owners along with their names, mailing addresses, and telephone numbers. If the applicant is a corporation, a corporate officer must provide written document authorizing any agent/contractor listed above to act on its behalf.
A letter of authorization must be provided from an owner receiving dredge spoils on their property, or where access through their property is required..

Property Owner's Name (If different from applicant)	Mailing Address
See Addendum	
Daytime Phone Number with Area Code - - Cell Phone Number - -	City State Zip Code

☒ No ☐ Yes Is there a MDEQ conservation easement or other easement, deed restriction, lease, or other encumbrance upon the property in the project area?
➡ If yes, attach a copy.

4 PROPOSED PROJECT PURPOSE, INTENDED USE, AND ALTERNATIVES CONSIDERED (Attach additional sheets if necessary)

Purpose/Intended Use: The purpose must include any new development or expansion of an existed land use.

Alternatives: Include a description of alternatives considered to avoid or minimize resource impacts. Include factors such as, but not limited to, alternative construction technologies; alternative project layout and design; and alternative locations. For utility crossings, include both alternative routes and alternative construction methods.

5 LOCATING YOUR PROJECT SITE

➡ Attach a black and white, legible copy of a map that clearly shows the site location and road from the nearest major intersection, and includes a north arrow.

Is there an access road to the project? ☐ No ☒ Yes (If Yes, type of road, check all that apply) ☐ private ☒ public ☐ improved ☐ unimproved

Name of roads at closest main intersection *Division Road* and *Old US 27 S*

Directions from main intersection *From Old US 27 S traveling north, turn west on Division Road. The site is located within the Enbridge Pipeline right-of-way to the south.*

Style of house or other building on site ☐ ranch ☐ 2-story ☐ cape cod ☐ bi-level ☐ cottage/cabin ☐ pole barn ☐ none ☐ other (describe) *N/A*

Color | Color of adjacent property house and/or buildings | House number | Street name

Fire lane number | Lot number | Address is visible on ☐ house ☐ garage ☐ mailbox ☐ sign ☐ other (describe)

How can your site be identified if there is no visible address? *Following Talmadge Creek to spill locations, area has been blocked off to prevent injury to the public.*

Provide directions to the project site, with distances from the best and nearest visible landmark and waterbody *Talmadge Creek*

Does the project cross the boundaries of two or more political jurisdictions? (City/Township, Township/Township, County/County, etc.)

☐ No ☒ Yes ➡ If Yes, list jurisdictions: *Fredonia Township*

6 List all other federal, interstate, state, or local agency authorizations required for the proposed activity, including all approvals or denials received.

Agency	Type approval	Identification number	Date applied	Date approved / denied	If denied, reason for denial
Calhoun County Road Commission	*SESC*				
MDNRE	*T&E Clearance*				

7 COMPLIANCE

If a permit is issued, date activity will commence (M/D/Y) *7/27/2010* | Proposed completion date (M/D/Y) / /

Has any construction activity commenced or been completed in a regulated area? ☐ No ☒ Yes

➡ If Yes, identify the portion(s) underway or completed on drawings or attach project specifications and give completion date(s) (M/D/Y) / / *See Addendum*

Were the regulated activities conducted under a MDEQ permit? ☒ No ☐ Yes

If Yes, list the MDEQ permit number

Are you aware of any unresolved violations of environmental law or litigation involving the property? ☒ No ☐ Yes (If Yes, explain)

8 ADJACENT/RIPARIAN AND IMPACTED OWNERS (Attach additional sheets if necessary)

- Complete information for all adjacent and impacted property owners and the lake association or established lake board, including the contact person's name.
- If you own the adjacent lot, provide the requested information for the first adjacent parcel that is not owned by you.

Property Owner's Name	Mailing Address	City	State	Zip Code
See Attached for Adjacent Landowner list, map, and labels				

Name of ☐ Established Lake Board ☐ or Lake Association

and the Contact Person's name, phone number, and mailing address

9 APPLICANT'S CERTIFICATION **READ CAREFULLY BEFORE SIGNING**

I am applying for a permit(s) to authorize the activities described herein. I certify that I am familiar with the information contained in this application; that it is true and accurate; and, to the best of my knowledge, that it is in compliance with the State Coastal Zone Management Program. I understand that there are penalties for submitting false information and that any permit issued pursuant to this application may be revoked if information on this application is untrue. I certify that I have the authority to undertake the activities proposed in this application. By signing this application, I agree to allow representatives of the MDEQ, USACE, and/or their agents or contractors to enter upon said property in order to inspect the proposed activity site and the completed project. I understand that I must obtain all other necessary local, county, state, or federal permits and that the granting of other permits by local, county, state, or federal agencies does not release me from the requirements of obtaining the permit required herein before commencing the activity. I understand that the payment of the application fee does not guarantee the issuance of a permit.

Property Owner / Agent/Contractor / Corporation/Public Agency – Title	Printed Name	Signature	Date (M/D/Y)
☐ Property Owner ☒ Agent/Contractor ☐ Corporation/Public Agency – Title *URS Corporation*	*Sherry Slocum*	Kris Permoff for Sherry Slocum	*8/2/2010*

10 PROJECTS IMPACTING WETLANDS OR FLOODPLAINS OR LOCATED ON AN INLAND LAKE OR STREAM OR A GREAT LAKE

- Check boxes A through M that may be applicable to your project and provide all the requested information.
- If your project may affect wetlands, also complete Section 12. If your project may impact regulated floodplains, also complete Section 13.

To calculate volume in cubic yards (cu yd), multiply the average length in feet (ft) times the average width (ft) times the average depth (ft) and divide by 27.
Some projects on the Great Lakes require an application for conveyance prior to Joint Permit Application completeness.

➡ Provide a cross-section and overall site plan showing existing lakes, streams, wetlands, and other water features; existing structures; and the location of all proposed structures, land change activities and soil erosion and sedimentation control measures. Review Appendix B and EZ Guides for completing site-specific drawings.

➡ Provide tables for multiple impact areas or multiple activities and provide fill and excavation/dredge calculations.

Water Level Elevation

On a Great Lake use IGLD 85 ☐ surveyed ☐ converted from observed still water elevation. On inland waters, ☐ NGVD 29 ☒ NAVD 88 ☐ other

Observed water elevation (ft) date of observation (M/D/Y)

☐ **A. PROJECTS REQUIRING FILL** (See All Sample Drawings)

- Attach both overall site plan and cross-section views to scale showing maximum and average fill dimensions.

(Check all that apply) ☐ floodplain fill ☐ wetland fill ☐ riprap ☐ seawall, bulkhead, or revetment ☐ bridge or culvert
☐ boat launch ☐ off-shore swim area ☐ beach sanding ☐ boatwell ☐ crib dock ☐ other

Fill dimensions (ft) length width maximum depth	Total fill volume (cu yd)	Maximum water depth in fill area (ft)

Type of clean fill ☐ pea stone ☐ sand ☐ gravel ☐ wood chips ☐ other

Will filter fabric be used under proposed fill? ☐ No ☐ Yes (If Yes, type)

Source of clean fill ☐ on-site, ➡ If on-site, show location on site plan. ☐ commercial ☐ other, ➡ If other, attach description of location.

Fill will extend feet into the water from the shoreline and upland feet out of the water. Fill volume below OHWM (cu yd)

☒ **B. PROJECTS REQUIRING DREDGING OR EXCAVATION** (For dredging projects see Sample Drawing 7, for excavation see other applicable Sample Drawings)

- Attach both overall site plan and cross-section views to scale showing maximum and average dredge or excavation dimensions and dredge disposal location.
- Refer to www.michigan.gov/jointpermit for disposal requirements and authorization.

(Check all that apply) ☒ floodplain excavation ☒ wetland dredge or draining ☐ seawall, bulkhead, or revetment
☐ navigation ☐ boat well ☐ boat launch ☐ other

Total dredge/excavation volume (cu yd) *See Addendum*	Dimensions length - width - depth -	Dredge/excavation volume below OHWM (cu yd) -	Method and equipment for dredging *See Addendum*

Has proposed dredge material been tested for contaminants? ☒ No ☐ Yes
If Yes, provide test results with a map of sampling locations.

Dredged or excavated spoils will be placed ☐ on-site ☒ off-site.
➡ Provide detailed disposal area site plan and location map.
➡ Provide letter of authorization from owner, if disposing of spoils off site.

Has this same area been previously dredged? ☒ No ☐ Yes If Yes, date and permit number: / / /
If Yes, are you proposing to enlarge the previously dredged area? ☐ No ☐ Yes

Is long-term maintenance dredging planned? ☒ No ☐ Yes If Yes, when and how much?

☐ **C. PROJECTS REQUIRING RIPRAP** (See Sample Drawings 2, 3, 8, 12, 14, 17, 22, and 23. Others may apply)

Riprap waterward of the ☐ shoreline OR ☐ ordinary high water mark	Dimensions (ft) length width depth	Volume(cu yd)
Riprap landward of the ☐ shoreline OR ☐ ordinary high water mark	Dimensions (ft) length width depth	Volume(cu yd)

Type of riprap ☐ field stone ☐ angular rock ☐ other

Will filter fabric be used under proposed riprap? ☐ No ☐ Yes (If Yes, type)

☐ **D. SHORE PROTECTION PROJECTS** (See Sample Drawings 2, 3, and 17) Complete Sections 10A, B, and/or C above, as applicable.

(check all that apply) ☐ riprap – length (ft) ☐ seawall/bulkhead – length (ft) ☐ revetment – length (ft)

Distances of project from both property lines (ft)

☐ **E. DOCK - PIER – MOORING PILINGS – ROOFS** (See Sample Drawing 10)

Dock Type ☐ open pile ☐ filled ☐ crib
Seasonal support structure? ☐ No ☐ Yes

Permanent Roof? ☐ No ☐ Yes Mounted on
Maximum Dimensions: length width height

Proposed structure dimensions (ft) length width

Dimensions of nearest adjacent structures (ft) length width

☐ **F. BOAT WELL** (See EZ Guides)

Type of sidewall stabilization ☐ wood ☐ steel ☐ concrete ☐ vinyl ☐ riprap ☐ other

Boat well dimensions (ft) length width depth

Number of boats

Volume of backfill behind sidewall stabilization (cu yd)

Distances of boat well from adjacent property lines (ft)

☐ **G. BOAT LAUNCH** (See EZ Guide) (check all that apply) ☐ new ☐ existing ☐ public ☐ private ☐ commercial ☐ replacement

Proposed overall boat launch dimensions (ft) length width depth

Type of material ☐ concrete ☐ wood ☐ stone ☐ other

Existing overall boat launch dimensions (ft) length width depth

Boat launch dimensions (ft) below ordinary high water mark length width depth

Distances of launch from both property lines (ft)

Number of adjacent Skid piers

Skid pier dimensions (ft) length width

☐ **H. BOAT HOIST** (See EZ Guide)

(Check all that apply) ☐ *seasonal* ☐ permanent ☐ cradle ☐ side lifter ☐ other

located on ☐ *seawall* ☐ *dock* ☐ bottomlands

10 Continued - PROJECTS IMPACTING WETLANDS OR FLOODPLAINS OR LOCATED ON AN INLAND LAKE OR STREAM OR A GREAT LAKE

☐ **I. BOARDWALKS AND DECKS IN ☐ WETLANDS - OR - ☐ FLOODPLAINS** (See Sample Drawings 5 and 6. Provide table if necessary)

	Dimensions (ft)			Dimensions (ft)	
Boardwalk ☐ on pilings ☐ on fill	length	width	Deck ☐ on pilings ☐ on fill	length	width

☐ **J. INTAKE PIPES** (See Sample Drawing 16) ☐ **OUTLET PIPES** (See Sample Drawing 22)

Type ☐ headwall ☐ end section ☐ pipe ☐ other

If outlet pipe, discharge is to ☐ wetland ☐ inland lake ☐ stream, drain, or river ☐ Great Lake ☐ other

Dimensions of headwall OR end section (ft) length	width	depth	Number of pipes	Pipe diameters and invert elevations

☐ **K. MOORING AND NAVIGATION BUOYS** (See EZ Guide for Sample Drawing)

➡ Provide an overall site plan showing the distances between each buoy, distances from the shore to each buoy, and depth of water at each buoy in feet.
➡ Provide cross-section drawing(s) showing anchoring system(s) and dimensions.

Number of buoys	Boat Lengths	Type of anchor system	Purpose of buoy ☐ mooring ☐ navigation ☐ swimming

Dimensions of buoys (ft) width height swing radius chain length

Do you own the property along the shoreline? ☐ No ☐ Yes
➡ Attach Authorization Letter from the property owner(s), if No above.

☐ **L. FENCES IN WETLANDS, STREAMS, OR FLOODPLAINS** (No Sample Drawing available)

- Provide an overall site plan showing the proposed fencing through wetlands, streams, or floodplains.
- Provide drawing of fence profile showing the design, dimension, post spacing, board spacing, and distance from ground to bottom of fence.

(check all that apply) ☐ wetlands ☐ streams ☐ floodplains	Total length (ft) of fence through wetlands streams floodplains	Fence height (ft)	Fence type and material

☐ **M. OTHER** - e.g., structure removal or construction, breakwater, aerator, fish shelter, and structural foundations in wetlands or floodplains

11 EXPANSION OF AN EXISTING OR CONSTRUCTION OF A NEW LAKE OR POND (See Sample Drawings 4 and 15)

Which best describes your proposed waterbody use (check all that apply)
☐ wildlife ☐ stormwater retention basin ☐ recreation ☐ wastewater basin ☐ other

Water source for lake/pond
☐ groundwater ☐ natural springs ☐ Inland Lake or Stream ☐ stormwater runoff ☐ pump ☐ sewage ☐ other

Location of the lake/basin/pond ☐ floodplain ☐ wetland ☐ upland

Maximum dimensions (ft) length width depth

Maximum Area: ☐ acres ☐ sq ft

Spoils will be placed ☐ onsite ☐ offsite outside of wetland and floodplain ☐ other
➡ Provide a Detailed Disposal Area Site Plan with location map, address and disposal dimensions
➡ Provide a Letter of Authorization from off site disposal site owner
➡ Provide elevations and cross sections for outlets and/or emergency. Complete Section 10J,

Will project involve construction of a dam, dike, outlet control structure, or spillway? ☐ No ☐ Yes (If Yes, complete Section 17)

12 ACTIVITIES THAT MAY IMPACT WETLANDS (See Sample Drawings 8 & 9, and complete sections 10 A and 10 B for dredge or excavation as applicable)

- For information on the MDEQ's Wetland Identification Program (WIP) visit www.michigan.gov/deqwetlands or call 517-373-1170.
- Complete the wetland dredge and wetland fill dimension information below for each impacted wetland area. ➡ Attach tables for multiple impact areas or activities
- Label the impacted wetland areas on a site plan, drawn to scale or with dimensions. ➡ Attach at least one cross-section for each wetland dredge and/or fill area.
- If dredge/excavation material will be disposed of on site, show the location on site plan and include soil erosion and sedimentation control measures.

(check all that apply) ☐ fill (Section 10A) ☒ dredge or excavation (Section 10B) ☐ boardwalk or deck (Section 10I) ☐ dewatering ☐ fences (Section 10L) ☐ bridges and culverts (Section 14) ☐ draining surface water ☐ stormwater discharge ☐ restoration ☐ other

wetland dredge/excavation dimensions	maximum length (ft)	maximum width (ft)	dredge/excavation area	average depth (ft)	dredge volume (cu yd)
	156.0	794.0	☒ acres ☐ sq ft 2.84	2.0	9173.17
wetland fill dimensions	**maximum length (ft)**	**maximum width (ft)**	**fill area**	**average depth (ft)**	**fill volume (cu yd)**
N/A	N/A	N/A	☐ acres ☐ sq ft N/A	N/A	N/A

Total wetland dredge/excavation area	Total wetland dredge/excavation volume (cu yd)	Total wetland fill area	Total wetland fill volume (cu yd)
☒ acres ☐ sq ft 2.84	9173.17	☐ acres ☐ sq ft N/A	N/A

The proposed project will be serviced by: ☐ public sewer ☐ private septic system ➡ Show system on plans

If septic system, has an application for a permit been made to the County Health Department? ☐ No ☐ Yes

If Yes, has a permit been issued? ☐ No ☐ Yes ➡ Provide a copy.

Has a professional wetland delineation been conducted for this parcel? ☐ No ☒ Yes
➡ Provide a copy of the delineation. ➡ Supply data sheets.

Applicant purchased property ☐ before OR ☐ after October 1, 1980.

Is there a recorded MDEQ easement on the property? ☒ No ☐ Yes If Yes, provide the easement number)

Has the MDEQ conducted a wetland assessment for this parcel? ☒ No ☐ Yes ➡ If Yes, provide a copy of assessment or WIP number:

Describe the wetland impacts, the proposed use or development, and any alternatives considered: *See Addendum*

Does the project impact more than 1/3 acre of wetland? ☐ No ☐ Yes
➡ If Yes, submit a Mitigation Plan that includes the type and amount of mitigation proposed. For more information go to www.michigan.gov/deqwetlands

Describe how impacts to waters of the United States will be avoided and minimized: *See Addensum*

Describe how impact to waters of the United States will be compensated. OR Explain why compensatory mitigation should not be required for the proposed impacts.
See Addendum

Is any grading or mechanized land clearing proposed? ☐ No ☒ Yes
➡ Show locations on submitted site plan.

Has any of the proposed grading or mechanized land clearing been completed? ☐ No ☒ Yes ➡ Show labeled locations on site plan.

13 FLOODPLAIN ACTIVITIES (See Sample Drawing 5. Others may apply.) For more information go to www.michigan.gov/deqfloodplainmanagement

- Complete Sections 10 A and 10 B and other Sections, as applicable.
- A hydraulic analysis or hydrologic analysis may be required to fully assess floodplain impacts. ➡ Attach hydraulic calculations.

➡ Attach additional sheets or tables with the requested information when multiple floodplain activities are included in this application.

(check all that apply) ☐ fill ☒ excavation ☐ other

Site is 1.0 feet above ☐ ordinary high water mark (OHWM) OR ☒ observed water level. Date of observation (M/D/Y) 7/30/2010

Fill volume below the 100-year floodplain elevation (cu yd) 0	Compensating cut volume below the 100-year floodplain elevation (cu yd) 8,428.78

14 BRIDGES AND CULVERTS (Including Foot and Cart Bridges) (See Sample Drawings 5, 14A, 14B, 14C, 14D, and EZ Guides)

- Provide detailed site-specific drawings of existing and proposed Plan and Elevation View, (Sample Drawing 14A), Elevation View (Sample Drawing 14B), Stream and Floodplain Cross-Section (Sample Drawing 14C), Stream Profile (Sample Drawing 14D) and Floodplain Fill (Sample Drawing 5) at a scale adequate for detailed review.
- Provide the requested information that applies to your project. If there is not an existing structure, leave the "Existing" column blank.
- If you choose to have a Licensed Professional Engineer "certify" that your project will not cause a "harmful interference" for a range of flood discharges up to and including the 100-year flood discharge, then you must use the "Required Certification Language." You may request a copy by phone, email, or mail. A hydraulic report supporting this certification may also be required. Is Certification Language attached? ☐ No ☐ Yes

➡ Attach additional sheets and table with the requested information for multiple crossings. Include hydraulic calculations.

		Existing	Proposed			Existing	Proposed
Culvert type (box, circular, arch) and material (corrugated metal, timber, concrete, etc.)				Bridge span (length perpendicular to stream) OR culvert ☐ width ☐ diameter (ft)			
Bridge type (concrete box beam, timber, concrete I-beam, etc.)				Bridge width (parallel to stream) OR culvert length (ft)			
Entrance design (projecting, mitered, wingwalls, etc.)				Bridge rise (from bottom of beam to streambed) OR Culvert rise (fill from top of culvert to streambed) (ft)			
Total structure waterway opening above streambed (sq ft)				Approach slope fill from existing grade to culvert or bridge			
☐ elevation of culvert crown	Upstream			Higher elevation of ☐ culvert invert OR	Upstream		
☐ bottom of bridge beam (ft)	Downstream			☐ streambed within culvert (ft)	Downstream		
Elevation of road grade at structure (ft)				Distance from low point of road to mid-point of bridge crossing (ft)			
Elevation of low point in road (ft)							

Cross-sectional area of primary channel (sq ft) (See Sample Drawing 14C)	Average stream width at OHWM outside the influence of the structure (ft)	Upstream Downstream

Reference datum used (show on plans with description) ☐ NGVD 29 ☐ NAVD 88 ☐ IGLD 85 (Great Lakes coastal areas) ☐ other

High water elevation – describe reference point and highest known water level above or below reference point and date of observation.

15 STREAM, RIVER, OR DRAIN CONSTRUCTION ACTIVITIES (No sample drawing available)

- Complete Section 10A for fill, Section 10B for dredge or excavation, and Section10C for riprap activities.
- If side casting or other proposed activities will impact wetlands or floodplains, complete Sections 12 and 13, respectively.

➡ Provide an overall site plan showing existing lakes, streams, wetlands, and other water features; existing structures; and the location of all proposed structures and land change activities.

➡ Provide cross-section (elevation) drawings necessary to clearly show existing and proposed conditions. Be sure to indicate drawing scales.

➡ For activities on legally established county drains, provide original design and proposed dimensions and elevations.

(check all that apply) ☐ maintenance ☐ improvement ☐ relocation ☐ enclosure ☐ new drain ☐ wetlands ☐ other

Dimensions (ft) of existing stream/drain channel to be worked on. length width depth

Dimensions (ft) of new, relocated, or enclosed stream/drain channel. length width depth	Volume of dredge/ excavation (cu yds)
Existing channel average water depth in a normal year (ft)	Proposed side slopes (vertical / horizontal)

How will slopes and bottom be stabilized?

Will old/enclosed stream channel be backfilled to top of bank grade? ☐ No ☐ Yes	Length of channel to be abandoned (ft)	Volume of fill (cu yds)

If an enclosed structure is proposed, check type ☐ concrete ☐ corrugated metal ☐ plastic ☐ other

Dimensions of the structure: diameter length volume of fill

Will spoils be disposed of on site? ☐ No ☐ Yes ➡ Show location of spoils on site plan if spoils disposed of on an upland area.)

Water elevation Reference datum used ☐ NGVD 29 ☐ NAVD 88 ☐ IGLD 85 (Great Lakes coastal areas) ☐ other

➡ Show elevation on plans with description.

Addendum to Joint Permit Application
Enbridge Pipelines, Inc. – Applicant
URS Corporation – Agent
Emergency Spill Clean Up
August 2010

2. Describe Proposed Project and Associated Activities, and the Construction Sequence and Methods
Written Summary of All proposed Activities – Project activities occurred within wetland and floodplain areas where Enbridge Line 6B oil spill occurred. Excavators and vacuum trucks were used within the impact area. Additionally stream, wetland, and floodplain surveys will be conducted at a later date once health and safety issues are improved. This will allow for a more accurate wetland line and impacts to stream.

Construction Sequence and Methods – 1. Excavation and vaccuuming of contaminated soils within wetland and floodplain areas, 2. Skimming and vaccuum trucks removing contamanents within stream, 3.Removal of soils and contaminated vegetation off-site, 4. Regrade and remediate wetland, and floodplain areas

3. Applicant, Agent/Contactor, and Property Owner Information
Property owner information other than adjacent landowners is not provided here. Property owners in the area of the spill have been evacuated and have not been contacted to date by URS Corporation in association with this submittal due to the nature of this permit as an emergency clean up general permit.

7. Compliance – Emergency clean up commenced soon after the initial spill on July 27, 2010. The impact area of the spill is detailed on attached site plans.

10B. Projects Requiring Dredging or Excavation - Excavation for this project will be occurring within the 100 year floodplain and wetland area.

Total dredge/excavation volume:
Floodplain - 8,428.78 cu yd
Wetland – 9,173.17

Dimensions:
Floodplain Excavation Dimensions
Length 162.0 ft **Width** 702.0 ft **Depth** 2.0 ft

Wetland Dredging Dimensions
Length 156.0 ft **Width** 794.0 ft **Depth** 2.0 ft

Dredge/excavation volume below OHWM (cu yd):
Due to safety concerns a stream survey was not possible. The volume of dredging within the floodplain is approximately 8,428.78 and the volume of dredging within the wetland

is approximately 9,173.17. A complete survey of the impact area will be conducted at a later date. To date vacuum trucks and skimmers have been working to clean and contain stream contamination further survey will be needed to determine any stream impacts below the OHWM.

Method and Equipment for dredging – Excavators, vacuum trucks, and skimmers were used in wetland, stream, and floodplain areas to remove contaminated soils, oil sheen, and vegetation.

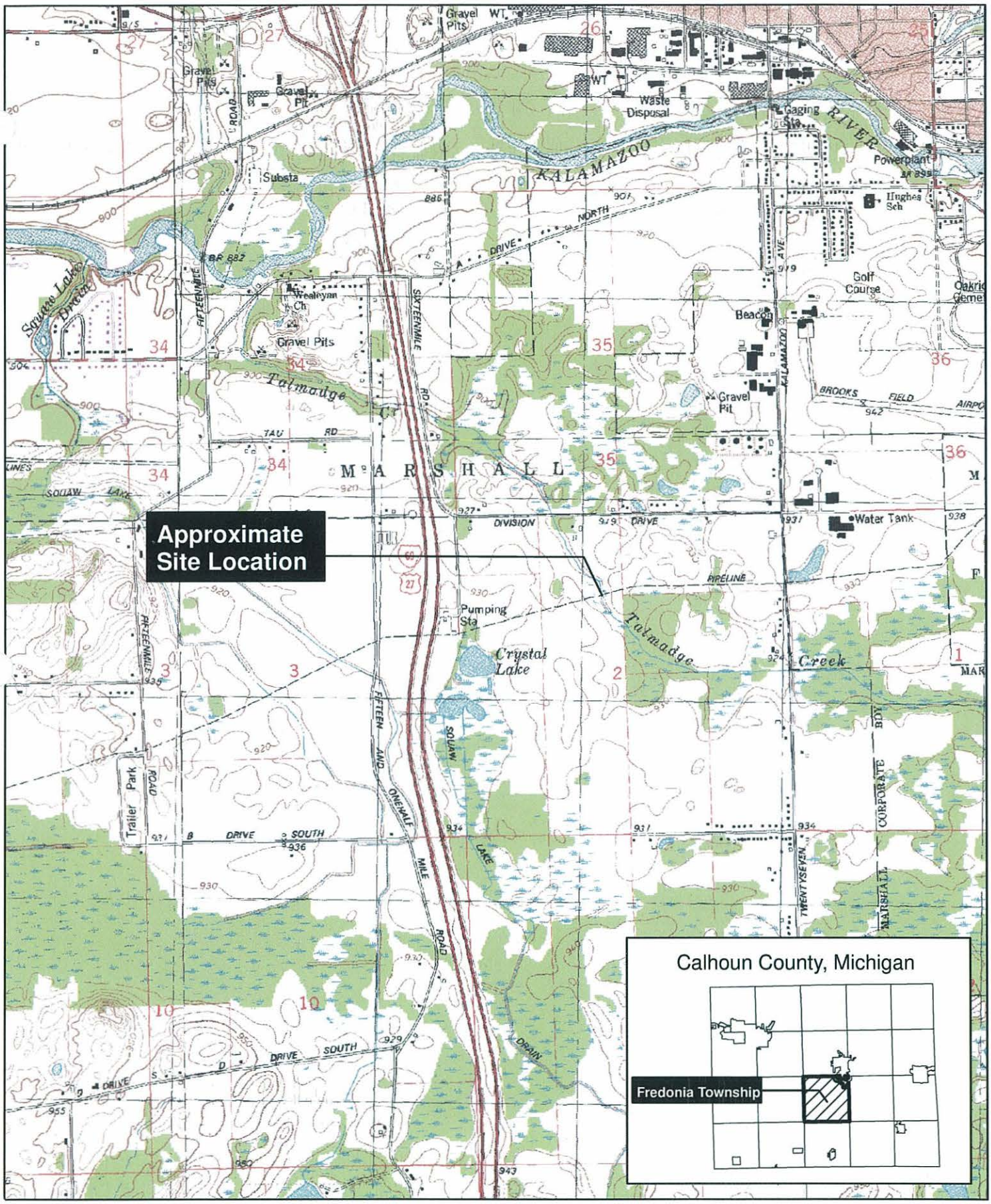
12. Activities that may impact wetlands

Describe the wetland impacts, the proposed use or development, and any alternatives considered: Wetland was impacted in order to conduct emergency spill clean up from the Enbridge Line 6B oil spill. The impacted wetland was excavated to remove contaminated soil and vegetation that was effected by the spill. The wetland excavation impacted approximately 2.84 acres of wetland. The impact to emergent wetland is 0.76 acre and 2.09 acres impact to forested wetland.

Due to safety concerns the wetland delineation conducted by URS Corporation was limited as access to the impact area was restricted. Consequently, the delineated wetland line and impacts may vary at a later date. Additionally, a detailed plant list was difficult to compile do to the amount of oil covering much of the vegetation in the impact area. At the point of pipe failure excavation accured to respond to the emergency situation, at this location there is not an existing plan and profile drawing of the ditch where the actual pipe failure happened, therefore that depth of impact to the wetland area for the pipe has not been taken into account. Due to the nature of this emergency situation this general permit is limited to the initial spill location and remediation.

Describe how impacts to waters of the United States will be avoided and minimized: Wetland impacts have been minimized as much as possible by placing control structures along the wetland boundaries as well as damming structures within the stream to prevent further impacts.

Explain why compensatory mitigation should not be required for the proposed impacts: The wetland impacts associated with the clean up are approximately 2.84 acres. The wetland impacts to emergent wetland (PEM) are approximately 0.76 acre and impacts to forested wetland (PFO) are approximately 2.09 acres. Due to safety concerns the wetland delineation of 6.61 acres conducted by URS Corporation on July 30, 2010, was limited as access to the impact area was restricted. Consequently, this delineated wetland line and impacts may vary at a later date and impact quantities are approximate. A more detailed survey will be completed when conditions at the site improve. Once the clean up is complete, Enbridge Pipelines, Inc. will restore the wetland area to its original condition according to the included wetland restoration plan. Wetland mitigation may be required by the MDNRE and a wetland mitigation plan will be provided by URS Corporation at a later date to mitigate for wetland impacts.



Site Location Map

Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan

Township 03S Range 06W Section 2

N

0 1,000 2,000 4,000 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

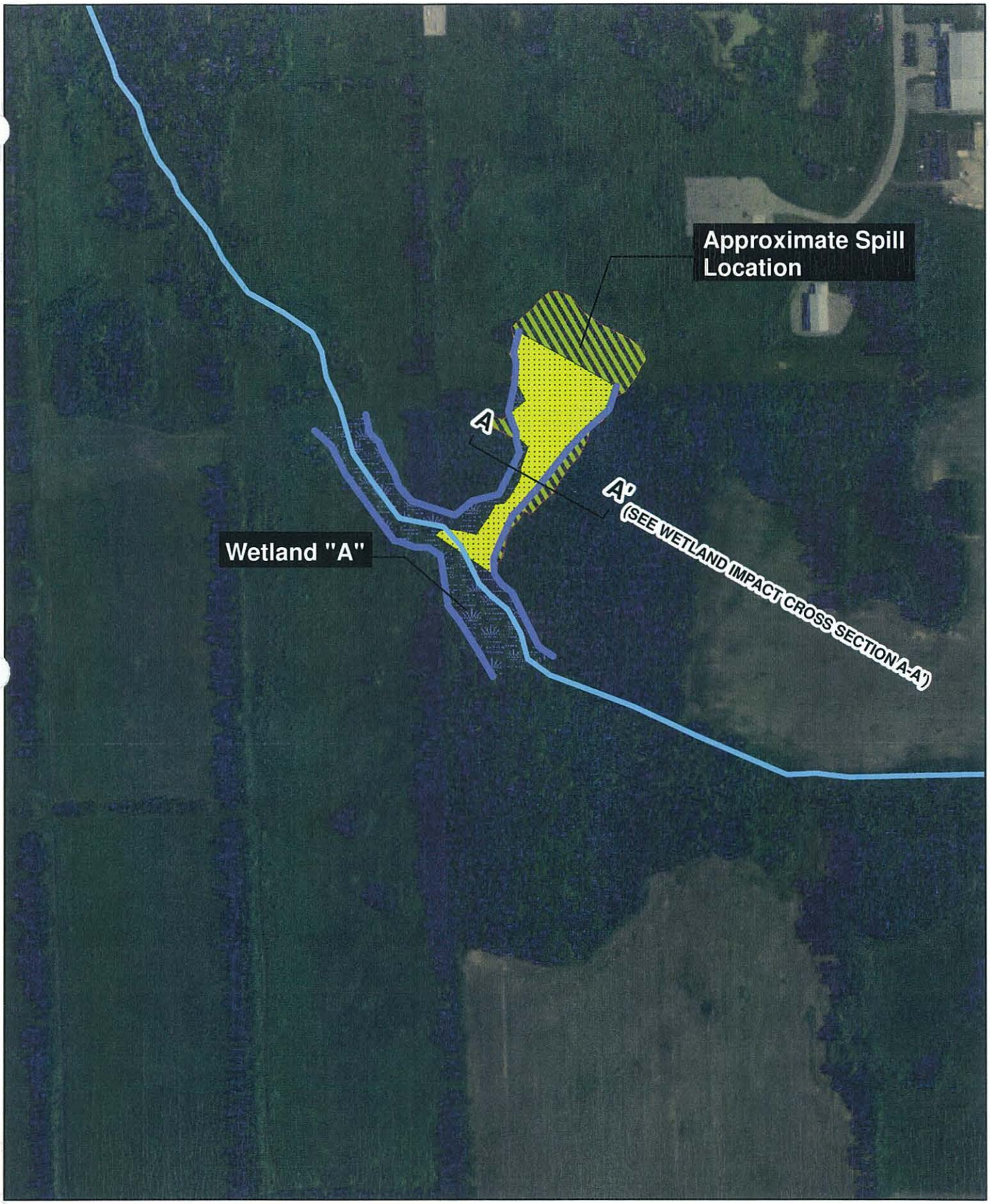
ENBRIDGE

0 0.03 0.06 0.09 0.12 Miles

Enbridge Energy, Limited Partnership
MP 608 - Marshall, MI

Release Area Site Base Map

DATE ISSUED:	July 31, 2010
DATE REVISED:	
SCALE:	1:1,000
DRAWN BY:	NMS/JPM
SERIES:	



Wetland "A" Impact Plan Talmadge Creek URS Wetland Delineation Wetland Impact Spill Area

N

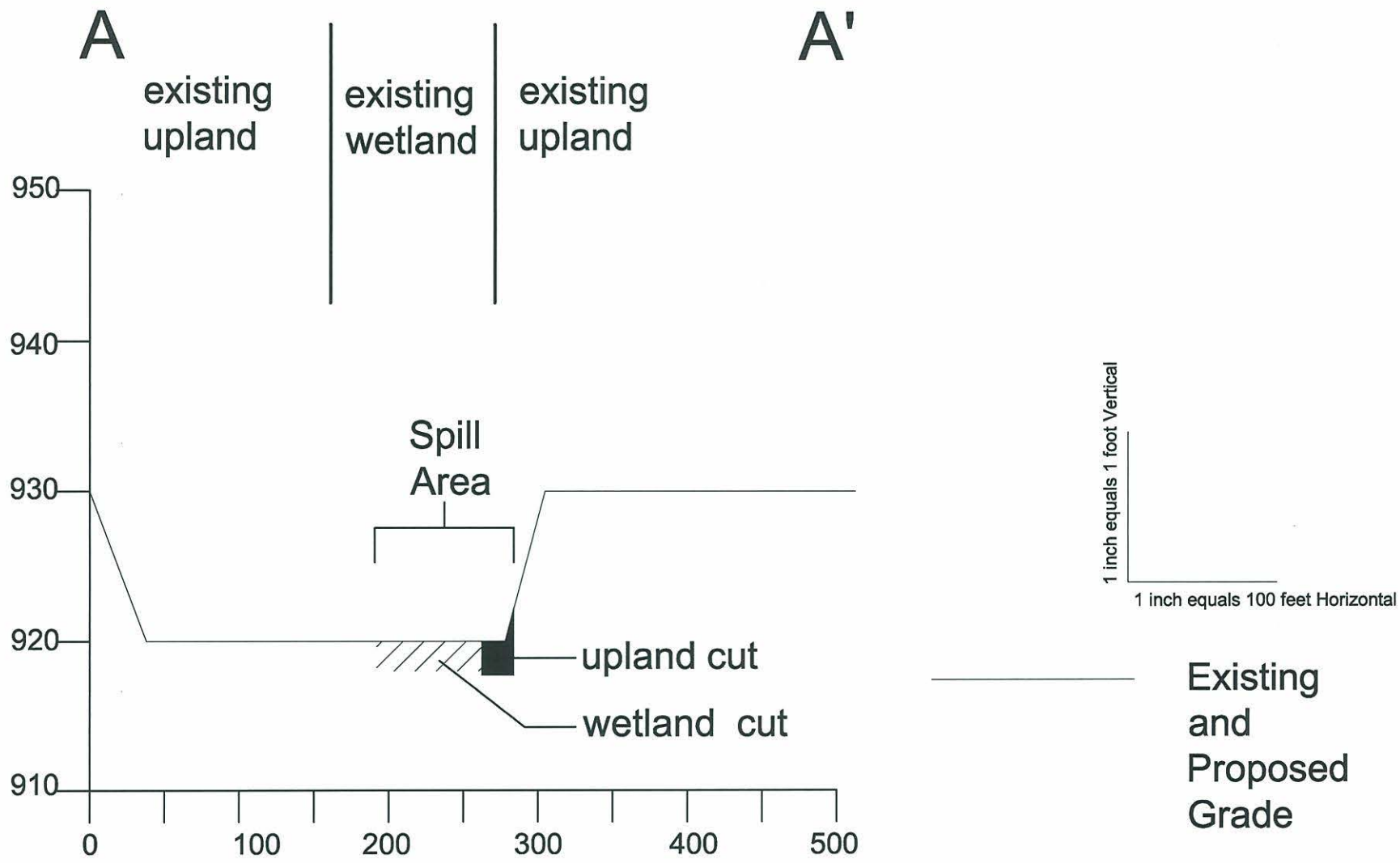
Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan

Township 03S
Range 06W Section 2

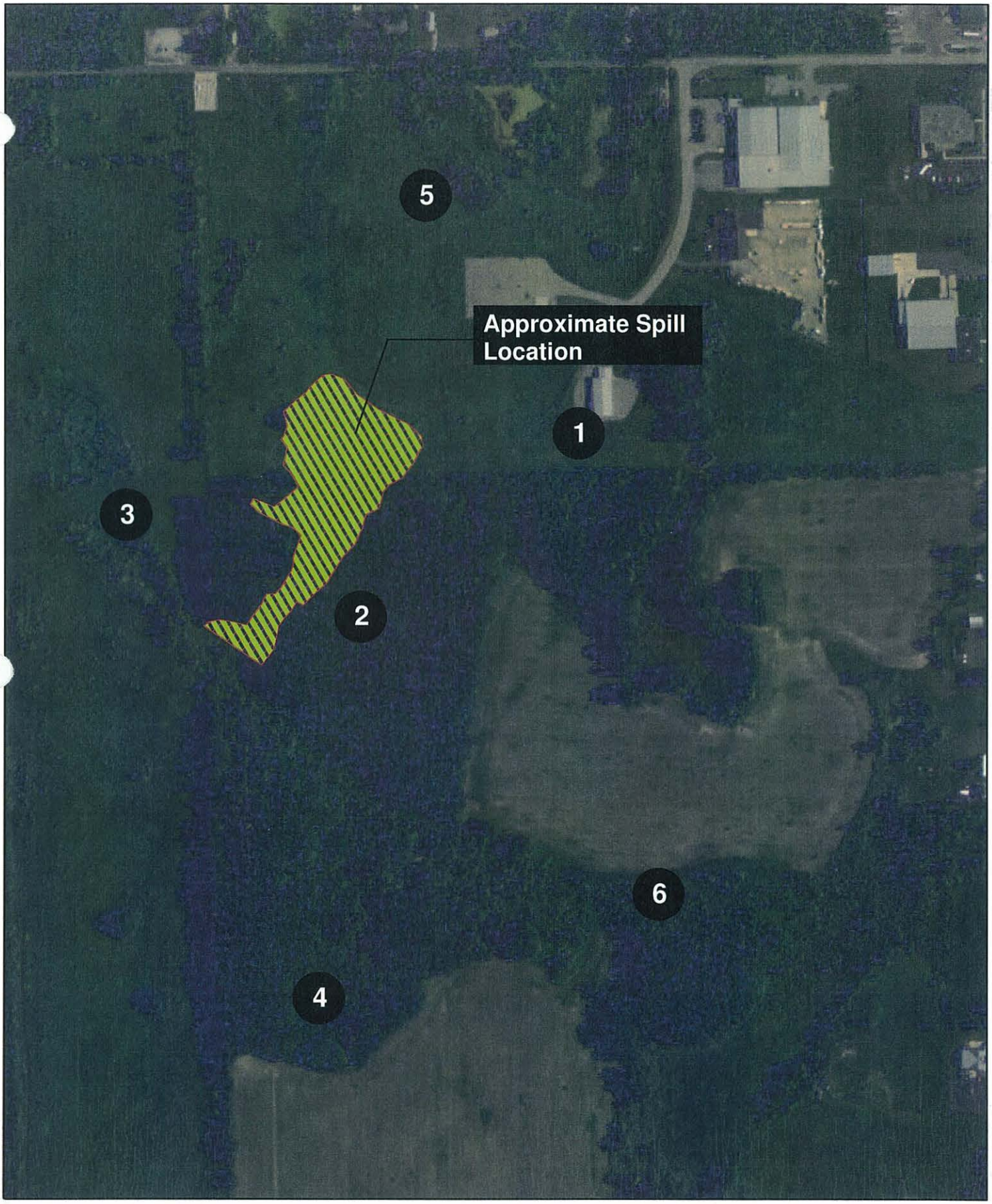
0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/



Wetland Impact Cross Section A-A'
ENBRIDGE, INC. Talmadge Creek Oil Spill, Fredonia Township, Michigan
Created by: JPB, URS Project , August 2, 2010



Adjoining Property Map

Spill Area

N

Enbridge Inc.,Talmadge Creek Oil Spill, Fredonia Township, Michigan

Township 03S
Range 06W Section 2

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

Adjacent Landowners to Enbridge Line 6B Spill

Map Id	Parcel Number	Contact	Street Address	City	State	Zip
1	53-003-053-00	Qualtek Inc	1611 Brooks Dr	Marshall	MI	49068
2	11-102-003-00	Haman, Joyce Ruth	11661 Old Us 27 South	Marshall	MI	49068
3	11-102-039-00	Zinn, D & Schaffer, B	16240 Division Dr	Marshall	MI	49068-9565
4	11-102-045-00	Simmons, Martin D. Living Trust	1621 Monroe Bch	Battle Creek	MI	49014-7544
5	53-003-025-00	City of Marshall	323 W. Michigan Ave.	Marshall	MI	49068
6	53-003-150-00	City of Marshall-Lafferty Prop	11301 Old US 27 S	Marshall	MI	49068

Joyce Ruth Haman
11661 Old Us 27 South
Marshall, MI 49068

Zinn, D & Schaffer B
16240 Division Dr
Marshall, MI 49068

Qualtek Inc.
1611 Brooks Drive
Marshall, MI 49068

City of Marshall
323 W. Michigan Ave
Marshall, MI 49068

Martin D. Simmons Living Trust
1621 Monroe Beach
Battle Creek, MI 49014-7544

City of Marshall – Lafferty Property
11301 Old US 27 S
Marshall, MI 49068

Enbridge Pipelines, Inc. Talmadge Creek Oil Spill
Line 6B Spill Clean Up, Fredonia Township, Calhoun County, Michigan
WETLAND RESTORATION PLANTING PLANS

INTRODUCTION

The following table presents proposed restoration plans for wetland impacts due to the safety area expansion.

RESTORATION OBJECTIVES

The goal of this plan is to restore the wetland, stream, and floodplain area to a condition as good as what previously existed, with a similar plant community and similar hydrologic regime, at the same finished grade as pre-existing conditions. Planting will incorporate species existing prior to disturbance. Due to the nature of the clean up effort topsoil will not be segregated; instead topsoil will be removed and hauled off site. New topsoil will be placed and spread prior to planting. Use straw mulch in level areas and mulch blankets for slopes.

PROPOSED MONITORING

The MDNRE may require monitoring of the restored wetland, stream and floodplain areas annually in the fall of each year for three years after the project is complete (2010 to 2013). For each monitoring visit, we will document the establishing plant community, compare to seeding treatments, and assess the results. Observe and report any wildlife use of the area. Observe and report on hydrology, and provide photos of each area. Submit by Dec. 31 of each year.

SEED MIX, TREE AND SHRUB RECOMMENDATIONS

Seed mix and shrub recommendations are based on plant inventories of pre-existing communities created during the site assessment phase. The wetland area is emergent and forested wetland. The suggested seed mix for the emergent area is an Emergent Wetland Seed Mix with additional shrub plugs. The Emergent mix is suitable for saturated soils and shallow standing water. It includes a mix of rushes, sedges, bulrushes, and wetland grasses, as well as oats for rapid temporary stabilization. Similar seed mixes are available from local or regional producers and may be used if species mix is substantially the same as outlined. Preference is for seed grown in or near Michigan for regional genotype. Recommended shrub species are silky dogwood - *Cornus*

amomum, red osier dogwood – *Cornus stolonifera* and sandbar willow - *Salix exigua* because they are suitable for seasonal shallow standing water and saturated soils.

The suggested seed mix for the forested wetland area is a Wooded Wetland Establishment Seed mix. This mix is suitable in saturated, newly reforested areas to reduce weed competition and provide soil stabilization. As the reforested land becomes more shaded, some of the species in this seed mix will establish a permanent herbaceous understory layer and help fill out the maturing wooded wetland. This mix includes grass and sedge species as well as native tree, forb and shrub species. Similar seed mixes are available from local or regional producers and may be used if species mix is substantially the same as outlined. Preference is for seed grown in or near Michigan for regional genotype.

SEED/SHRUB PLANTING INSTALLATION RECOMMENDATIONS

Optimum seeding time is October 1 to June 15. It can be done outside of this window but establishment may take longer. Mid-summer seeding is not recommended. With regards to planting plugs, detailed instructions should be obtained with the nursery where the plants are purchased. However, important points to remember in planting in wetland areas include the following:

- Plant emergent plants in the spring after water levels have lowered in order to establish a root system strong enough to overwinter.
- Summer planting of live plants will be successful if regularly watered.
- Label a few plants to prevent accidental weeding and assist in monitoring.
- Gently pry apart from roots in the bottom half of the root ball to stimulate root growth.
- Avoid burying plants either too deep or too shallow. Plant so that the surface of the root ball exactly matches the existing soil surface.
- Mulch the top surface of the root ball with lightly covered mulch layer.

Other erosion controls (silt fences, mulch blankets, straws etc.) should be installed prior to seeding.

Scarify soil surface by raking or shallow tilling. Press seed into soil using a roller or similar equipment. Light raking may also be used, but do not cover seed more than ¼" deep.

Summary of Wetland Restoration Planting Plans			
Wetland ID and Type Impacted	**Pre-Disturbance Dominant Plant Species**	**Planting Recommendations and Notes**	**Soil Treatment**
A Emergent Wetland	*Typha angstifolia,* narrow leaved cattail *Cornus foemina,* gray dogwood *Phalaris arundinacea,* reed canary grass *Onoclea sensibilis,* senstitive fern *Eupatoriadelphus maculates,* spotted joe-pye-weed *Thelypteris thelypteroides* , Marsh fern *Cicuta maculate*, Water hemlock *Parthenocissus quinquefolia*, Virginia creeper *Eupatorium perfoliatum*, boneset	Emergent Wetland Seed Mix	New topsoil
A Forested Wetland	*Onoclea sensibilis,* senstitive fern *Phalaris arundinacea,* reed canary grass *Cornus foemina,* gray dogwood *Cornus amomum*, silky dogwood *Fraxinus pennsylvanica* , Green ash *Parthenocissus quinquefolia* , Virginia Creeper *Ulmus Americana,* American Elm *Populus deltoids,* Eastern Cottonwood	Wooded Wetland Establishment Seed Mix Wetland Shrubs – Planted just above waterline. Recommend: silky dogwood (*Cornus amomum),* red osier dogwood (*Cornus stolonifera),* sandbar willow (*Salix exigua),* American Elm (*Ulmus Americana)*, Eastern Cottonwood (*Populus deltoids)*	New topsoil

- Detailed Seed Mixes on Following Pages -

Enbridge Pipelines, Inc. Talmadge Creek Oil Spill
Line 6B Spill Clean Up, Fredonia Township, Calhoun County, Michigan

Suggested Plant list for Wetland Restoration
For the emergent wetland areas the following plants will be used:

Scientific Name	Common Name	Oz/Acre
Permanent Grasses/Sedges/Rushes		
Carex comosa	bristly sedge	2.50
Carex lacustris	common lake sedge	0.25
Carex lurida	bottlebush sedge	4.00
Carex vulpinoidea	brown fox sedge	6.00
Eleocharis ovata	blunt spike rush	1.00
Juncus effuses	common rush	1.00
Leersia oryzoides	rice cut grass	3.00
Scirpus acutus	hard-stemmed bulrush	2.50
Scirpus pungens	chairmaker's rush	4.00
Scirpus validus	great bulrush	6.00
Temporary Cover		
Avena sativa	common oat	360.00
Lolium multiflorum	annual rye	104.00
Forbs		
Acorus calamus	sweet flag	1.00
Alisima sp.	water plantain	2.00
Asclepias incarnata	swamp milkweed	1.50
Cephalanthus occidentalis	buttonbush	1.00
Decodon verticillatus	swamp loosestrife	1.25
Eupatorium maculatum	spotted Joe-pye weed	0.50
Hibiscus sp.	rose mallow	3.00
Iris virginica	blue flag	6.00
Lobelia cardinalis	cardinal flower	0.25
Lobelia siphilitica	great blue lobelia	1.50
Ludwigia alternifolia	seedbox	0.25
Mimulus ringens	monkey flower	1.00
Peltandra virginica	arrow arum	16.00
Pontederia cordata	pickerel weed	10.00
Sagittaria latifolia	common arrowhead	2.00
Sparganium americanum	American bur reed	2.00
Sparganium eurycarpum	common bur reed	4.00
Verbena hastata	blue vervain	1.00

For the wetland edge areas that will not be inundated the following seed mix should be used:

Scientific Name	Common Name	Oz/Acre
Permanent Grasses/Sedges/Rushes		
Carex comosa	bristly sedge	1.00
Carex cristatella	crested oval sedge	2.00
Carex frankii	bristly cattail sedge	4.00
Carex lurida	bottlebush sedge	4.00
Carex vulpinoidea	brown fox sedge	3.00
Eleocharis palustris	great spike rush	0.50
Elymus virginicus	Virginia wild rye	12.00
Glyceria striata	fowl manna grass	1.00
Leersia oryzoides	rice cut grass	1.50
Scirpus atrovirens	dark green rush	1.00
Scirpus cypernius	wool grass	0.75
Scirpus pungens	chairmaker's rush	1.00
Scirpus validus	great bulrush	6.00
Sparganium eurycarpum	common bur reed	4.00
Temporary Cover		
Avena sativa	common oat	360.00
Lolium multiflorum	annual rye	100.00
Forbs		
Acorus calamus	sweet flag	1.00
Alisima sp.	water plantain	2.00
Asclepias incarnata	swamp milkweed	1.00
Aster puniceus	bristly aster	1.00
Bidens sp.	Bidens	2.00
Decodon verticillatus	swamp loosestrife	1.00
Eupatorium perfoliatum	common boneset	1.00
Helenium autumnale	sneezeweed	2.00
Hibiscus sp.	rose mallow	3.00
Iris virginica	blue flag	2.50
Lobelia siphilitica	great blue lobelia	1.00
Ludwigia alternifolia	seedbox	0.25
Mimulus ringens	monkey flower	1.50
Peltandra virginica	arrow arum	4.00
Rudbeckia laciniata	wild golden glow	0.75
Sagittaria latifolia	common arrowhead	2.00
Senna hebecarpa	wild senna	2.00
Thalictrum dasycarpum	purple meadow rue	1.50
Verbena hastata	blue vervain	1.20
Verbesina alternifolia	wingstem	0.75
Vernonia sp.	ironweed	2.00

For the forested wetland areas the following seed mix should be used:

Scientific Name	Common Name	Oz/Acre
Permanent Grasses/Sedges/Rushes		
Calamagrostis canadensis Grass	Bluejoint	1.00
Carex crinita	Fringed Sedge	2.00
Carex lupulina	Common Hop Sedge	4.00
Carex lurida	Bottlebrush Sedge	1.50
Carex frankii	Bristly Cattail Sedge	3.00
Carex squarrosa	Narrow-leaved Cattail Sedge	1.00
Carex typhina	Common Cattail Sedge	1.00
Carex vulpinoidea	Brown Fox Sedge	4.00
Elymus virginicus	Virginia Wild Rye	20.00
Glyceria striata	Fowl Manna Grass	2.00
Leersia oryzoides	Rice Cut Grass	2.00
Scirpus atrovirens	Dark Green Rush	2.00
Spartina pectinata	Prairie Cord Grass	1.00
Temporary Cover		
Avena sativa	common oat	360.00
Lolium multiflorum	annual rye	100.00
Forbs / Shrubs		
Alisma spp	Water Plantain Mix	3.00
Angelica atropurpurea	Great angelica	1.00
Aster puniceus	Bristly aster	0.75
Aster umbellatus	Flat-Top aster	0.25
Bidens cernua	Nodding Bur Marigold	2.50
Campanula americana	Tall Bellflower	0.25
Cephalanthus occidentalis	Buttonbush	0.50
Helenium autumnale	Sneezeweed	2.00
Heracleum lanatum	Cow Parsnip	0.75
Hibiscus moscheutos	Swamp Rose Mallow	2.00
Lobelia siphilitica	Great Blue lobelia	1.50
Lycopus americanus	Common Water Horehound	0.25
Mimulus ringens	Monkey Flower	1.25
Penthorum sedoides	Ditch Stonecrop	0.50
Polygonum spp.	Smartweed Mix	0.50
Rudbeckia laciniata	Wild Golden Glow	0.75
Verbesina alternifolia	Wingstem	2.00

Plugs planting: Planted just above the water line.

Plugs / Trees		
Scientific Name	Common Name	Price Per Plant
Cornus amomum	Silky dogwood	$0.90
Cornus stolonifera	Red Osier dogwood	$0.90
Salix exigua	Sandbar Willow	$1.35
Ulmus Americana	American Elm	$1.45
Populus deltoides	Eastern Cottonwood	$0.90

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Environmental Guidelines for Construction

December 2003

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WATERCOURSES and WETLANDS

02–11

Purpose

Watercourses are a major environmental concern associated with pipeline construction. Poor construction schedules or inadequate environmental mitigation measures can damage fish habitat, harm aquatic life and interfere with downstream water users. Pipeline construction also may alter stream substrates, cause physical or chemical changes in water quality or block fish movement. Although many environmental impacts are relatively short-term (i.e., the impact stops soon after the crossing is completed), long-term impacts may result if the watercourse is not properly restored.

Due to the unstable nature of some wetland soils, construction activities may differ from typical pipeline construction. As such, construction activities may be minimized in wetlands and/or special construction techniques required to minimize disturbance to plants and soils, and to protect wetland hydrology.

Requirements

Project Scheduling

Carry out instream activities during periods of low flow unless government agencies request an alternate schedule.

Postpone construction in watercourses if excessive flows or flood conditions exist or are anticipated, and construction methods cannot be modified to cope with the increased flow.

To minimize the duration and severity of disturbance, complete all instream activity within 48 hrs, unless site-specific conditions make this impractical.

NOTE: For more information on scheduling construction activities, see 01-3, Project Scheduling.

Permits/Licenses/Approvals

Where instream activities are required, obtain approval from fish and wildlife authorities, including federal authorities if required.

Any alternatives or modifications to the wetland crossing requirements specified in permits must be approved by the company before construction begins.

Before starting work, the contractor must provide the company with a tentative watercourse construction plan and schedule, and confirm the schedule (a) 14 days before and (b) 2 days before starting crossing construction.

NOTE: For more information on activities that require environmental permits and/or regulatory approvals, see 01-2, Planning and Preparation.

Clearing and Grading

Restrict clearing and grading to the minimum necessary to safely complete the job (see 02-4, Clearing and Grubbing, and 02-7, Grading).

Trenching

When practical, salvage upper stream bed material and replace last during stream bed restoration.

For information on trenching in watercourses and wetlands, see 02-8, Trenching.

Fish Habitats

When sport fish are concentrated in a watercourse area that requires blasting, use blast reflectors or absorbers, time delay charges and the smallest charges practical. If practical, remove fish and block their access to the area.

Erosion Control

Install temporary erosion control measures within 24 hrs of backfilling the crossing (see 02-13, Slope Breakers and 02-14, Temporary Sediment Barriers. For information on backfilling, see 03-2, Backfilling).

Guidelines

Construction Methods

Select an appropriate watercourse construction method based on geotechnical, biological and hydraulic considerations, and discussions with government agencies. Use Table 1, Watercourse Construction Methods as a guide to selecting an appropriate watercourse crossing construction method.

NOTE: If contaminated stream substrate is suspected, e.g., by industrial pollution, use a construction method that minimizes disturbance of the substrate (e.g., drill, bore).

Table 1
Watercourse Construction Methods

Construction Method	Small Watercourse less than 10 m (33 ft)			Medium Watercourse 10 to 20 m (33 to 65 ft)			Large Watercourse greater than 20 m (65 ft)		
	L	M	H	L	M	H	L	M	H
Wet Trench									
• hoe	4	4	7	4	4	7	4	4	7
• dragline	$	7	7	$	7	7	4	7	7
• dredging	$	$	$	$	$	$	4	4	4
Dry Trench									
• flume	4	4	4	4	4	4	—	—	—
• dam and pump	4	4	4	4	4	4	—	—	—
• high volume pump	4	4	4	4	4	4	—	—	—
Trenchless									
• boring	$	4	4	$	4	4	—	—	—
• directional drilling	$	$	$	$	$	$	$	4	4
Aerial									
• bridge attachment	$	$	4	$	4	4	$	4	4

NOTES

L = Low sensitivity
- no downstream water users
- no fish habitat impacted by construction
- no flow

M = Medium sensitivity
- downstream water users
- no significant impact on fish habitat by construction
- low probability of downstream habitat impacted by sediment

H = High sensitivity
- downstream water users cannot tolerate sediment load
- fish habitat directly impacted by sedimentation

4 = environmentally acceptable
$ = environmentally acceptable, however, may not be practical due to high construction cost
7 = not environmentally acceptable
— = not usually possible from an engineering or construction standpoint

Wet Trench

Use a wet trench construction method on narrow and/or warm water streams and rivers that will not be flumed, dammed and pumped, or directionally drilled (see Figure 1, Typical Waterbody Crossing Wet Trench Method)

NOTE: For dry intermittent streams and agricultural drainage ditches, use standard construction procedures (i.e., involving stringing, welding, excavating the trench with backhoes, installing the pipe in the trench and backfilling the trench with native material).

Where sedimentation is not a major concern, use the wet open cut method (see Figure 2, Water Crossing-Wet Open Cut of Large Rivers and Figure 3, Wet Open Cut of Small Rivers).

Dry Trench

Use a dry instream construction method where sedimentation is a concern, and where required by permits.

Dam and Pump/High Volume Pump

Use the dam and pump method on narrow watercourses with low stream flow (see Figure 4, Typical Waterbody Crossing Dam and Pump). On watercourses with moderate stream flow, use the high volume pump method (see Figure 5, Water Crossing-High Volume Pump).

NOTE: Have two pumps on hand, each sized with the pumping capacity of the anticipated stream flow, to ensure standby function.

If fish passage is a concern, do not use either the dam and pump or high volume pump construction method.

The dam and pump method involves damming the stream before excavating:

- Construct upstream and downstream dams of sandbags, steel plates, Aquadams™ or clean gravel with a plastic liner.
- Prevent interrupting downstream flow by pumping the water simultaneously with dam construction.
- Pump water across the construction area through a hose and onto an energy dissipation device back into the dry stream bed downstream (see Figure 4, Typical Waterbody Crossing, Dam and Pump Method).
- Continuously monitor dams for proper seal.
- Adjust the dams as necessary to prevent large volumes of water from seeping around the dams and into the construction work area.

NOTE: For more information on dewatering, see 02-17, Dewatering.

Place the pump in an impermeable, bermed area on the upstream side of the construction site to prevent any spilled fuel from entering the watercourse.

NOTE: Electric submersible pumps are the best option and should eliminate concerns with fuel spills.

Monitor the pumping operation at all times, and adjust the pump as necessary to maintain an even flow of water across the work

area and near-normal water levels upstream and downstream from the crossing.

A backup pump of equal or greater capacity must be onsite at all times in case the primary pump fails.

Pump standing water that is isolated in the construction area by the dams, or any stream water that leaks around the dams or seeps from the ground into the trench into a filter bag or a dewatering structure (see 02-17, Dewatering).

Flume

Use the flume method to cross sensitive, relatively narrow streams that have straight channels and that are relatively free of large rocks and bedrock at the point of crossing.

NOTE: The diameter of conduit (flume) must be large enough to accommodate the maximum stream flow.

The flume method involves placing a conduit in the stream bed to direct stream flow across the construction area without introducing sediment into the water (see Figure 6, Typical Waterbody Crossing, Flume Method):

- Install the flume(s), typically at least 12–18 m (40–60 ft) long, before trenching.
- Align the flumes such that water is not impounded upstream of the flume(s).
- Construct dams of sandbags, metal plate, water dam, plastic sheeting or clean rock (or equivalent) around the upstream and downstream ends of the flume(s).

NOTE: Construct the upstream dam first, to funnel stream flow into the flume(s). The downstream dam prevents backwash of water into the trench and construction work area, and keeps water in the excavation from moving downstream if flooding occurs.

Continuously monitor dams to ensure a watertight seal.

Adjust the dams as necessary to prevent large volumes of water from seeping around the dams and into the trench and construction work area.

Pump standing water that is isolated in the construction area by the dams, or any stream water that leaks around the dams or seeps from the ground into the trench:

- if clean, into the watercourse downstream of the crossing

- if dirty, into a filter bag or a dewatering structure (see 02-17, Dewatering)

NOTE: Salvage any stranded fish and relocate upstream

After backfilling a high sensitivity watercourse with a gravel bed, consider washing the gravel before removing the flume to minimize sediment washing downstream from the construction zone.

Remove the flume(s) after the pipeline is installed and stream banks have been restored.

Directional Drilling

Use directional drilling for large watercourses that are environmentally sensitive to instream or streambank activity, or where conventional methods are not feasible due to engineering or navigational constraints (see Figure 7, Typical Waterbody Crossing Directional Drill Method).

Directional drilling may be economically feasible for large deep rivers that require considerable extra cover, expensive reclamation work, or where slope stability is a concern or bank disturbance must be avoided.

NOTE: Obtain geotechnical data before drilling. Drilling may not be feasible in streambed materials such as unconsolidated gravel.

Set up drilling equipment a minimum of 16 m (50 ft) from the edge of the watercourse. Do not clear or grade this 16 m buffer area.

Use water from an approved source (typically the river) in accordance with applicable permits to mix drilling mud. The mud mix must be appropriate for aquatic life in the stream, e.g., pure bentonite clay with no unapproved additives.

During drilling operations, prevent mud and slurry from flowing into the stream or adjacent wetlands by storing it well back from the river bank, contained by an earthen berm sediment control structure, tanks or other methods.

Minimize mud pump pressure during entry and exit of the bore to prevent frac-out, i.e., borehole fracture and escape of mud.

NOTE: For more information on temporary erosion and sedimentation control, see 02-14, Temporary Sedimentation Control.

After the pipe is in place, spread excess drilling mud and slurry over an upland area if approved by the company, or haul excess offsite to an approved location.

Boring

Use the boring (or punching) method to cross irrigation canals and where practical, to cross natural watercourses (see Figure 8, Water Crossing Bored or Punched). This method may not be possible if there is excessive groundwater, sand or gravel, cobbles, large boulders or bedrock.

Obtain geotechnical data before boring or punching.

Push/Pull Method

For large wetlands with standing water and saturated soils, assemble the pipeline in an upland area, and position the pipe in the trench using the push-pull and/or float techniques:

- excavate the trench using a backhoe supported on timber mats
- push-pull the prefabricated section of pipe into position or float the pipe across the wetland
- when the pipeline is in position, remove floats, if used
- backfill the trench

NOTE: The push-pull and float techniques usually requires additional temporary workspace next to the ROW (for more information, see 01-6, Determining Workspace.

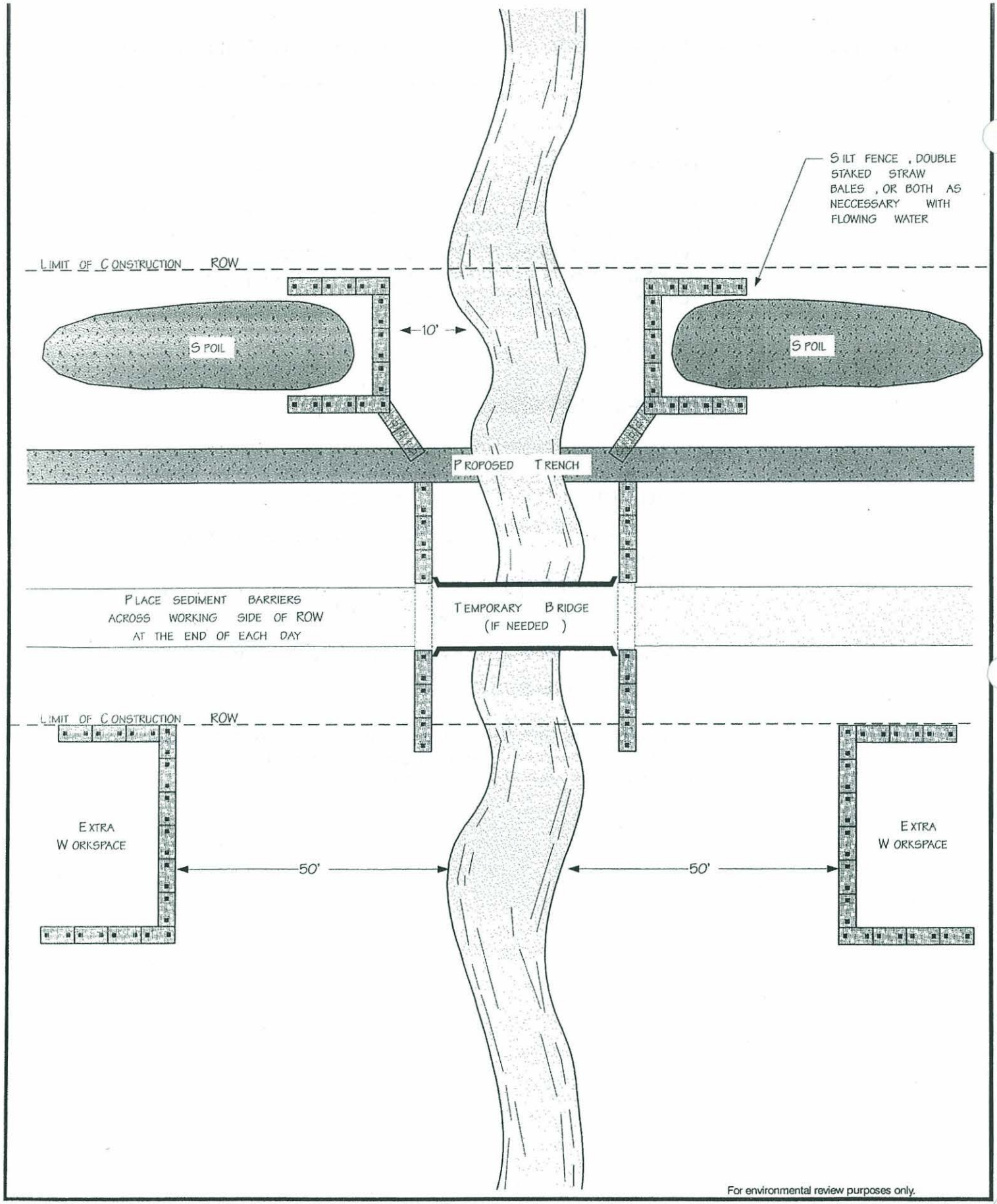

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Figure 1

Typical Waterbody Crossing
Wet Trench Method

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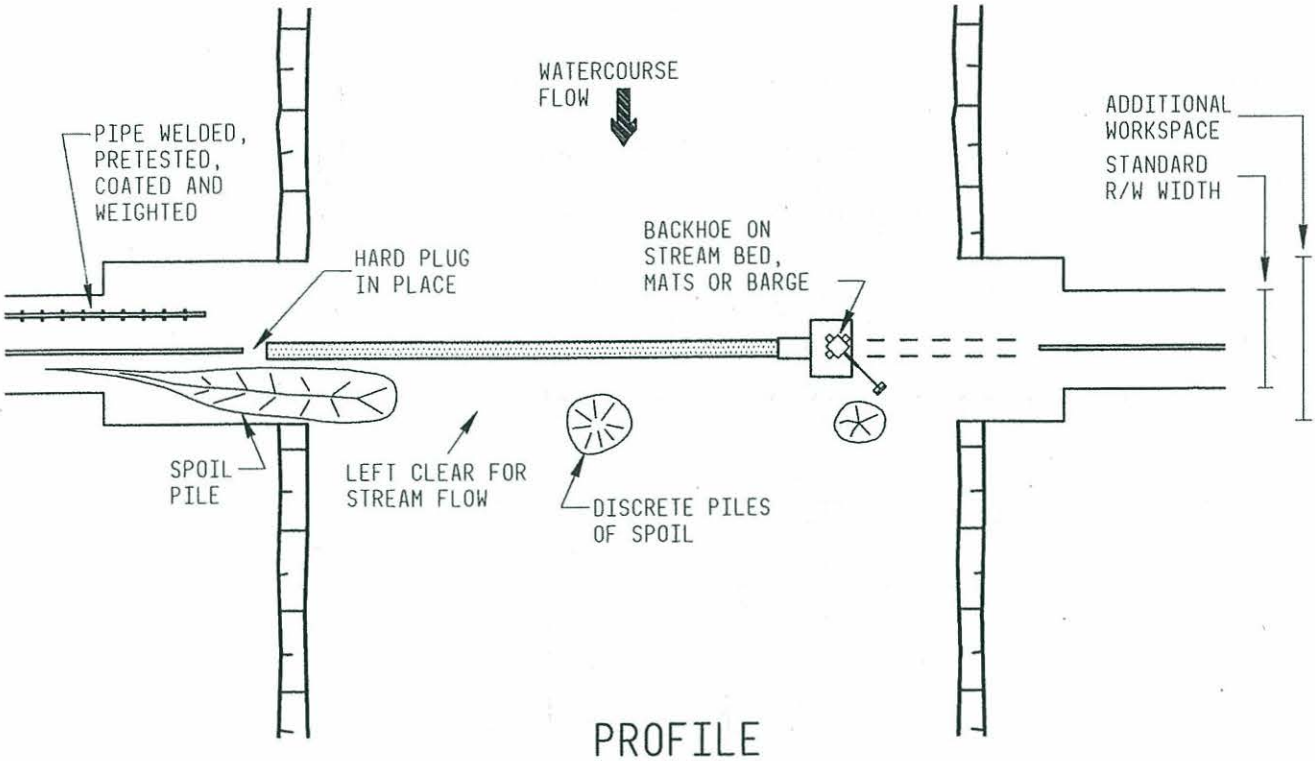

NOTES:

1. USE THIS TECHNIQUE ON LARGE WATERCOURSES WHEN A BACKHOE CANNOT REACH AT LEAST HALFWAY INTO THE CHANNEL.
2. SCHEDULE INSTREAM ACTIVITY FOR LOW FLOW PERIODS AND FOR THE APPROPRIATE TIMING WINDOW. OBTAIN ALL GOVERNMENT APPROVALS PRIOR TO INSTREAM CONSTRUCTION.
3. OBTAIN ADDITIONAL TEMPORARY WORK SPACE TO ALLOW INSTREAM SPOIL TO BE STORED ON BANKS WHERE POSSIBLE.
4. RESTRICT ROOT GRUBBING. DO NOT GRUB WITHIN 10m OF WATERCOURSE EXCEPT ALONG TRENCH LINE AND SPOIL PILE AREA WHEN ABSOLUTELY NECESSARY.
5. LEAVE HARD PLUGS AT BANK.
6. WELD, COAT, PRETEST AND WEIGHT PIPE PRIOR TO COMMENCEMENT OF INSTREAM CONSTRUCTION.
7. SERVICE OR REFUEL MOBILE CONSTRUCTION EQUIPMENT A MINIMUM OF 100m AWAY FROM WATERCOURSE.
8. TRENCH THROUGH WATERCOURSE RETAINING HARD PLUGS AT EACH BANK UNTIL JUST PRIOR TO PIPE INSTALLATION. STOCKPILE AS MUCH SPOIL ON BANKS AS POSSIBLE. PLACE INSTREAM STORAGE IN DISCRETE PILES AVOIDING AREAS OF HIGHEST WATER VELOCITY. DO NOT WINDROW SPOIL ACROSS THE CHANNEL OR BLOCK MORE THAN 2/3 OF THE CHANNEL. IF NECESSARY TO CONTROL WATER FLOW AND TRENCH SLOUGHING, INSTALL TEMPORARY SOFT PLUGS AND DEWATER TRENCH ON TO STABLE VEGETATED LAND, NOT DIRECTLY TO WATERCOURSE. MAINTAIN STREAMFLOW, IF PRESENT, THROUGHOUT CROSSING CONSTRUCTION. LOWER IN AND BACKFILL IMMEDIATELY. RESTORE STREAM CHANNEL TO APPROXIMATE PRECONSTRUCTION PROFILE AND SUBSTRATE. ATTEMPT TO COMPLETE ALL STREAM ACTIVITY WITHIN 24 HOURS.
9. RESTORE AND STABILIZE WATERCOURSE BANKS AND APPROACHES TO AS CLOSE TO ORIGINAL GRADES AS POSSIBLE (TO A MAXIMUM 3:1). INSTALL BANK PROTECTION WHERE APPROPRIATE.
10. SEED AND FERTILIZE BANKS IMMEDIATELY.

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Figure 2

Water Crossing -
Wet Open Cut of Large Rivers

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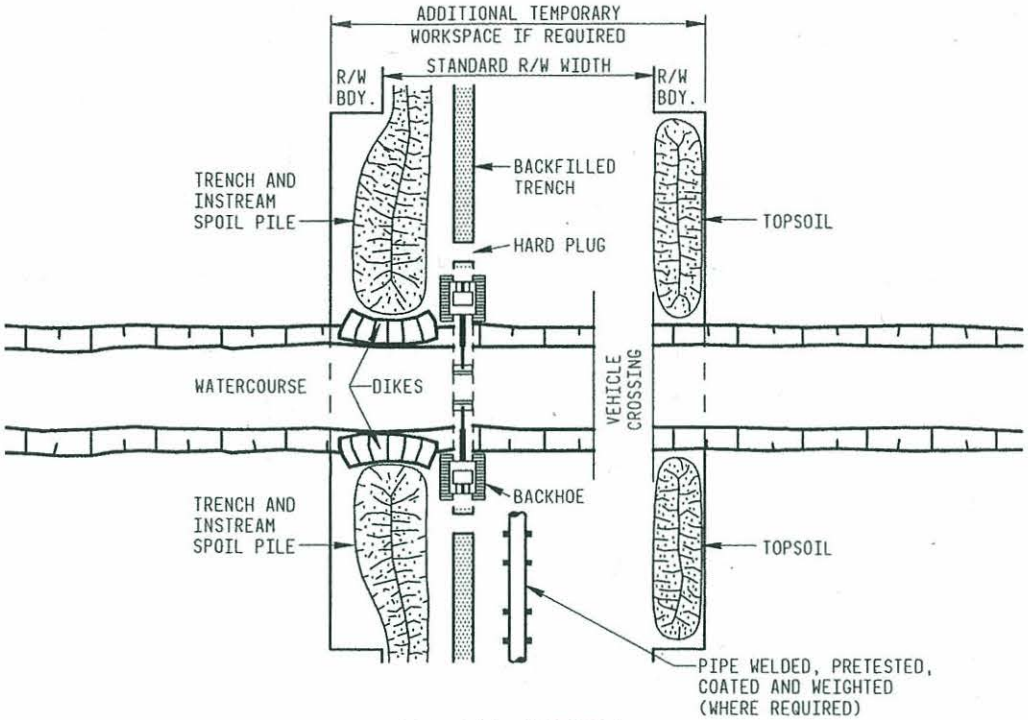

PLAN VIEW

NOTES:

1. USE THE WET CROSSING METHOD WHEN CONTROL OF SEDIMENTATION IS NOT A MAJOR CONCERN.
2. SCHEDULE INSTREAM ACTIVITY FOR LOW FLOW PERIODS AND FOR THE APPROPRIATE TIMING WINDOW. OBTAIN ALL GOVERNMENT APPROVALS PRIOR TO INSTREAM CONSTRUCTION.
3. OBTAIN ADDITIONAL TEMPORARY WORK SPACE TO ALLOW INSTREAM SPOIL TO BE STORED ON BANKS. ALL SPOIL SHOULD BE STORED ON BANKS OF ANY WATERCOURSES LESS THAN 20m WIDE.
4. INSTALL VEHICLE CROSSING IF REQUIRED.
5. RESTRICT ROOT GRUBBING. DO NOT GRUB WITHIN 10m OF WATERCOURSE EXCEPT ALONG TRENCH LINE AND SPOIL PILE AREA WHEN ABSOLUTELY NECESSARY.
6. WELD, COAT, PRETEST IFREQUIRED AND WEIGHT PIPE PROIR TO COMMENCEMENT OF INSTREAM CONSTRUCTION.
7. SERVICE OR REFUEL MOBILE CONSTRUCTION EQUIPMENT A MIN. OF 100m AWAY FROM WATERCOURSE.
8. TRENCH THROUGH WATERCOURSE RETAINING HARD PLUGS AT EACH BANK UNTIL JUST PRIOR TO PIPE INSTALLATION. STOCKPILE ALL INSTREAM SPOIL ON BANKS IF POSSIBLE. ON LARGER WATERCOURSES STOCKPILE AS MUCH SPOIL ON BANKS AS POSSIBLE. IF INSTREAM STORAGE IS REQUIRED; PLACE IN DISCRETE PILES AVOIDING AREAS OF HIGHEST WATER VELOCITY. DO NOT WINDROW SPOIL ACROSS THE CHANNEL OR BLOCK MORE THAN 2/3 OF CHANNEL. IF NECESSARY TO CONTROL WATER FLOW AND TRENCH SLOUGHING, INSTALL TEMPORARY SOFT PLUGS AND DEWATER TRENCH ON TO STABLE VEGETATED LAND, NOT DIRECTLY TO WATERCOURSE. MAINTAIN STREAMFLOW, IF PRESENT, THROUGHOUT CROSSING CONSTRUCTION. INSPECT, REPAIR OR REPLACE PIPE AND BACKFILL IMMEDIATELY. RESTORE STREAM CHANNEL TO APPROXIMATE PRECONSTRUCTION PROFILE AND SUBSTRATE. ATTEMPT TO COMPLETE ALL STREAM ACTIVITY WITHIN 24 HOURS.
9. RESTORE AND STABILIZE WATERCOURSE BANKS AND APPROACHES TO AS CLOSE TO ORIGINAL GRADE AS POSSIBLE (TO A MAXIMUM 3:1). INSTALL BANK PROTECTION WHERE APPROPRIATE.
10. SEED AND FERTILIZE BANKS IMMEDIATELY.

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Figure 3

Water Crossing -
Wet Open Cut of Small Rivers

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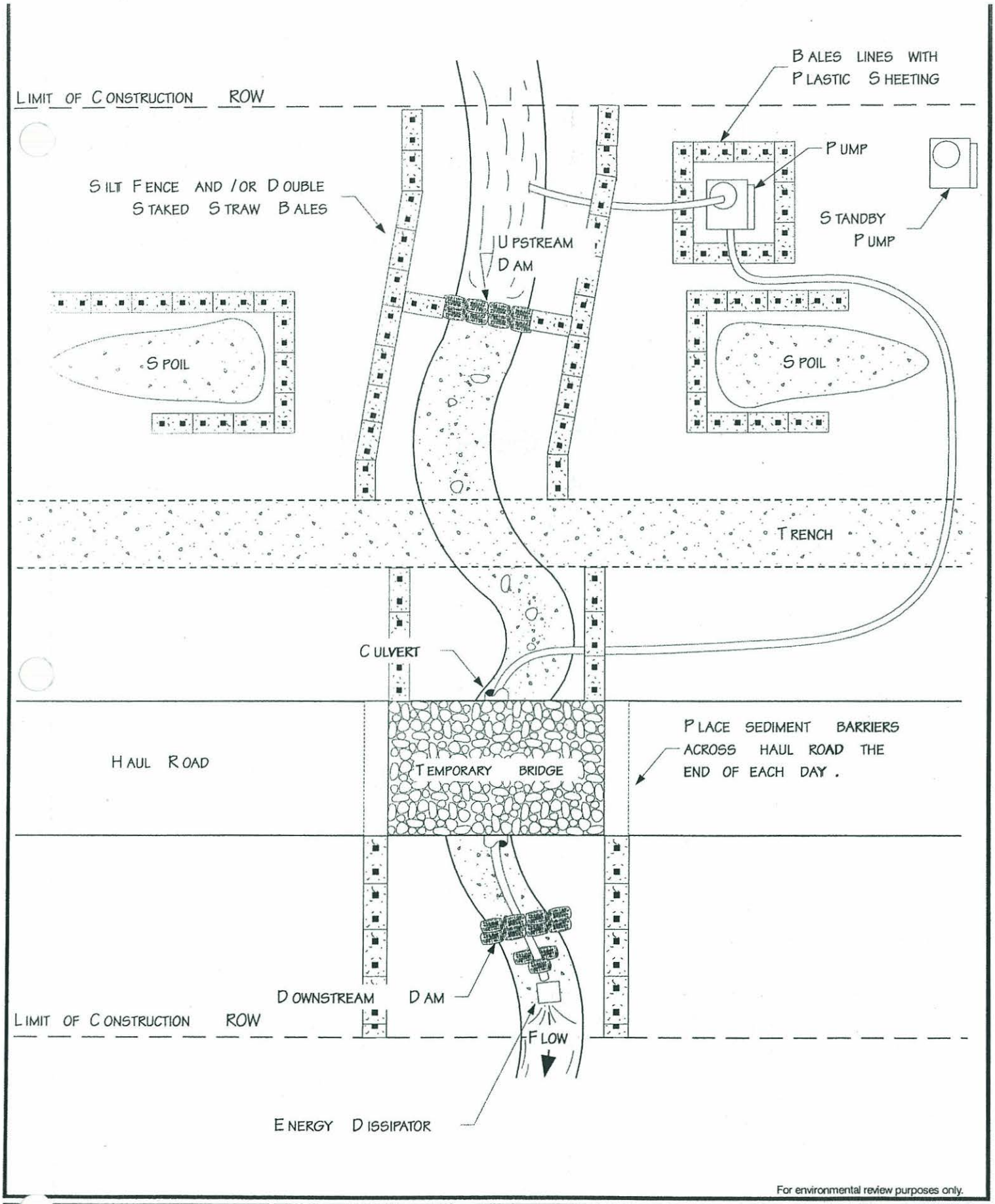

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Figure 4

Typical Waterbody Crossing
Dam and Pump Method

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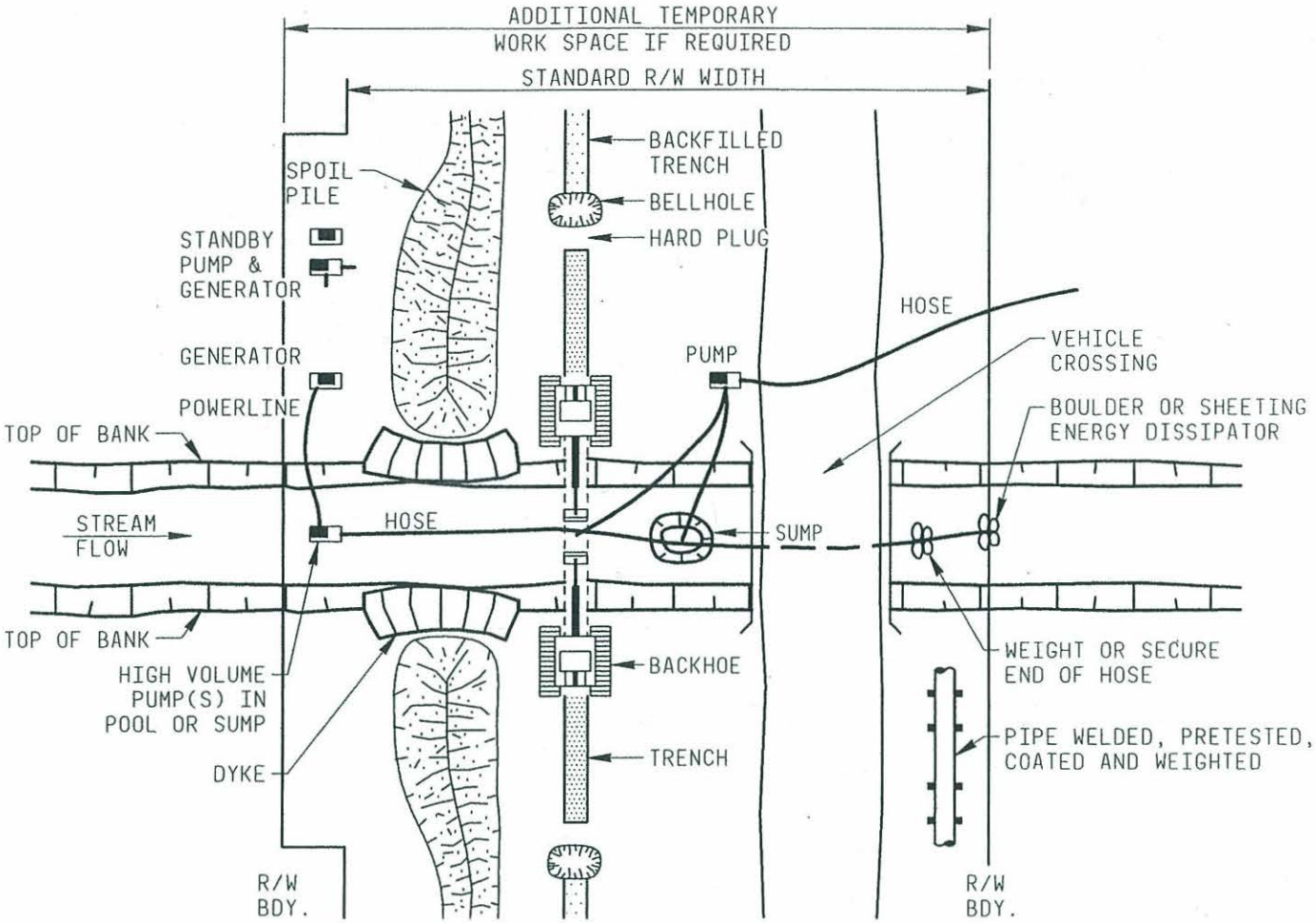

PLAN VIEW

NOTES:

1. USE HIGH VOLUME PUMP METHOD ON WATERCOURSES WITH MODERATE STREAMFLOW TO PREVENT SEDIMENTATION AND INTERRUPTION OF STREAMFLOW DURING INSTREAM WORK. THIS METHOD IS NOT APPROPRIATE IF FISH PASSAGE IS A CONCERN.
2. SCHEDULE CONSTRUCTION DURING LOW FLOW ON LARGE WATERCOURSES.
3. INSTALL TEMPORARY VEHICLE CROSSING
4. ENSURE ADEQUATE ELECTRIC POWER SUPPLY AND ADEQUATELY SIZED PUMPS. HAVE STANDBY PUMP(S) ON SITE.
5. INSTALL PUMP IN POOL LOCATED UPSTREAM OF THE EXCAVATION. DIG TEMPORARY SUMP UPSTREAM IF NO NATURAL POOL EXISTS. ADD ADDITIONAL PUMPING CAPACITY IF REQUIRED. DISCHARGE WATER THROUGH OR INTO AN ENERGY DISSIPATOR INTO THE RIVER CHANNEL SUFFICIENTLY DOWNSTREAM OF THE TRENCH TO PREVENT WATER FLOWING BACK INTO THE EXCAVATION.
6. IMMEDIATELY INITIATE FISH SALVAGE FROM ISOLATED POOLS. ENSURE FISH SALVAGE PERMIT(S) ARE ACQUIRED PRIOR TO INSTALLING PUMP.
7. DIG A SMALL SUMP DOWNSTREAM OF CROSSING TO COLLECT SILT LADEN WATERS. INSTALL SMALL PUMPS IN SUMP AND TRENCH TO DISCHARGE SILT-LADEN WATER ON TO WELL VEGETATED SOILS AWAY FROM THE WATERCOURSE.
8. EXCAVATE TRENCH, COMPLETE REPAIR WORK AND BACKFILL TRENCH. MOVE HOSE AS REQUIRED TO MAINTAIN STREAMFLOW.
9. WASH BACKFILLED TRENCH AREA INTO SUMP. PUMP SILT-LADEN WATER FROM TRENCH ONTO A WELL VEGETATED AREA OFF RIGHT OF WAY. ALSO COMPLETE THIS STEP IN THE EVENING PRIOR TO SHUTTING OFF UPSTREAM PUMP IF INSTREAM WORK IS TO OCCUR ON SUCCESSIVE DAYS.

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Figure 5

Water Crossing -
High Volume Pump

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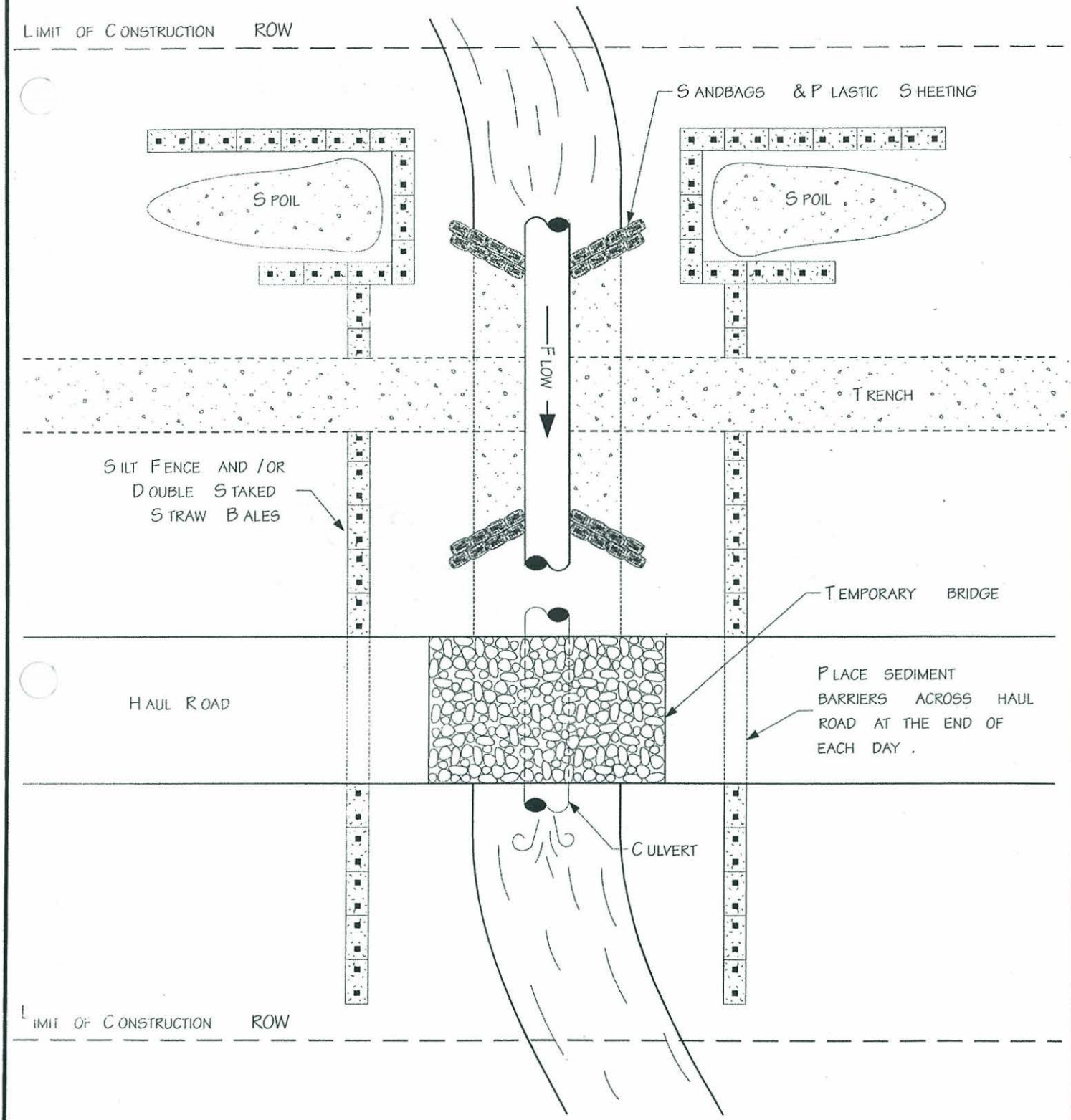

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Figure 6

Typical Waterbody Crossing
Flume Method

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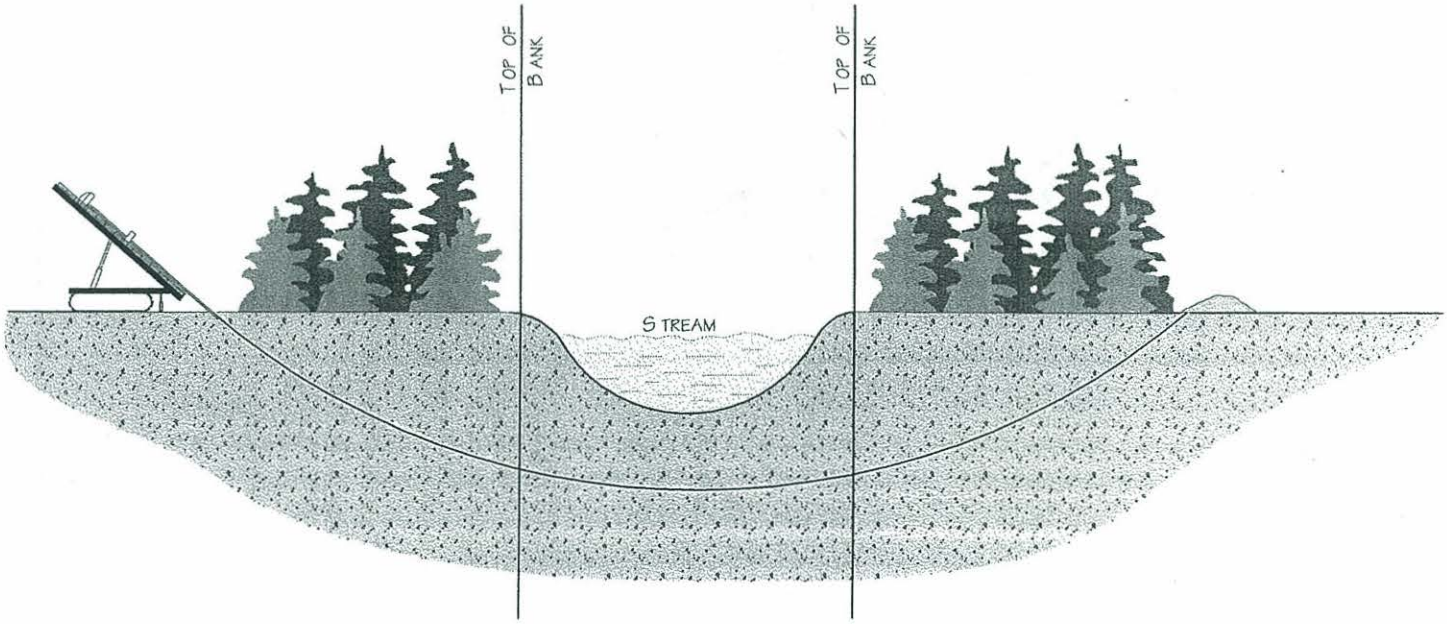

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Figure 7

Typical Waterbody Crossing
Directional Drill Method

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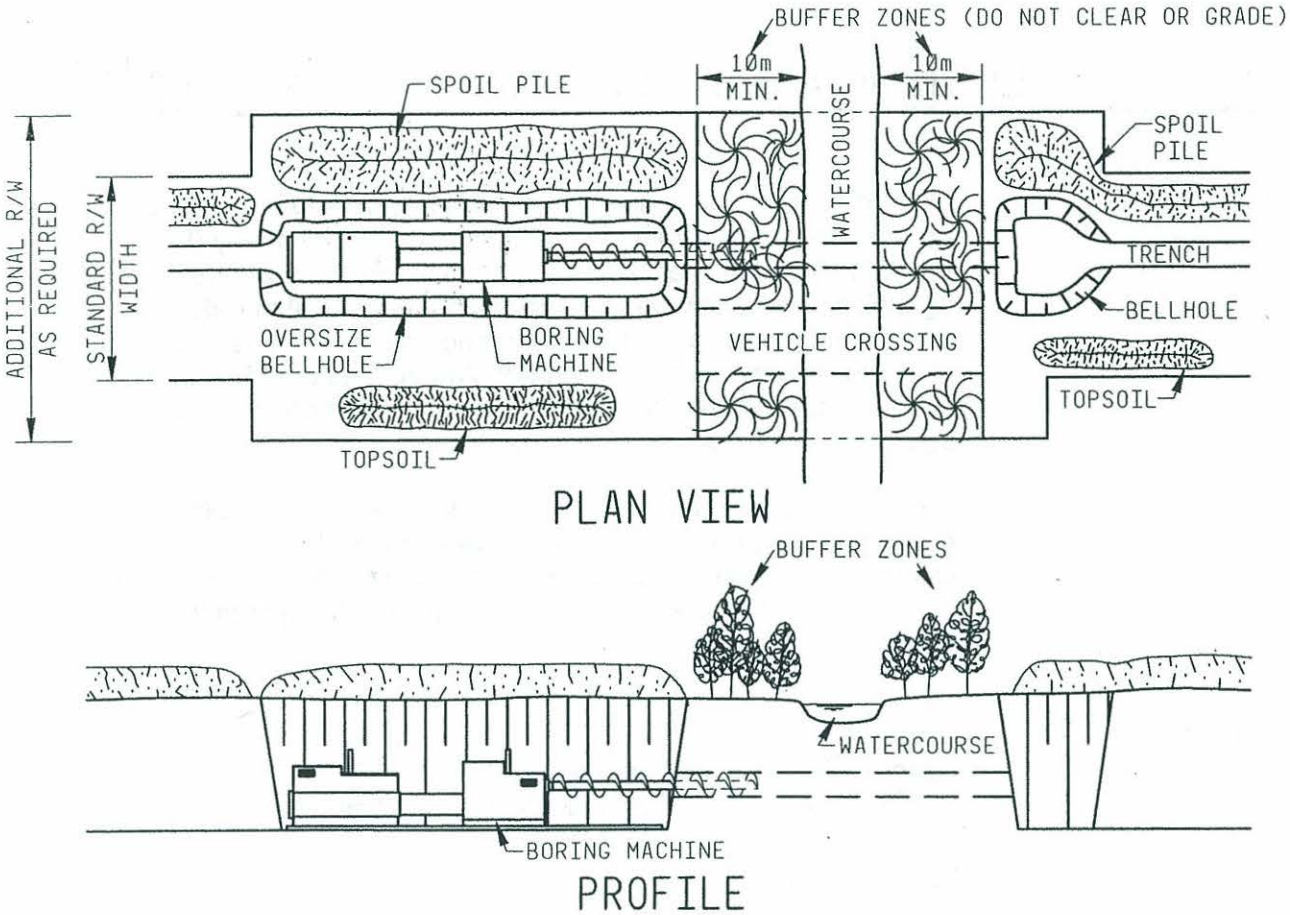

NOTES:

1. BORE (OR PUNCH) WATERCOURSE CROSSING TO PREVENT SEDIMENTATION OF WATERCOURSE, INTERRUPTION OF STREAM FLOW, AND ALTERATION OF STREAM SUBSTRATE. THIS METHOD IS APPROPRIATE FOR CROSSING IRRIGATION CANALS AND OCCASIONALLY, FOR CROSSING NATURAL WATERCOURSES. HOWEVER, IT MAY NOT BE POSSIBLE IF THERE IS EXCESSIVE GROUNDWATER, OR A PERMEABLE OR ROCKY SUBSTRATE OF GRAVEL, COBBLES, LARGE BOULDERS OR BEDROCK. OBTAIN GEOTECHNICAL DATA PRIOR TO COMMENCING BORING (OR PUNCHING).
2. AQUIRE AND MARK ADDITIONAL TEMPORARY WORK SPACE.
3. INSTALL VEHICLE CROSSING.
4. EXCAVATE BELLHOLE. STORE SPOIL ON OPPOSITE SIDE OF RIGHT OF WAY.
5. COMPLETE BORING AND TIE-IN TO MAINLINE.
6. PUMP BELLHOLE DRY IF SEEPAGE BECOMES A PROBLEM.
7. BACKFILL AND COMPACT. LEAVE A CROWN TO ALLOW FOR SUBSIDENCE.
8. RESEED AND FERTILIZE AS APPROPRIATE.

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Figure 8

Water Crossing - Bored or Punched

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OVERVIEW of RESTORATION

03–1

Purpose

Once pipe laying is complete, the company is required to clean up, restore and maintain the project site and right-of-way (ROW) in a condition that is acceptable to both landowners and regulatory agencies. Poor clean up and restoration may result in reduced agricultural, recreational and other land use capabilities, and may cause long-term impacts to fish populations and wildlife habitats. In addition, public relations with landowners and government agencies may be adversely affected.

The standards and procedures in this tab ensure the effectiveness of ongoing long-term environmental protection. Where environmental impacts are suspected, a post-activities inspection and monitoring program must be established as required by government agencies.

Legislation

CAN

Canada

National Energy Board (NEB):

- Onshore Pipeline Regulations, latest edition

Land Use Regulations

USA

United States

Department of Transportation (DOT), Pipeline Safety Regulations:

- Part 195, Transportation of Hazardous Liquids by Pipeline

Area contingency plan/regional contingency plan
Clean Air Act
Clean Water Act
Comprehensive Environmental Response Cleanup and Liability Act (CERCLA)
Emergency Planning and Community Right to Know Act (EPCRA)
Federal, state and local environmental agency regulations
National Environmental Policy Act (NEPA)
Oil Pollution Act (OPA)
Safe Drinking Water Act

BACKFILLING

03–2

Purpose

Backfilling generally involves replacing the material excavated from the trench and is the first stage in restoring the right-of-way (ROW). In areas where topsoil has been segregated, the subsoil is replaced and the topsoil spread uniformly over the area where it was removed. An earth crown is left over the trench line (except in wetlands) to allow backfill material to settle.

Improper backfilling can affect the quality of final restoration on the project. Poorly compacted backfill material or an excessive crown can cause drainage problems and inconvenience to landowners, livestock and wildlife. In addition, mixing topsoil with subsoil during backfilling may reduce soil capability.

Guidelines

Before backfilling, inspect the trench for small mammals and reptiles, skids, refuse, welding rods and other debris, and remove if present. Inspect the backfill material to ensure it is free of debris or other material that could damage the pipeline.

Backfill as soon as practicable after lowering-in the pipe to the desired depth. During winter construction, ensure backfill is completed by nightfall.

Confine backfill activities to the ROW. To prevent damage off the ROW, use a Mormon board, backhoe or specialized excavator (e.g., Gradall) where there is insufficient working space for bulldozers.

Use a backfill auger (e.g., Brown Bear), power dozer or suitable equipment to break up clods or frozen soils if required.

Avoid mixing snow with spoil.

Pad the pipe if backfill is frozen or stony, or if bedrock must be replaced. Dispose of surplus rocks at sites approved by the landowner or government agency.

On cultivated lands, leave the top 0.5 m (20 in.) of trench free from rocks to prevent interference with farm equipment. The average spacing and size of rocks left on the ROW should be no more than on adjacent lands.

On pasture lands and woodlands, avoid scalping the sod layer when replacing the topsoil and spoil. To prevent scalping, mount a urethane "prairie protector" attachment to backfill equipment, or use modified street sweepers to protect the sod layer.

On sandy soils and dunes, replaced graded fill to less than the natural angle of repose so that continual sloughing does not become a problem.

Trench Breakers

Before backfilling on steep slopes, install any necessary trench breakers to force groundwater along the pipe to the surface (see 02-15, Trench Breakers).

Subdrains

Before backfilling, install any necessary subdrains to divert shallow groundwater flow from the ROW and to improve slope stability (see Figure 1, Subdrains).

Drain Tiles

Before backfilling, determine whether any drain tiles crossed during trenching were damaged during construction. Use a sewer rod or pipe snake to probe open ends of tiles (see Figure 2, Drainage Tile Restoration).

Repair any damaged tiles by inserting a competent support (e.g., length of solid pipe) around the tile to prevent settling. If damage is extensive, remove broken tile and replace with new tile.

Drain tiles damaged during construction must be repaired to their preconstruction condition or better.

Backfill around drain tiles in lifts. Compact each lift.

Compaction

Backfill the trench with soil to a height approximately 300 mm (1 ft) above the level of the surrounding ground, except at potential drainage courses.

To compact backfilled spoil, run a grader along the trench once it has been filled just below the level of the surrounding ground.

NOTE: Compaction with a grader is essential to avoid ditch subsidence. Although the degree of compaction is limited by factors such as soil type, frost and moisture content, depth of cover, pipe strength and insulation, compaction is typically achieved by a few passes with a grader.

CAUTION: Do not run a grader over foreign lines. To compact backfill near foreign lines, use manually operated compaction equipment or another approved method.

On irrigated fields and open cut road crossings, 100% percent compaction is desirable. Use appropriate-sized compaction equipment and compact in multiple lifts.

To minimize subsidence on irrigated fields, compact backfill in a series of 15 cm (6 in.) lifts, or as indicated in project specifications. Avoid the formation of a trench crown or other obstacles that may impede the movement of sprinkler systems.

Compact the trench crown where pivot irrigation wheels pass. If compaction is not adequate at pivot wheel crossings, install a steel plate until compaction is achieved.

NOTE: Inspect and monitor the trench before and during the first irrigation season to determine the success of the trenchline compaction and leveling.

Take extra care to avoid using saturated, wet spoil when compacting the trench at the banks of watercourses.

If trench spoil is frozen, postpone compaction until cleanup in mid to late spring.

Watercourses

Backfill stream beds to their original contour with original stream bed material unless permits specify otherwise.

When backfilling stream banks, pump the ditch dry, then use dry soil in compacted lifts to prevent stream bank sloughing.

At watercourses where sport fish spawn, replace the upper layer of streambed material with previously salvaged materials (see 02-11, Watercourses and Wetlands), or backfill the upper layer of the trench with material equal to, or better than, original stream bed material.

Wetlands

When backfilling wetlands, replace subsoil material removed from the trench during construction so that no crown remains, unless soils are frozen. If a crown is left over the trench in wetlands to account for settling of frozen backfill, leave periodic breaks to prevent damming, and restore the original contours during cleanup the following spring or summer.

Do not use segregated topsoil as padding. Return segregated topsoil to its original horizon over the backfilled trench.

Crowning

Crown the trench with remaining spoil to allow for settlement. The height of the crown depends on:

- land use
- degree of compaction desired
- swell coefficient of backfill (see Table, Swell Coefficient of Backfill)
- soil temperature

Ensure the crown is centered over the ditchline.

On forested lands, a higher crown is acceptable provided drainage and wildlife are unaffected.

Frozen soils require higher crowns than unfrozen soils.

On agricultural lands with unfrozen soils, the crown should be low and wide to facilitate replacing topsoil.

Feather excess spoil over the stripped portions of the ROW to create a smooth mound. If more room is needed for excess spoil, strip one blade width (approximately 3–4 m [10–13 ft]) of topsoil from the spoil or work areas of the crown to facilitate feathering out excess trench spoil without mixing subsoil with topsoil.

Leave breaks in the trench crown:

- in obvious drainage runs
- whenever seepage occurs
- at regular intervals where sidehill is encountered

Compact backfill where breaks in the trench crown are left.

NOTE: The breaks may require maintenance the following year to fill in settled areas.

Table 1 shows the swell coefficient of various soil types. To calculate the height of a crown, use the formula:

$$R = s \times D$$

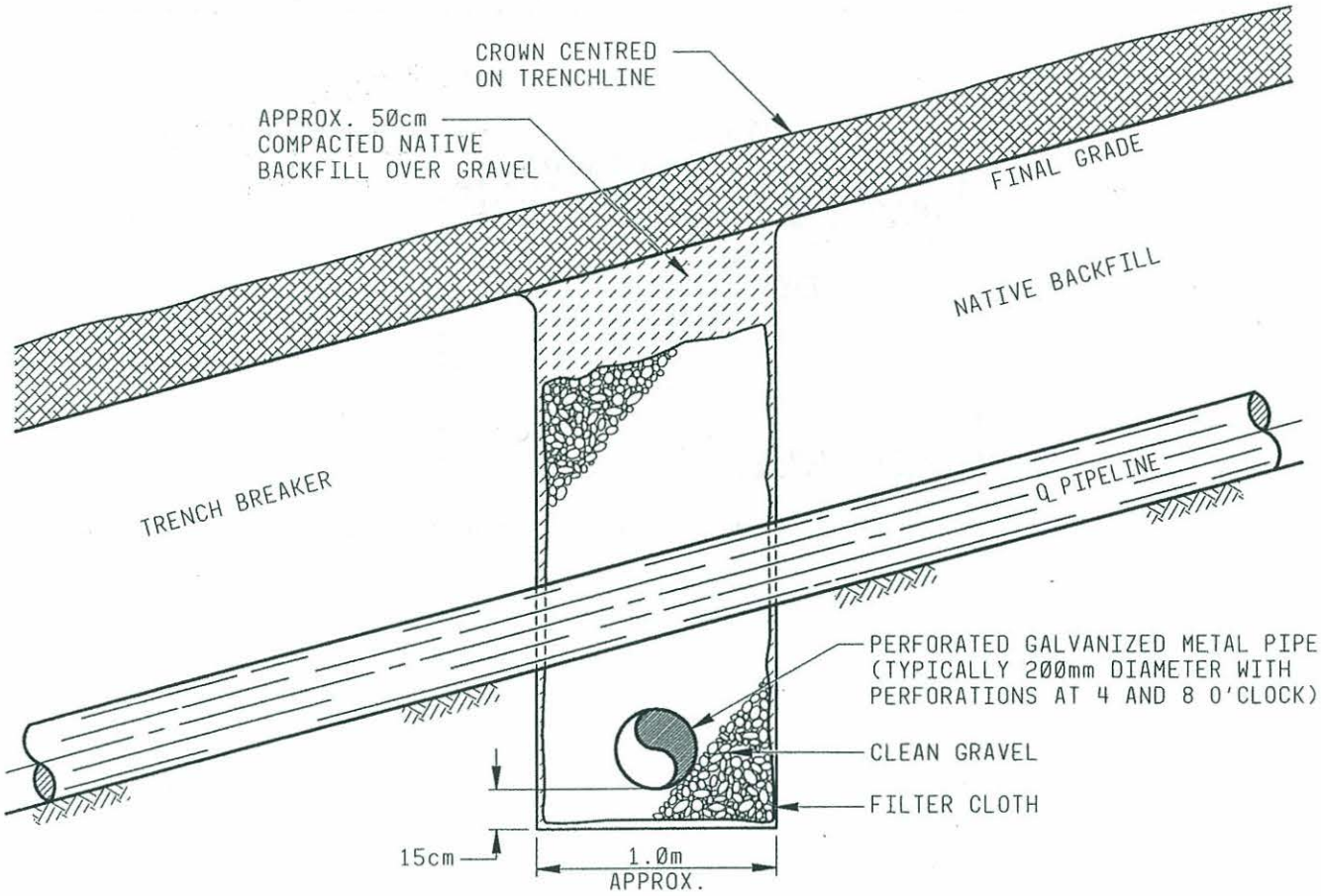
Where:

R = height of crown
s = swell coefficient
D = depth of trench

Table 1
Swell Coefficient of Backfill

Type of Backfill	Swell Coefficient
blasted rock	.00–.05
sand and gravel	.05–.10
sand	.08–.15
silty sand	.10–.15
silt	.10–.20
clay	.10–.25
organic (muskeg)	.50–1.00

NOTE: The higher numbers in the range represent the worst case (i.e., frozen or clods).



PROFILE

NOTES:

1. INSTALL A SUBDRAIN TO DIVERT SHALLOW GROUNDWATER FLOW AWAY FROM THE PIPELINE, TO IMPROVE SLOPE STABILITY. CLEAN GRAVEL, WRAPPED IN FILTER CLOTH, PERMITS DRAINAGE AIDING IN RETENTION OF BACKFILL. IN CERTAIN CIRCUMSTANCES, A PARALLEL DRAIN MAY BE INSTALLED LENGTHWISE DOWN THE SLOPE UNDERNEATH THE PIPELINE. A GEOTECHNICAL ENGINEER CAN ADVISE IN WHICH METHOD IS MOST APPROPRIATE.

2. DETERMINE THE LOCATION OF DRAIN BY ON-SITE INVESTIGATION CONSIDERING SUCH FACTORS AS GROUNDWATER CONDITIONS IN TRENCH, SOIL TYPES, LOCAL TOPOGRAPHY, AND DRAINAGE PATTERNS.

3. SKEW CROSS DRAIN WITH DOWNHILL GRADING AT 5° TO ENSURE SUFFICIENT DRAINAGE.

4. INSTALL TRENCH BREAKER DOWNSLOPE OF DRAIN, WHERE DRAINS CROSS PIPELINE TRENCH, TO PREVENT DRAIN WATER FLOWING DOWN PIPE TRENCH

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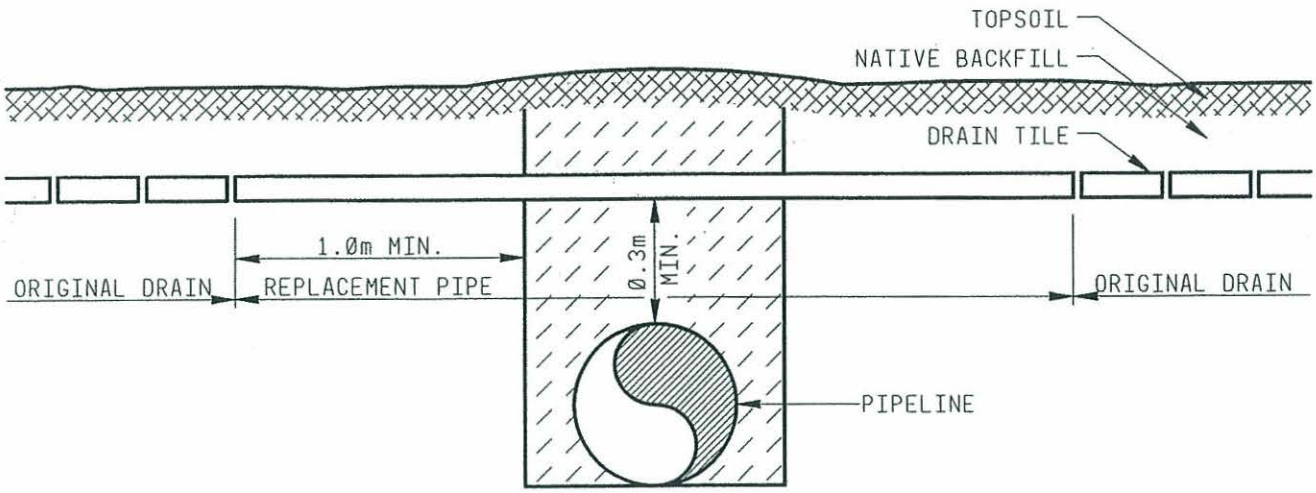
Figure 1

Subdrain



PROFILE
(CROSS-SECTION OF TRENCH)

NOTES:

1. IF TILE OR TUBE DRAINS ARE CUT DURING TRENCHING, MARK LOCATIONS, CAP DRAINS TO PREVENT CLOGGING WITH DIRT OR DEBRIS, AND INSTALL A TEMPORARY FLUME TO MAINTAIN DRAINAGE.

2. PROIR TO TOPSOIL REPLACEMENT, REPLACE DRAINS WITH A LENGTH OF SOLID PIPE TO PREVENT SETTLING. IF DISTURBANCE IS EXTENSIVE, REPLACE WITH NEW DRAIN TUBING, OR PERFORATION SOLID PIPE ON A COMPACTED BED.

3. INSERT A SEWER ROD OR PIPE SNAKE INTO OPEN DRAIN ENDS FAR ENOUGH TO ENSURE THAT RIGHT OF WAY TRAFFIC HAS NOT DAMAGED OR DISPLACED DRAINS

4. REPAIR ANY DAMAGED TILES BY INSERTING A COMPETENT SUPPORT (E.G. LENGTH OF SOLID PIPE) AROUND THE TILE TO PREVENT SETTLING.

5. IF DAMAGE IS EXTENSIVE, REMOVE BROKEN TILE AND REPLACE WITH NEW TILE.

6. REPLACE DRAIN TO ITS FORMER GRADIENT AND ALIGNMENT.

7. BACKFILL AND COMPACT SUBSOIL IN LIFTS BENEATH AND AROUND PIPE.

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Figure 2

Drainage Tile Restoration

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CLEANUP

03–3

Purpose

Cleanup typically involves removing construction refuse and debris from the right-of-way (ROW), grading to restore disturbed areas to original contours, installing or repairing erosion control structures, and replacing topsoil and fences removed during construction. The quality of work done during cleanup often directly affects future relations with landowners and government agencies.

Guidelines

Scheduling

Summer/Fall

Clean up summer/fall projects as soon as possible after backfilling, and before freezeup, if possible.

Postpone cleanup on wet ground until soils dry out.

Winter/Spring (Rough)

Begin rough cleanup of winter projects as soon as possible after backfilling (frozen conditions) and before spring breakup.

Winter/Spring (Final)

Begin final cleanup of projects not completed before freezeup and cleanup of winter projects as soon as possible after spring breakup.

Schedule cleanup to minimize interference with agricultural operations, migratory birds and fish spawning as much as possible.

For damaged soils, postpone cleanup until soils dry out.

Before final cleanup, consult with the landowner to ensure any special concerns can be addressed before completing restoration.

Waste

Collect and dispose of all construction-related garbage, debris, wastes and hazardous materials from the ROW in designated containers or at approved facilities.

NOTE: For appropriate waste management practices, see the Waste Management Plan.

Do not leave waste on or along the ROW, or buried in an excavation.

Remove stones to achieve equivalence with the surrounding subsoil/topsoil, as well as stones from the upper 30 cm (1 ft) of soil that will interfere with topsoil replacement or cultivation, i.e., stones larger than 10 cm (4 in.) in diameter. Dispose of stones at locations approved by landowners or government agencies.

Dispose of excess rock displaced from the trench or ROW by blasting as directed by landowners or government agencies.

Topsoil Replacement

Replace topsoil as evenly as possible over stripped areas of the ROW.

Postpone replacing topsoil during wet weather or high winds to prevent damaging soil structure or erosion of topsoil.

Immediately before replacing topsoil, cut a clean edge with a grader. Distribute edge cut material evenly over the prepared subsoil surface.

Regrading

Regrade areas with vehicle ruts, erosion gullies, settled trenches or where the trench crown is misaligned.

Regrade stream banks and approaches to a maximum of 1:3 (rise over run), unless otherwise directed by a geotechnical engineer.

Recontouring

Recontour the right-of-way (ROW) to restore surface drainage and the approximate preconstruction profile. When replacing sidehills or other graded areas is not practical due to the risk of slope failure or ovalling the pipe, recontour slopes to grades not exceeding 1:3 (rise over run) or as advised by a geotechnical engineer.

If fill is frozen, postpone recontouring until spring.

On flood irrigated lands, recontour the ROW to preconstruction profile.

Wetlands

Restore the original contours of wetlands, and remove any excess backfill to an upland area approved by the environmental department.

Damaged Soils

Rip compacted subsoils, temporary access trails and soils damaged during wet weather with a multishank ripper to a depth of 30 cm (12 in).

Use a disk plow or cultivator on ripped subsoils to break up lumps and to smooth the surface.

NOTE: To minimize further compaction, limit disking to what is necessary to break up clods.

Till or cultivate fields and any severely compacted or rutted areas with a deep tillage device or chisel plow to loosen compacted soils.

Corduroy

Remove corduroy from locations where drainage disruptions are likely, where requested by landowners or government agencies, and from mineral soils.

Remove and return clay or sand caps overlying corduroy to the original location, unless otherwise requested by landowners or government agencies.

Ensure adequate culverts or other cross drainage is provided in any capped corduroy that is left in place.

Dispose of corduroy, slash and any remaining leaning trees in the same manner as the original clearing (see 02-4, Clearing).

Cultivation

Cultivate the ROW where it crosses fields, bush or woodlands to a depth adequate to alleviate surface compaction and in a manner acceptable to the landowner. Do not pulverize soil.

If seeding immediately after topsoil is replaced, harrow the ROW.

Cultivate hay and pasture land if the sod layer is broken or badly compacted.

With the approval of the landowner at problem sites, add manure or plant legumes to increase organic matter.

Equipment Crossings

Where possible, remove equipment crossing structures before freezeup (summer/fall projects) or before spring breakup (winter projects).

If equipment crossings are needed for access during final seeding, they can be replaced after spring breakup.

Temporary Erosion Control

Use temporary erosion control measures, e.g., sandbags, logs or straw bales, during rough cleanup on undisturbed pasture or well-sodded right-of-way (ROW).

Install temporary stream bank protection during rough cleanup if erosion is evident at water crossings (see 02-13, Slope Breakers and 02-14, Temporary Sediment Barriers).

To minimize drifting soils and loss of topsoil in areas prone to wind erosion:

- spread wood chips or straw crimping
- sow a fast growing ground cover
- walk down tree and shrub debris over exposed soils

If winter conditions preclude final cleanup, stabilize the area (e.g., flatten topsoil piles, partially fill grade cuts) and keep temporary erosion control measures in place until permanent erosion control measures can be installed.

Temporary Slope Breakers/Sediment Barriers

During frozen conditions, install temporary slope breakers and sediment barriers during rough cleanup if final cleanup is not completed until the following spring (see 02-13, Slope Breakers and 02-14, Temporary Sediment Barriers).

Mulch

Mulch slopes greater than 5%. Apply mulch after the last grading operation of winter construction.

NOTE: Mulch can be applied to snow-covered ground.

Do not apply mulch by hand or apply more than 2 tons per acre, as it may be removed the following spring before seeding.

Wetlands

Restore the original contours of wetlands, and remove any excess backfill to an upland area approved by the environmental department.

Damaged Soils

Rip compacted subsoils, temporary access trails and soils damaged during wet weather with a multishank ripper to a depth of 30 cm (12 in).

Use a disk plow or cultivator on ripped subsoils to break up lumps and to smooth the surface.

NOTE: To minimize further compaction, limit disking to what is necessary to break up clods.

Till or cultivate fields and any severely compacted or rutted areas with a deep tillage device or chisel plow to loosen compacted soils.

Corduroy

Remove corduroy from locations where drainage disruptions are likely, where requested by landowners or government agencies, and from mineral soils.

Remove and return clay or sand caps overlying corduroy to the original location, unless otherwise requested by landowners or government agencies.

Ensure adequate culverts or other cross drainage is provided in any capped corduroy that is left in place.

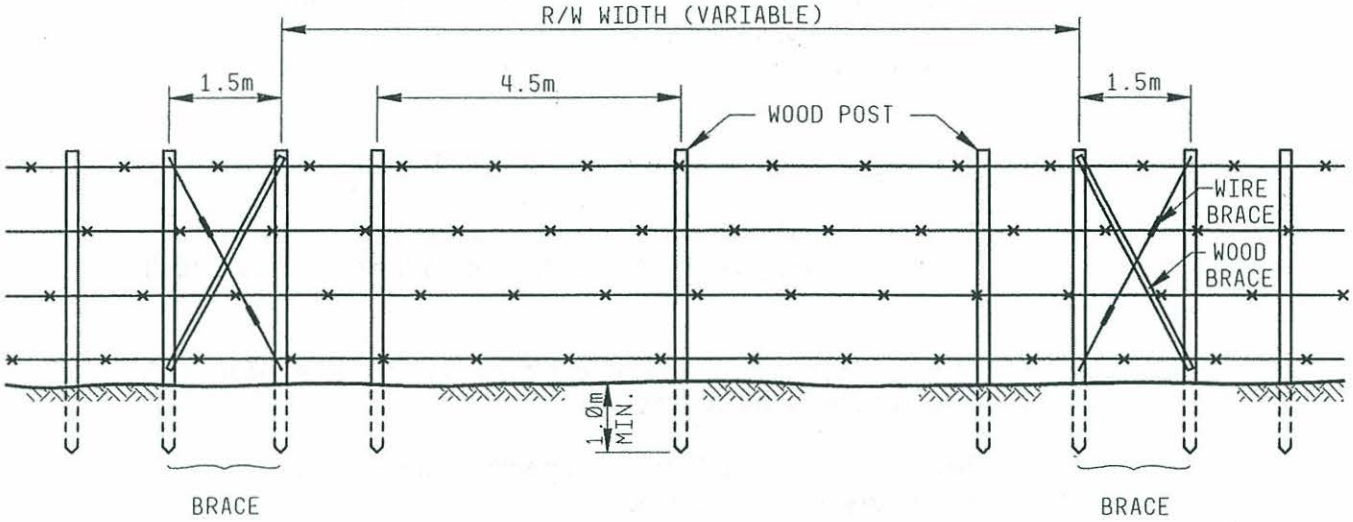
Dispose of corduroy, slash and any remaining leaning trees in the same manner as the original clearing (see 02-4, Clearing).

Cultivation

Cultivate the ROW where it crosses fields, bush or woodlands to a depth adequate to alleviate surface compaction and in a manner acceptable to the landowner. Do not pulverize soil.

If seeding immediately after topsoil is replaced, harrow the ROW.

Cultivate hay and pasture land if the sod layer is broken or badly compacted.



PROFILE

NOTES:

1. INSTALL POST AND WIRE FENCES TO REPLACE TEMPORARY GATES INSTALLED FOR PIPELINE CONSTRUCTION.

2. FOLLOWING PIPELINE CONSTRUCTION, REMOVE TEMPORARY GATE AND REPLACE WITH NEW FENCE USING MATERIAL OF EQUAL OR BETTER QUALITY THAN THE ORIGINAL FENCE. RETAIN BRACES AS PERMANENT PART OF FENCE STRUCTURE. IF GROUND IS FROZEN, USE METAL POSTS AND REPLACE WITH WOOD POSTS WHEN SOIL HAS THAWED. WHERE APPROPRIATE, MAINTAIN A MINIMUM BOTTOM WIRE ELEVATION OF 0.4m TO ACCOMMODATE SMALL WILDLIFE SPECIES.

3. INSPECT FENCE FOR 100m IN BOTH DIRECTIONS FOR SLACK WHEN TENSIONING THE WIRES.

4. REMOVE ALL EXCESS WOOD, WIRE, STAPLES, AND OTHER WASTE.

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Figure 1

Post and Wire Fence

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REVEGETATION

03–4

Purpose

Permanent revegetation involves preparing the seed bed and seeding disturbed areas to establish a permanent groundcover.

Guidelines

Seed and fertilize disturbed areas of the right-of-way (ROW) as requested by landowners or government agencies as soon as possible after final cleanup, weather and soil conditions permitting.

When re-establishing cover, consider seasonal factors including:

- seed dormancy
- hot, dry conditions
- access during spring breakup

Mix and sow specific seed mixes as recommended in the project specifications or in consultation with the environment department for the following:

- steep slopes
- stream banks
- native pasture/prairie
- critical wildlife areas
- sandy soils or sand dunes
- highly erodible soils and locations
- areas with high visual impact
- contaminated soils
- wetland, muskeg, slough and marsh areas
- urban areas, lawns, etc. (sod as required)

Where problems may be expected in establishing vegetation (e.g., on sandy soils and dunes) consider using any or a combination of the following:

- install wind barriers such as slat fences, straw bales, brush grid, cover crops or straw crimping
- apply manure, green feed, peat or material rich in organic content to amend the soil
- prepare the surface to enhance seed germination by tilling or by creating gouges, furrows or impressions with specialized equipment, such as chisel plows or land imprinters

- install diversion berms and ditches on slopes
- apply slash rollback or mulches. Import slash as required
- seed drought resistant grasses and legumes, and a cover crop of annual rye or barley
- transplant container-grown native shrubs and herbaceous species
- apply fertilizer as per soil analysis and as identified in the construction specifications

Ensure straw mulch and seed mix used to revegetate the ROW are free of noxious weed seed. Use certified seed and retain the analysis certificate in case a dispute arises concerning weeds.

Restrict public vehicle access over newly grassed areas.

Agricultural Land

Seed and fertilize cultivated land on the ROW as part of normal farming operations where possible.

On those portions of the ROW where the landowner is not planting a crop during the next growing season:

- Purchase seed in accordance with Pure Live Seed (PLS) analysis for the seed mix, i.e., compare seed cost based on purity percentage multiplied by germination percentage (PLS).
- Use seed within 12 months of germination testing.
- Treat legume seed with an inoculant specific to the species. When hydroseeding, use four times the manufacturer's recommended rate of inoculant. Do not hold inoculated seed in a slurry without fertilizer for more than 1 hr.
- Fence the ROW if practical until seedlings are well established and to prevent damage from livestock.

Wetlands

Wetlands generally revegetate naturally. Revegetate disturbed wetland areas with annual ryegrass planted at a rate of 40 lb/acre, unless there is standing water or unless permanent planting or seeding with native wetland vegetation is required.

Do not apply fertilizer, lime or mulch in wetlands.

During frozen conditions, apply annual ryegrass as a dormant seeding. If dormant seeding is not feasible, seed annual ryegrass during the next growing season in wetlands that are sufficiently dry to support appropriate equipment.

Watercourses

On steep approaches to watercourses where the slope was extensively graded, transplant native shrubs, willow cuttings or use other bioengineering techniques, e.g., vegetative geogrid (see Figure 1, Vegetated Geogrid, and 03-7, Installing Willow Cuttings).

Revegetate watercourse banks and approach slopes with a standard mix plus an annual cover crop, i.e., barley or annual rye, applied at twice the standard rate. After seeding, apply erosion control blanket, e.g., high velocity curlex, or mulch.

Swales

Seed and mulch swales with straw for the width of the ROW.

Mulch

Mulch stabilizes the soil surface and limits soil movement and the availability of soil to enter runoff. Typical mulch materials include straw or hay, or erosion control fabrics, such as high and low velocity curlex or jute blanket.

Do not apply mulch to cropland unless specifically requested by the landowner.

After seeding, mulch slopes greater than 5% or sandy areas with 2 tons of straw or hay per acre, or as specified by the company (see Figure 2, Typical Low Relief Drainage Way Stabilization-Seed & Straw Mulch).

Mulch all areas of dormant seeding with 2 tons per acre of hay or straw, or as specified by the company to cover >75% of the ground surface.

Anchor mulch to minimize loss by wind and water. If soil conditions allow, use a mulch anchoring tool or farm disc set in the straight position to crimp the mulch 2–3 in. deep.

NOTE: Liquid tackifiers may be used after obtaining written approval from the company.

If final cleanup is delayed longer than 10 days, or if construction is interrupted for extended periods, apply mulch before seeding. To provide temporary vegetative cover for extended periods, seed upland areas with annual rye.

Do not apply mulch in wetlands.

Seed and Fertilizing Methods

To promote seed germination on dry or wind exposed sites:

- use straw crimping
- apply manure (with landowner approval)
- use or import small diameter slash (uncultivated areas)
- thinly spread wood chips (uncultivated areas)

Where terrain and soil conditions allow, apply seed using a seed drill equipped with packing wheels.

NOTE: Ensure the depth control on the drill is set correctly.

Broadcast or aerial seed and fertilize wet soils to minimize surface disturbance.

Broadcast seed and fertilizer on berms and other erosion control structures to ensure immediate revegetation or soil stability.

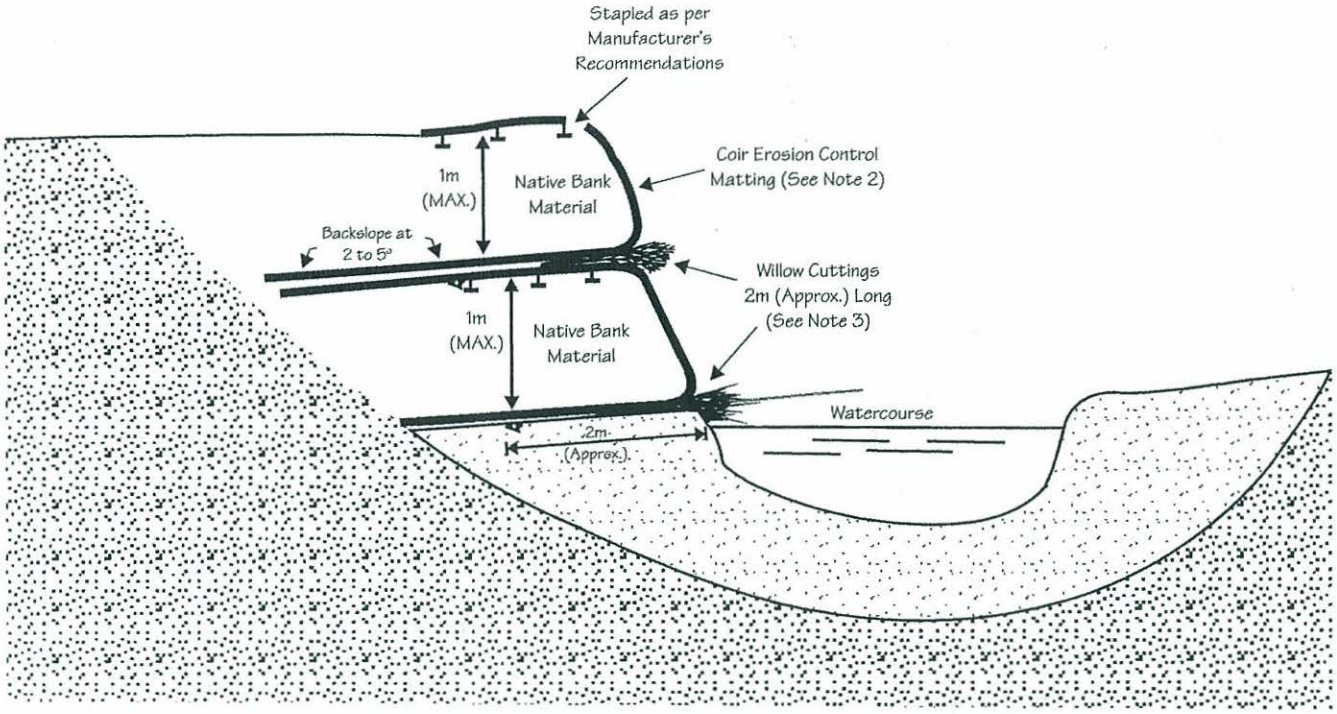
Use hydroseeders, mulches, tackifiers, seed impregnated netting or other suitable methods on steep or erosion-prone slopes.

Broadcast seed but do not fertilize next to watercourses. Harrow or hand rake to incorporate seed.

When broadcast seeding, firm the seed bed with a harrow-packer or roller after seeding.

Apply fertilizer and pH modifying agents, e.g., lime, as specified by the company and in consultation with landowners and government agencies.

NOTE: If spring cleanup extends to many weeks, a weed control program may be required.



PROFILE
(Not To Scale)

NOTES:

1. Install vegetated geogrid on steep approach slopes to watercourses where extensive grading of the slope was required.
2. Install coir erosion control matting shown above during nonfrozen conditions. Only matting that meets or exceeds the requirements noted in the construction specifications or is approved by the environmental department shall be installed. All materials used in the coir matting shall be biodegradable.
3. Ensure willow cuttings are fresh with a minimum 1cm (Min.) diameter at their base. Install willow cuttings at frequency of 25 (Approx.) per linear metre.
4. Compact, to the extent practical, each lift of backfill separately.
5. Hand broadcast seed prior to installation of the coir matting, if practical, or on the surface of the coir matting.

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Figure 1

Vegetated Geogrid

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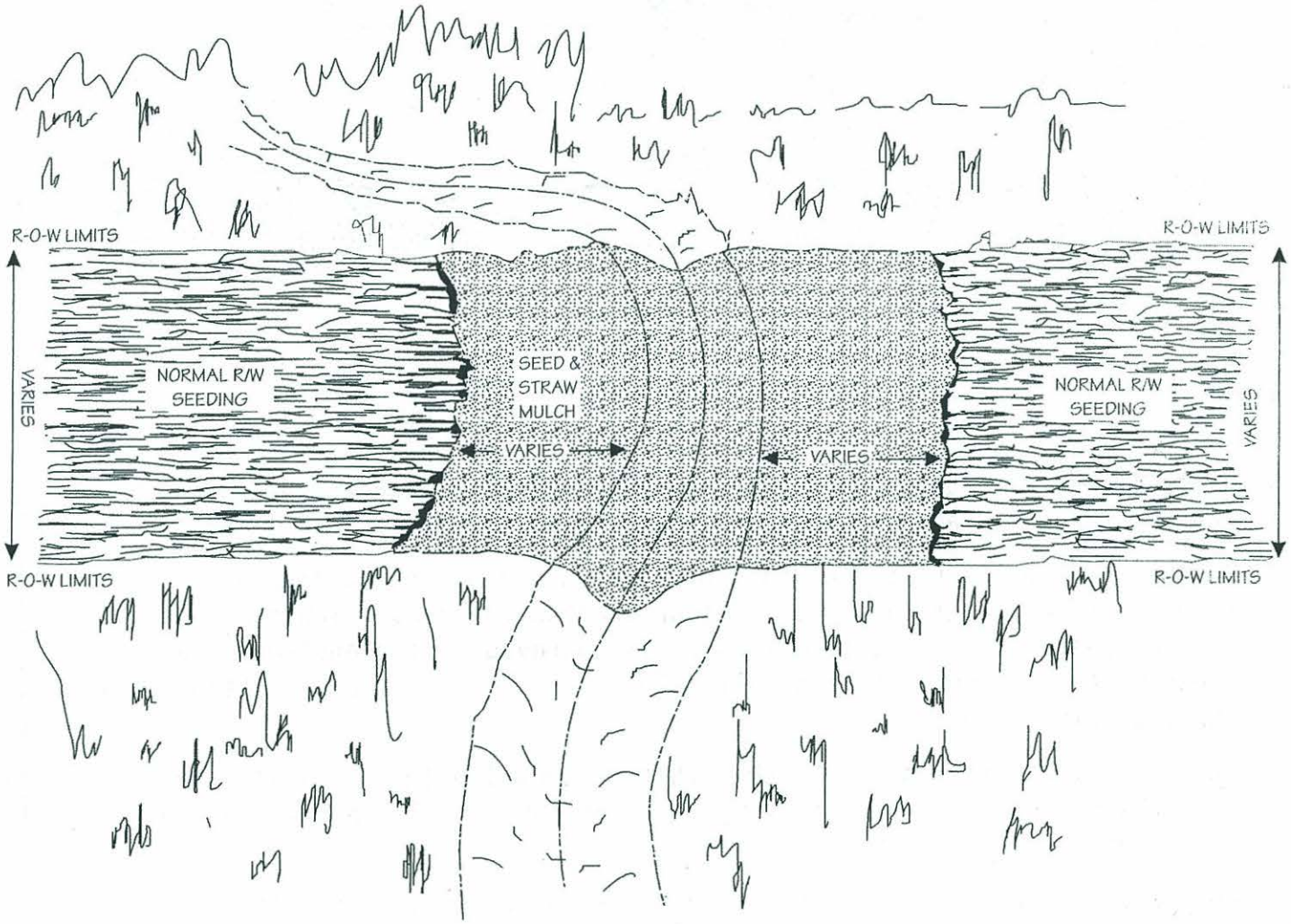

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ENBRIDGE

Figure 2

Typical Low Relief Drainage Way Stabilization
Seed and Straw Mulch

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PERMANENT EROSION and SEDIMENTATION CONTROL 03–5

Purpose

Permanent soil erosion and sedimentation control begins as soon as possible upon completion of backfilling. Erosion control is necessary to prevent pipe exposure and the subsequent cost to restore the site to previous conditions. Erosion control is also required to minimize siltation in watercourses.

Guidelines

Slopes

After final grading, stabilize disturbed steep slopes in areas other than cropland with permanent erosion control structures (see Figure 1, Permanent Slope Breakers-Perspective View), especially if heavy runoff, spring breakup or heavy storms are likely and there is a risk of significant soil erosion. Consider any of the following:

- install cross ditches and diversion berms
- walk down tree and shrub debris over exposed soils
- armor berms and ditches with logs, polyethylene or sandbags
- install netting or filter cloth
- apply tackifier
- install and stake sod
- hydromulch
- hydroseed, spread straw and crimp
- seed an annual crop of barley, fall rye or oats
- plant native shrubs or willow cuttings

Install permanent slope breakers according to the same design and spacing used for temporary slope breakers (see 02-13, Slope Breakers).

On slopes over 30%, install erosion control blanket, e.g., curlex, jute, or equivalent (see Figure 2, Erosion Control Blanket-Steep Slopes > 30%).

Stream Banks

Since most water crossings have individually designed crossing plans, obtain the special instructions from a company representative before working next to watercourses. If there are no special conditions, use a company standard design to ensure appropriate erosion control measures are in place.

NOTE: For information on installing stream bank protection, see the procedures in this tab.

Install berms or other sediment filter devices at the base of sloped approaches to streams greater than 50% (for information on berms, see 02-13, Slope Breakers).

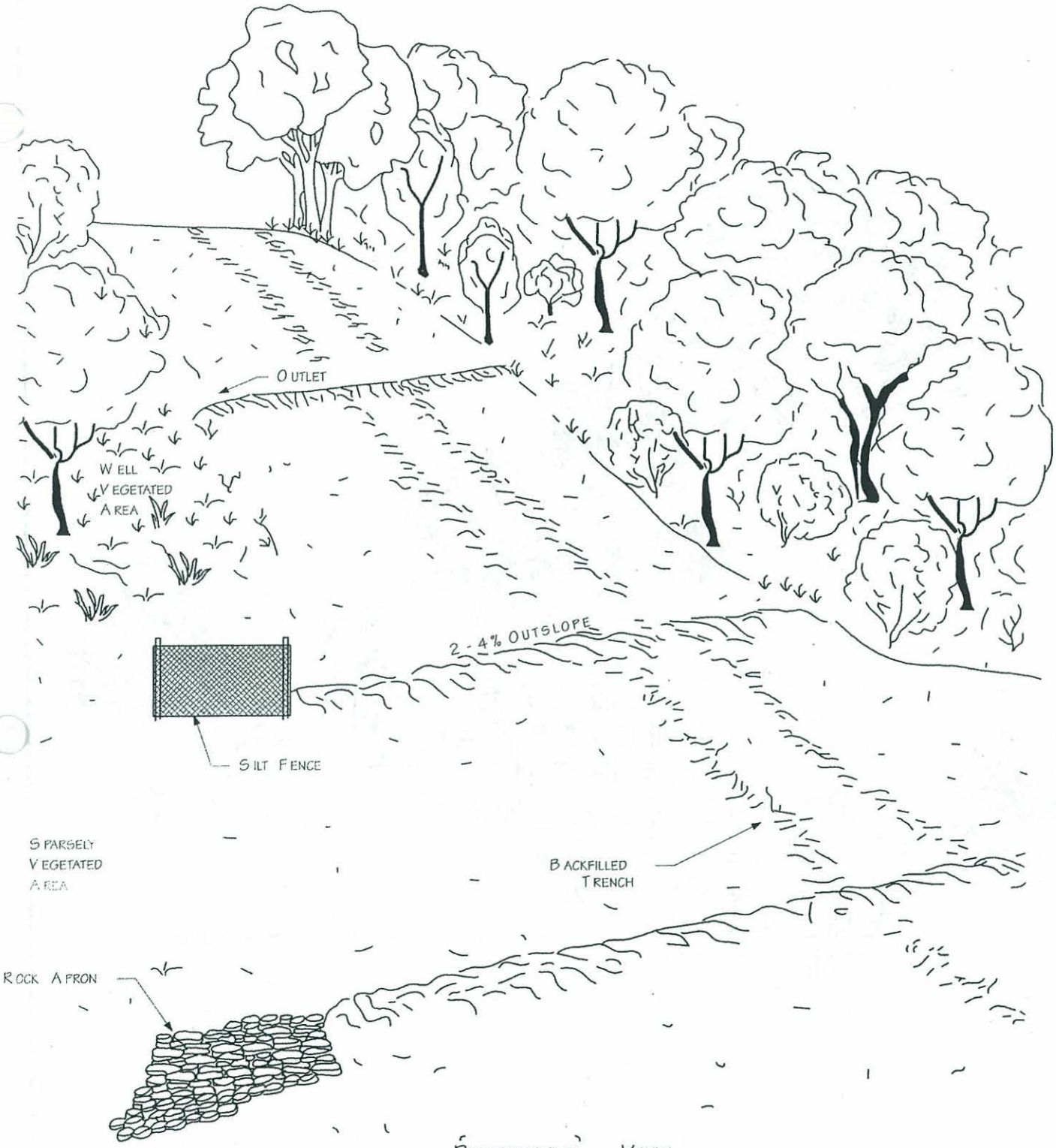
Immediately after stream banks are restored to their original contours, or to a 3:1 slope, whichever is less steep, install bank protection according to site and permit requirements:

- place riprap and geotextile fabric (see Figure 3, Typical Stream Bank Stabilization Riprap & Erosion Control Blanket) and prepare soil for seeding upslope
- if not riprapped with rock, seed with the specified seed mix and cover with an erosion control blanket (see Figure 4, Typical Streambank Stabilization Erosion Control Blanket - Seed and Straw Mulch).

NOTE: For more information, see 03-6, Installing Riprap.

Watercourses

Permanently restore and stabilize drainage ditches and intermittent streams with erosion control blanket, permanent seeding or other appropriate measures.



PERSPECTIVE VIEW
(NOT TO SCALE)

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Figure 1

Permanent Slope Breakers - Perspective View

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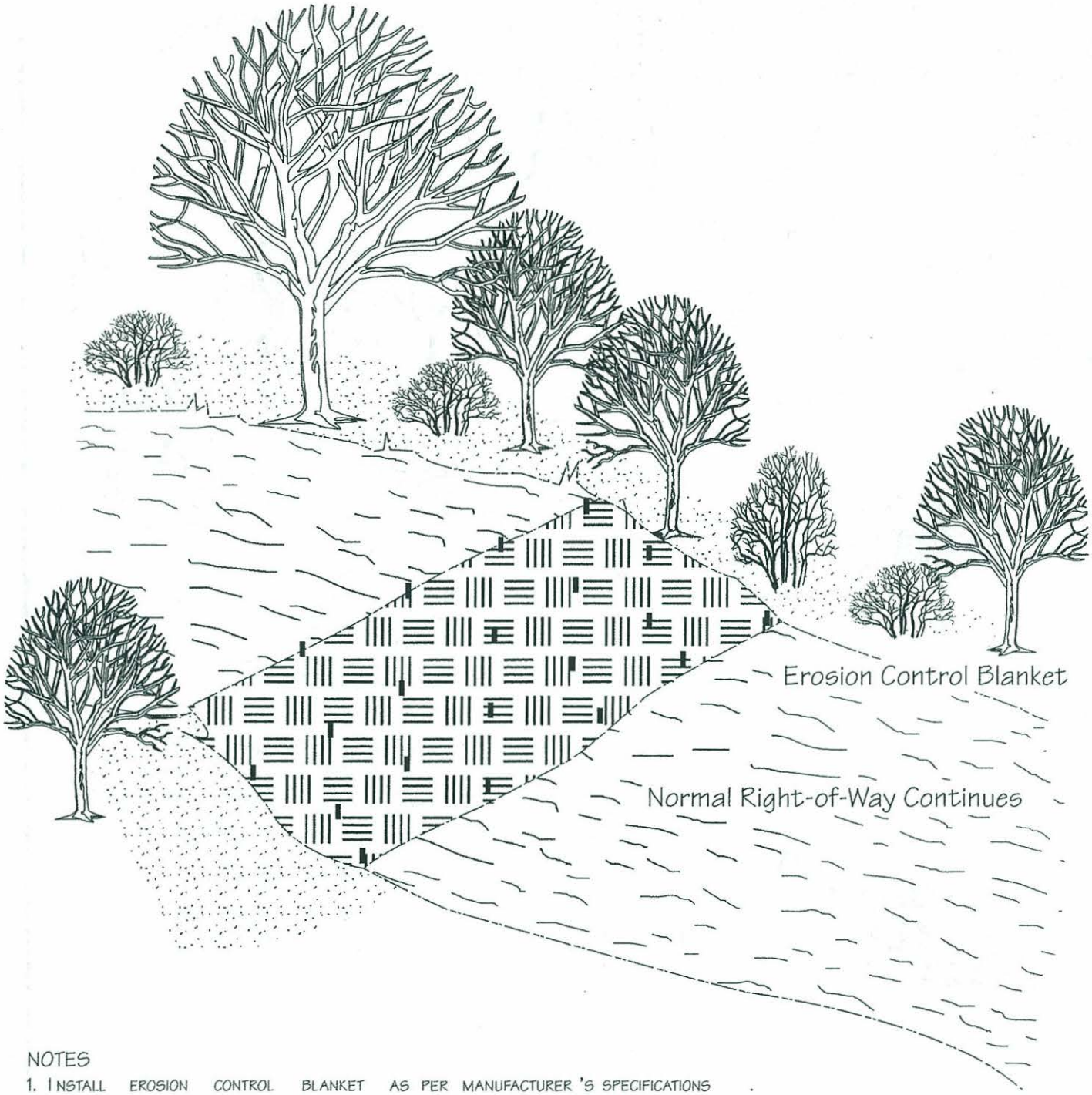

NOTES

1. INSTALL EROSION CONTROL BLANKET AS PER MANUFACTURER'S SPECIFICATIONS.

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Figure 2

Erosion Control Blanket - Steep Slopes (≥30%)

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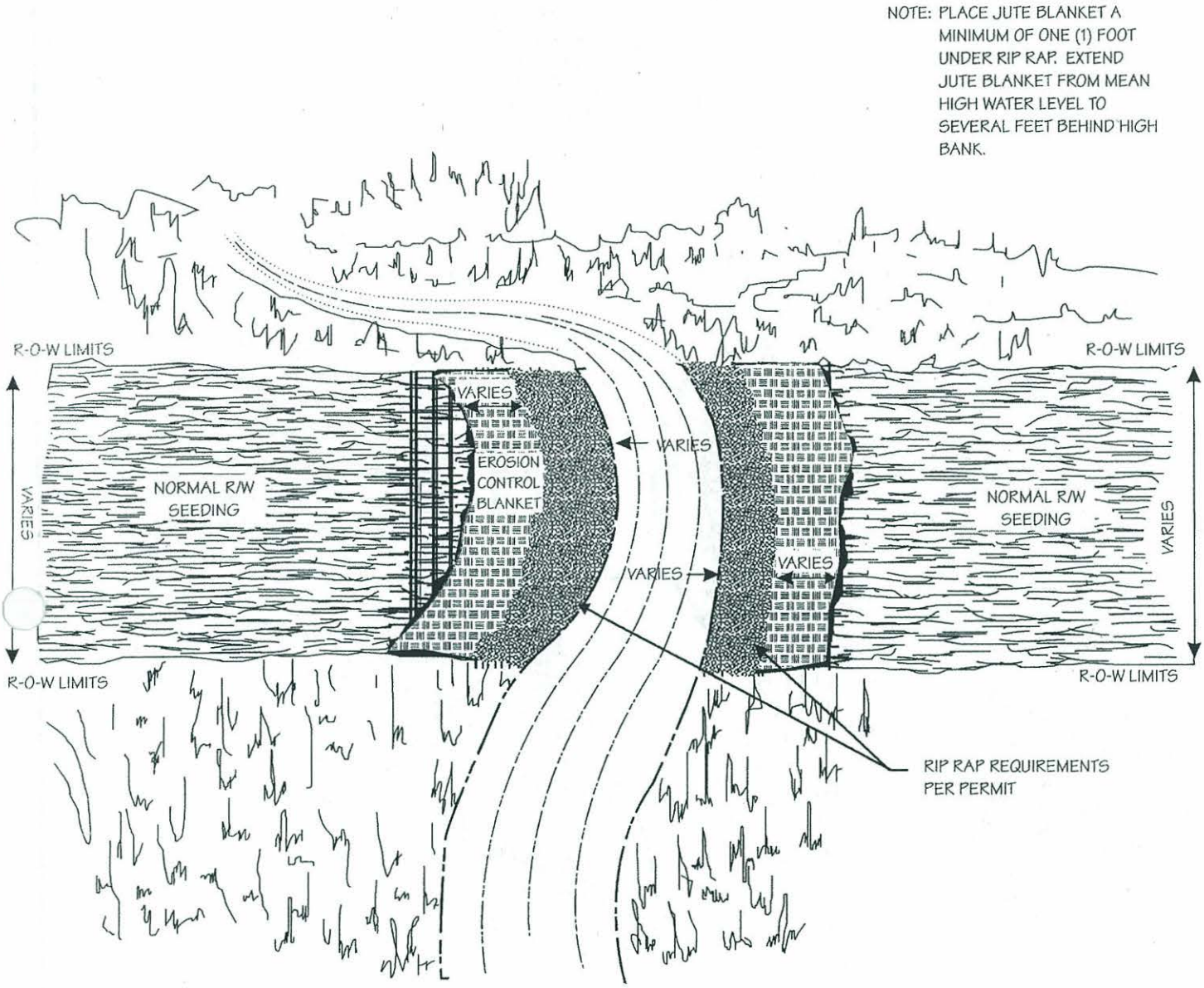

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Figure 3

Typical Stream Bank Stabilization
Riprap & Erosion Control Blanket

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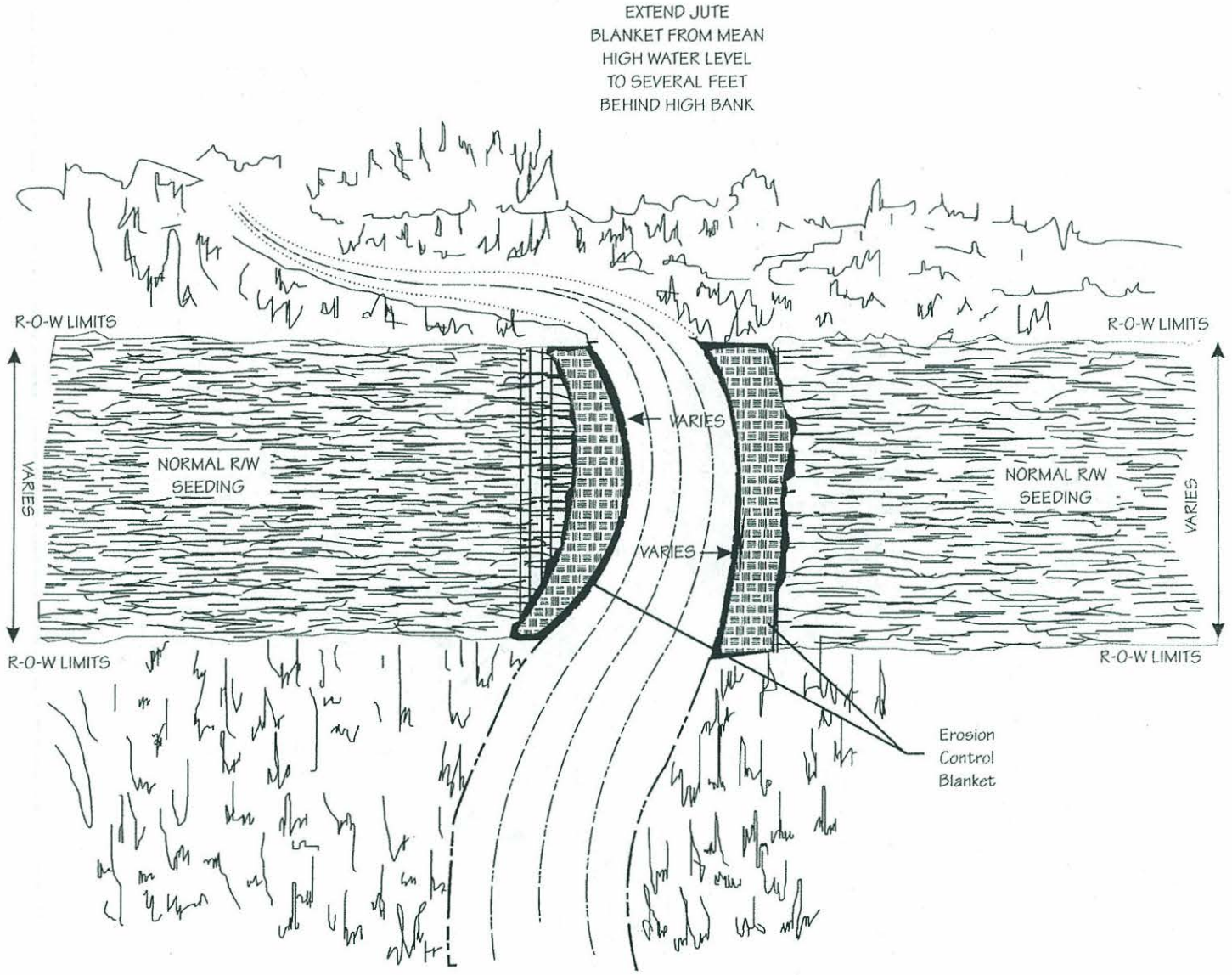

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Figure 4

Typical Stream Bank Stabilization
Erosion Control Blanket, Seed and Straw Mulch

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INSTALLING ROCK RIPRAP

03–6

Purpose

Rock riprap is installed immediately after streambank restoration or as required to stabilize erosion-sensitive watercourse banks at locations where pre-construction banks did not overhang or provide shade to provide significant fish habitat.

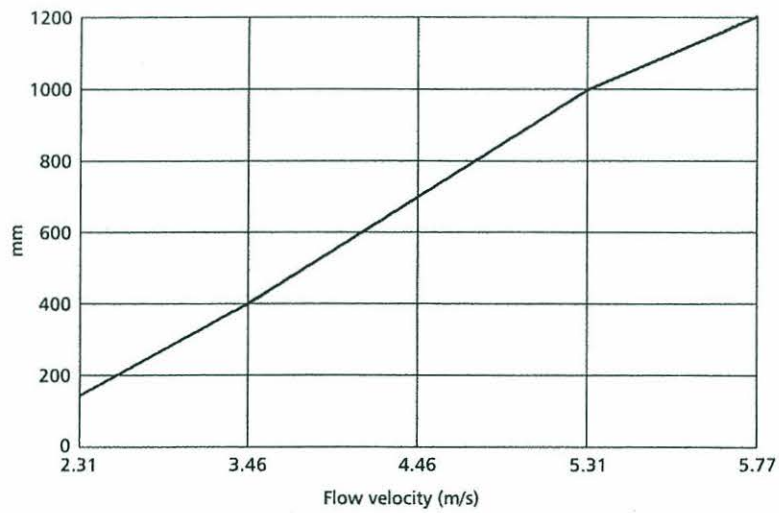
Guidelines

Use rock riprap on watercourse banks where flow conditions are likely to preclude vegetative stabilization.

Rock riprap should be dense, durable, roughly equal in dimension (not flat and thin), angular and clean.

Size of riprap depends on stream bank slope and water velocity. Recommended rock sizes for various flow rates are shown below. The size distribution of the riprap should ensure 50% of the mixture is larger than the median specified.

Geotextile is usually unnecessary under riprap and may inhibit vegetative growth.



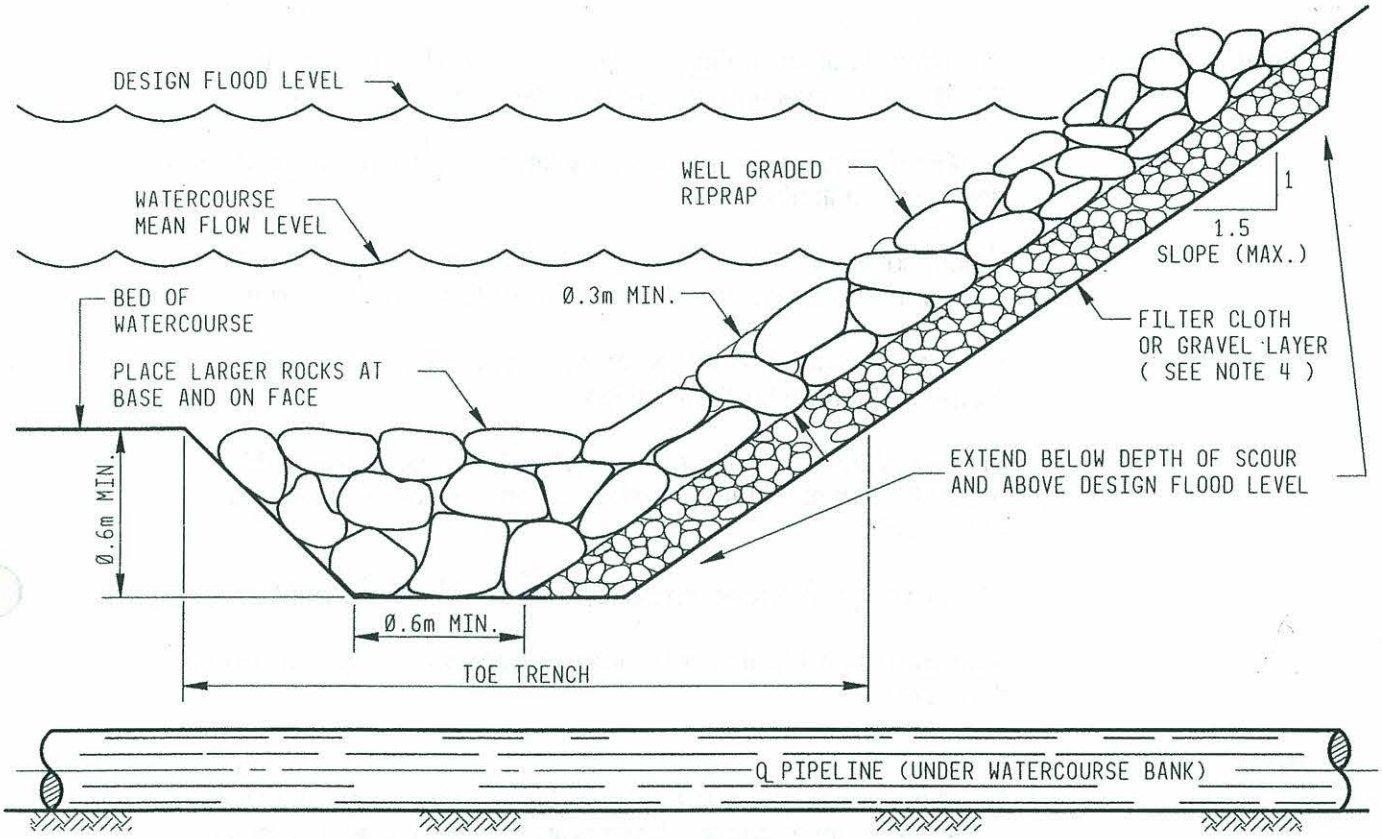
Median Size of Riprap for Maximum Flow Rates

Procedure

NOTE: Refer to Figure 1, Streambank Protection – Riprap Armour.

1. Remove all stumps, organic matter and work material.
2. Regrade watercourse banks to a 1.5:1 maximum slope.

3. Construct a toe trench to tie in the bottom of armor protection.
4. Install filter cloth if watercourse bank erosion could result between large rocks.
5. Place riprap on the slope to be protected.
6. Install riprap to a depth approximately two times the diameter of the riprap.
7. Construct riprap boundaries in a manner that riprap will not be undermined from the side.
8. Place riprap with flat surface up to resist movement by ice and water, minimize void space and ensure no rocks protrude more than 30 cm (1 ft) above design lines and grades.



PROFILE

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Figure 1

Streambank Protection -
RIPRAP Armour

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INSTALLING WILLOW CUTTINGS

03–7

Purpose

Live willow cuttings are installed when reconstructing watercourse banks to improve stability and to re-establish cover and habitat for fish-bearing streams.

Guidelines

Transplant willow cuttings as quickly as possible, preferably within 2 to 4 hrs of collecting, to prevent them from drying out.

NOTE: If necessary, cuttings may be stored instream for several days without ill effects.

Select cuttings from bottom branches approximately 12 to 25 mm ($^1/_2$ to 1 in.) in diameter and 0.3 to 0.6 m (1 to 2 ft) in length.

In hard soils, use a steel rod of equal diameter to the cuttings to make a pilot hole for the cuttings.

In soft soil, use a neoprene-lined post hole pounder or rubber mallet to minimize damage when driving willow cuttings into streambanks.

Plant cuttings in a random pattern, approximately 1 m (3 ft) apart.

If desired, transplant small clumps of willow bushes to the stream bank area.

Procedure

1. Make willow cuttings from nearby indigenous brush using sharp pruning shears, hand saw or knife to make clean cuts.
2. Mark the basal ends to ensure correct installation, i.e., cut top ends at 90° and bottom ends at 45° to form a point.
3. Ensure there are two lateral buds above the surface.
4. Trim side shoots close to the main stock.
5. Insert the cuttings into the soil at an angle by hand, approximately 1.5 m (5 ft) back from watercourse banks for the entire right-of-way (ROW) width.
6. If soil is compacted or extremely dry, use a frost pin to make a pilot hole.
7. Once installed, firm soil around cuttings and place mulch ≈1 in. deep around the cuttings to preserve moisture.

INSTALLING CRIBWALL

03–8

Purpose

Cribwalls are installed during restoration to provide erosion control and fish habitat.

NOTE: To avoid sedimentation of the stream, cribwalls should be installed as part of crossing activities—otherwise, it may be necessary to isolate the crossing a second time.

Guidelines

Install an overhanging cribwall where the original contour of stream banks was an overhang.

Install a vertical cribwall where the original contour of stream banks was vertical.

Constructing cribwall is a permit-specific activity; review permits before proceeding.

Procedure

Overhanging Cribwall

NOTE: Refer to Figure 1, Streambank Protection - Cribwall.

1. Install a log overhang if the vertical distance (A–B) is greater than 30 cm (1 ft).
2. Use native timber to build the structure (coniferous where possible).
3. Ensure the maximum distance (depth) from the streambed to ground level (A1–B1) is not less than the original distance (A–B).
4. Ensure the width of the stream channel (C1–D1) is not greater than the original width (C–D).
5. Backfill with coarse, nonerodible material.
6. Replace subsoil and topsoil.
7. Transplant native vegetation.
8. Sow an appropriate seed mix.

Vertical Cribwall

NOTE: Refer to Figure 1, Streambank Protection - Cribwall

1. Install pressure-treated (if allowed) vertical posts three times the length of the exposed height.
2. Use native timber or lumber for the horizontal structure.
3. Ensure the maximum distance (depth) from the streambed to ground level (A1–B1) is not less than the original distance (A–B).
4. Ensure the width of the stream channel (C1–D1) is not greater than the original width (C–D).
5. Anchor posts to a horizontal structure as required.
6. Backfill with coarse, nonerodible material.
7. Replace subsoil and topsoil.
8. Transplant native vegetation.
9. Sow an appropriate seed mix.

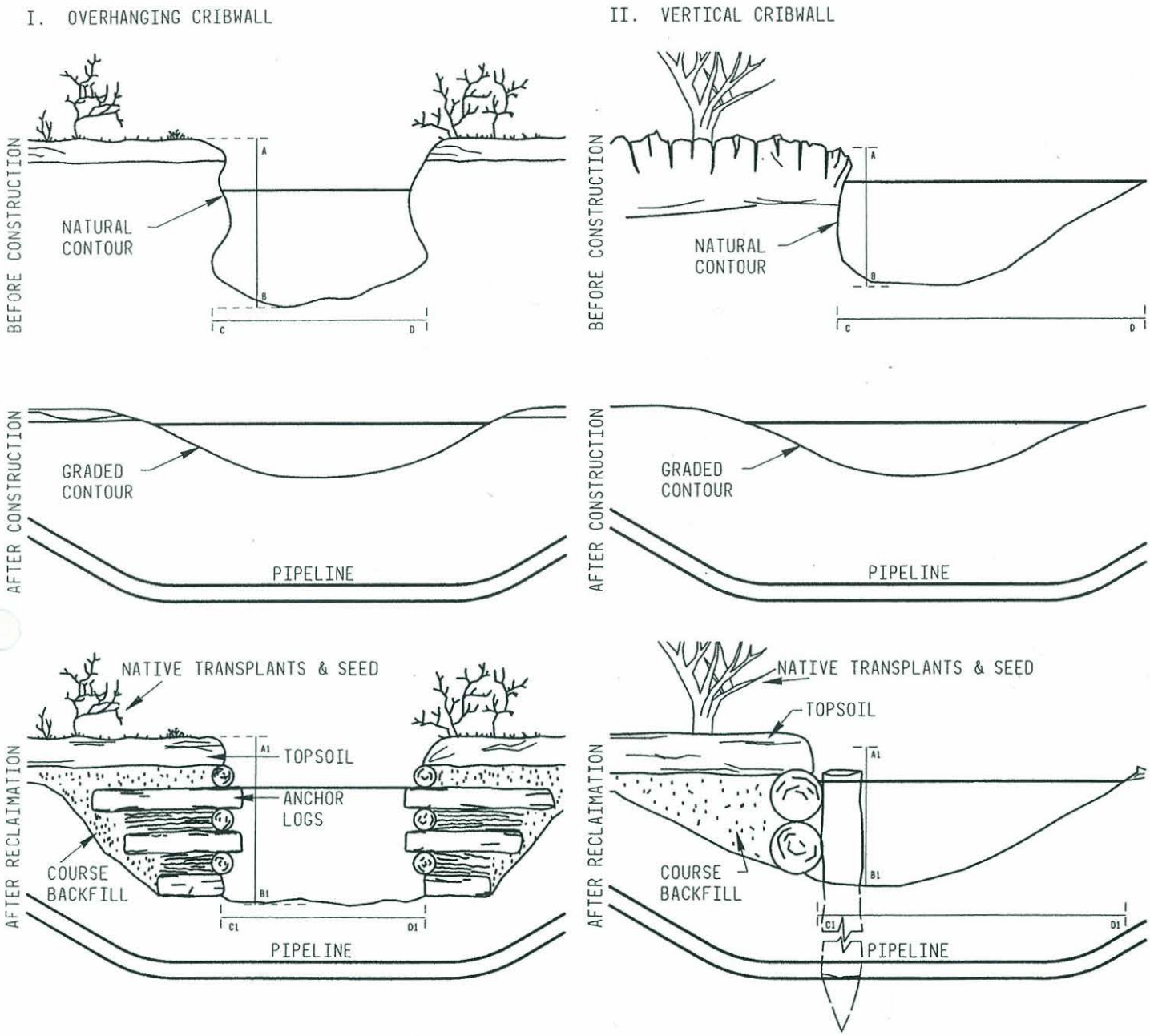

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Figure 1

Streambank Protection - Crib Wall

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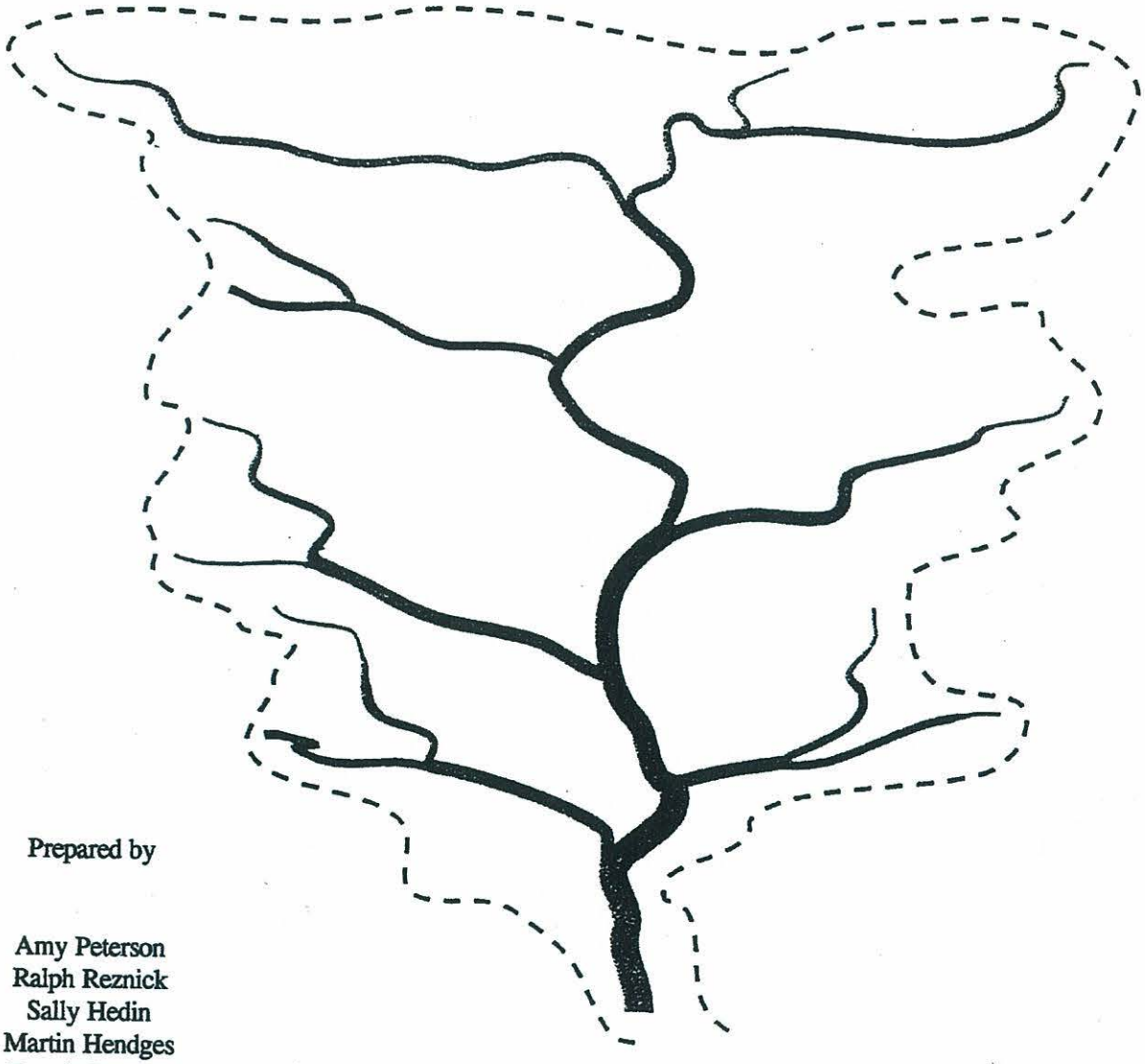
Guidebook of Best Management Practices for Michigan Watersheds

Reprinted October, 1998



Prepared by

Amy Peterson
Ralph Reznick
Sally Hedin
Martin Hendges
Dennis Dunlap

Michigan Department of Environmental Quality,
Surface Water Quality Division
Russell J. Harding, Director
John Engler, Governor

Riprap

Updated September, 1997

Definition

Riprap is a permanent cover of rock used to stabilize streambanks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows.

This BMP addresses using riprap to stabilize streambanks, line channels and provide stable outlets. For purposes of this BMP, "rock" can be used interchangeably with "stone". For information on designing various types of stream liners (including vegetation and riprap), see the Stormwater Conveyance Channel BMP.

All work conducted below the ordinary high water mark of a lake or stream, or in a floodplain or wetland will require permits from the Michigan Department of Environmental Quality, Land and Water Management Division. This includes the placement of riprap. (See Exhibit 1 for a definition of ordinary high water mark).

Other Terms Used to Describe

Armoring
Energy Dissipator

Pollutants Controlled and Impacts

The use of riprap in channels and below concentrated flows protects stream banks and discharge channels from higher erosive flow velocities. This reduces downcutting and lateral cutting, which in turn decreases sediment input to a watercourse.

Application

Land Use
All land uses.

Soil/Topography/Climate
The rock to be used as riprap must be capable of withstanding freezing and thawing and the flow or wave action of the water where it is used. The soil texture on the site and whether seepage is occurring are factors in determining the need and thickness of filters beneath the riprap.

When to Apply
Riprap used at outlets should be in place before the outlet is discharging. Streambank grading should be done when it is most feasible to bring stone to the site. Riprap should be placed as soon after grading as possible.

Where to Apply
Riprap is most often used in streambanks, on slopes, and at outlets.

Relationship With Other BMPs

Riprap is often used in making Stabilized Outlets, in Streambank Stabilization (including bioengineering techniques), and Slope/Shoreline Protection. Filters should be used underneath riprap to

help stabilize the soils.

Specifications

General Considerations:

Riprap structures should be designed by licensed professional engineers or other persons qualified in the design of such structures.

Stone Type

The material used for riprap should be fieldstone or rough unhewn quarry stone. Stone should be hard, angular, and of such quality that it will not disintegrate on exposure to water or weathering. It should also be chemically stable, capable of withstanding freezing and thawing, and suitable in all other respects for the intended use.

Because it is not as aesthetically pleasing as rock, broken concrete is a less favorable riprap alternative. If concrete is used, it should be clean and otherwise meet design criteria. Asphalt should *not* be used as riprap.

Riprap Size

Riprap comes in a variety of sizes. The appropriate size to use primarily depends on the intended use of the structure. For example, the size of riprap used to stabilize streambanks depends on the velocity of the water.

Structural design is usually based on the diameter of stone in the mixture for which a percentage, by weight, will be smaller. For example, D_{50} indicates a mixture of stones in which 50 percent of the stone by size would be larger than the diameter specified, and 50% would be smaller than the stone size specified. In other words, the design is based on the average size of stone in the mixture.

Table 1 lists some typical riprap by weight, spherical diameter and corresponding rectangular dimensions. These stone sizes are based on an assumed specific weight of 165 lbs./ft^3.

Table 1

Size of Typical Riprap Stones

Weight (lbs)	Mean Spherical Diameter (in)	Typical Rectangular Shape Length (in)	Width, Height (in)
50	10	18	6
100	13	21	7
150	14	24	8
300	18	30	10
500	22	36	12
1000	27	45	15
1500	31	52	17
2000	34	57	19
4000	43	72	24
6000	49	83	28
8000	54	90	30

Source: USDA Soil Conservation Service

Gradation

Riprap should be composed of a well-graded mixture down to the one-inch size particle such that 50 percent of the mixture by weight is larger than the D_{50} size as determined from the design procedure. For the purposes of this BMP, a well-graded mixture is defined as a mixture composed primarily of the larger stone sizes but with a sufficient mixture of other sizes to fill the progressively smaller voids between the stones. The diameter of the largest stone size in such a mixture should not be more than 1.5 times the D_{50} stone size.

After determining the riprap size that will be stable under the flow conditions, the designer should consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size.

Riprap structures for **streambank stabilization** should be designed to be stable for bank-full flows in the reach of the channel being stabilized.

Thickness

For both streambank stabilization and outlets, the minimum thickness of the riprap layer should be 1.5 times the D_{50} diameter, or 6 inches, whichever is greater. **A geotextile or stone filter must be placed under the riprap to prevent water from removing the underlying soil material through the voids in the riprap.** (Removal of the soil material leaves cavities behind the riprap and failure of the riprap may result). The filter may consist of smaller sized stone (usually 2"), a geotextile material, or a combination of both. Stone filters should be a minimum of 6 inches thick, and greater if the area has high seepage pressures. Follow the specifications below.

Granular (Stone) Filter Blanket. For dumped riprap, a filter ratio of 5 or less between successive layers will result in a stable condition. The filter ratio is defined as the ratio of D_{15} size of the coarser layer to the D_{85} size of the finer layer. An additional requirement for stability is that the ratio of the D_{15} size of the coarse material to the D_{15} size of the fine material should exceed 5 and be less than 40. A further requirement is that the ratio of the D_{50} size of the coarse material to the D_{50} size of the fine material not exceed 40. These requirements can be stated as follows:

$$\frac{D_{15}\text{ (coarser layer)}}{D_{85}\text{ (finer layer)}} < 5 < \frac{D_{15}\text{ (coarser layer)}}{D_{15}\text{ (finer layer)}} < 40$$

$$\frac{D_{50}\text{ (coarser layer)}}{D_{50}\text{ (finer layer)}} < 40$$

The filter requirements apply between the bank material and the filter blanket, between successive layers of filter blanket material if more than one layer is used, and between the filter blanket and the stone cover.

If a single layer of filter material will not satisfy the filter requirements, one or more additional layers of filter material must be used. In addition to the filter requirements, the grain size curves for the various layers should be approximately parallel to minimize the infiltration of the fine material into the coarser material. Not more than 5 percent of the filter material should pass the No. 200 sieve.

The minimum thickness of each layer of granular filter material shall be 6 inches, or 3 times the D_{50} size of the filter, whichever is greater.

Synthetic (Geotextile) Filter Fabric. The Filters BMP includes information on geotextile materials which may be used may be used in place of or in conjunction with granular filters. Always check manufacturer's specifications to ensure that the filter fabric selected meets the tensile strength and

durability requirements for the determined rock size. Some guidance in selecting filter fabric is given below.
The following particle size relationships must exist:

For filter fabric adjacent to granular materials containing 50 percent or less (by weight) of fine particles (less than 0.075 mm):

a) $\frac{D_{85} \text{ base (mm)}}{\text{EOS* filter fabric (mm)}} > 1$

b) Total open area of filter fabric is less than 36 percent.

For filter fabric adjacent to all other soils:

a) EOS less than U.S. Standard Sieve No. 70.

b) Total open area of filter is less than 10 percent.

*Equivalent Opening Size to a US Standard Sieve Size

No filter fabric should be used with less than 4 percent open area or an EOS smaller than U.S. Standard Sieve No. 100.

Stream Bank Protection and Channel Lining

See Exhibit 1 for applications.

General Planning Considerations:

1. Slopes on which riprap is used to stabilize streambanks should be no steeper than 1.5:1.

2. All bare soil on the slope above the riprap should be stabilized with seed and mulch, or sod. See the Vegetative BMPs.

3. When riprap is used in conjunction with other vegetative practices or bioengineering, the riprap should extend 1 foot above the ordinary high water mark. When only riprap is being used for bank stabilization, the top of the riprap should extend 3 feet above the ordinary high water mark. See Exhibit 1 for an explanation of the ordinary high water mark.

4. Determine a means of accessing the site before designing any riprap structure.

5. Determine how the riprap will be placed on the site. If the rock is to be dumped, it must be done in a manner which will not cause separation of the small and large stones. If rock is to be dumped over a bank and placed by hand, it must be done so that it does not create more erosion. Consider using aluminum or wooden shutes to roll rock down a bank to the waters' edge.

6. If riprap placement requires re-configuring banks or slopes, the filter should be placed as soon after the banks are prepared as possible. Placement of riprap should follow immediately after the placement of the filter.

7. The finished surface should not have pockets of finer materials which would flush out and

weaken the structure. Some hand placing should be done to provide a stable surface.

8. Riprap used both at the outlet of storm sewers and to protect an eroding bank, should be designed to accommodate both uses. Riprap used as outlet protection should be constructed before the pipe or channel begins to operate.

Design:

Stone Size Selection for Streambank Stabilization:

The design method described below is adapted from *Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15* of the Federal Highway Administration. It is applicable to both straight and curved sections of channel where the flow is not perpendicular to the bank of the channel.

A. Straight Sections of Channel.

This design method determines a stable rock size for straight and curved sections of channels. It is assumed that the shape, depth of flow, and slope of the channel are known. A stone size is chosen for the maximum depth of flow. If the sides of the channel are steeper than 3:1, the stone size must be increased accordingly. The final design size will be stable on both sides of the channel and the bottom.

1. Enter Exhibit 3 with the maximum depth of flow (feet) and channel slope (feet/foot). Where the two lines intersect, choose the d_{50} size of stone.

2. If channel side slopes (z) are steeper than 3:1, continue with step 3, if not, the procedure is complete.

3. Enter Exhibit 4, with the side slope and the base width to maximum depth ratio (B/d). Where the two lines intersect, move horizontally left to K1. Record K1.

4. Determine from Exhibit 5, the angle of repose (Ar) for the d_{50} size of stone. The angle of repose is the angle in which the rocks will lay in relation to the bank. Banks should be designed so that the natural angle of repose of the stone mixture is greater than the slope of the bank being stabilized. (Use Ar=42° for d_{50} greater than 1.0 ft. Do not use riprap on slopes steeper than the angle of repose for the size of stone.)

5. Enter Exhibit 6, with the side slope (z) of the channel and the angle of repose (Ar) for the d_{50} size of stone. Where the two lines intersect, move vertically down to read K2. Record K2.

6. Compute $d'_{50} = d_{50} \times K1/K2$, where d'_{50} is to determine the correct size stone for the bottom and side slopes of straight sections of channel.

B. Curved Sections of Channel

1. Compute the radius of the curve (Ro), measured at the outside edge of the bottom.

2. Compute the ratio of the top width of the water surface (Bs) to the radius of the curve (Ro), Bs/Ro.

3. Enter Exhibit 7, with the ratio Bs/Ro. Move vertically until the curve is intersected.

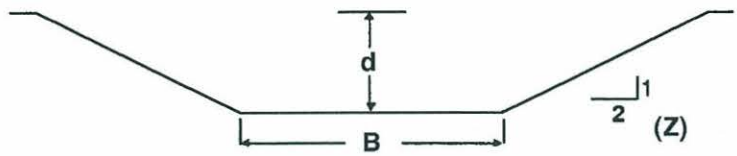
Move horizontally left to read K3.

4. Compute $d_{50c} = d'_{50} \times K3$, where d_{50c} is the correct size stone for bottom and side slopes of curved sections of channel.

C. Design Example Problems:

Problem #1

Given: A trapezoidal channel 3 feet deep (d), with an 8-foot bottom (B), 2:1 side slopes (z), and a 2 percent slope. **Calculate**: A stable riprap size for the bottom (B) and side slopes (z) of the channel.



Solution:

1. From Exhibit 3, for a 3-foot deep channel on a 2 percent grade: d_{50} = 0.75 feet or 9 inches.

2. Since the side slopes (z) are steeper than 3:1, continue with Step 3.

3. From Exhibit 4 for B/d = 2.67 and z = 2; K1 = 0.8

4. From Exhibit 5 for d_{50} = 9 inches; Ar = 41°

5. From Exhibit 6 for z = 2 and Ar = 41°; K2 = 0.75

6. $d'_{50} = d_{50} \times K1/K2 = 0.75 \times 0.8/0.75 = 0.8$ feet

   0.8 ft x 12 inches = 9.6 inches

   Use d'_{50} = 10 inches

Problem #2

Given: The preceding channel in Problem #1 has a curved section with a radius of 50 feet at the outside edge of the bottom. **Calculate**: A stable riprap size for the bottom and side slopes of the curved section of channel.

Solution:

1. Radius of curvature, Ro = 50 feet

2. Top width at water surface,

   Bs = 8 +(2 x 3 x 2) = 20 feet

   Bs/Ro = 20/50=0.40

3. From Exhibit 7 for Bs/Ro = 0.40; K3 = 1.1

4. $d_{50c} = d'_{50} \times K3 = 0.84 \times 1.1 = 0.92$ feet

   Use d_{50c} = 1.0 ft = 12 inches

Length/Thickness/Height of Streambank Area to be Riprapped
Refer back to page RIP-3 for specifications on the proper thickness.

Length: The appropriate length of channel in which rock should be placed should be at least the entire eroded section that is being protected, plus a minimum of 10 feet upstream and downstream of the eroded area. Be sure that the stone on the upstream and downstream ends are trenched in to prevent dislodging.

Where riprap is used only for slope or bank protection and does not extend across the bottom at the channel, riprap should be "keyed in" as shown in Exhibit 2.

Height: Install riprap to a height of three feet above the ordinary high water mark, or 1 foot above the ordinary high water mark if used in conjunction with bioegineering techniques. All exposed soil above the riprap should be stabilized according to the vegetative BMPs.

Design Example Problem:
A streambank has an ordinary high water mark of 3 feet, an 8 foot bottom width, 2:1 side slopes and a two percent slope. There is a 75 foot long curved bank that is eroding. Determine the proper rock size, appropriate stone gradation, and dimensions of the riprap.

1. Refer to example Problems #2 to solve for the proper stone size. Use a D_{50} stone size of 12 inches.

2. This riprap will be placed to a height of 6 feet (3 feet above the ordinary high water mark). The depth will be 24 inches: [1.5 x (stone size of 12 inches) = 18 inches + 0.5 foot granular stone = total of 24 inches].

3. The length of area covered with riprap will be the eroded area (75 feet) + 10 feet upstream and downstream = 95 feet.

4. A geotextile fabric will be installed beneath the riprap.

Construction:

1. Where grading is required, grade the site according to the grading plan. Grade only when stone is ready to be placed.

2. Compact gravel subgrades according to design. Any fill that is used should be compacted to a density approximating that of the surrounding undisturbed area.

3. Install geotextile filter fabrics according to the manufacturer's specification. Always bury both the upper-most and toe of the geotextile fabric to prevent unravelling. (Basic installa-

tion techniques are discussed in the Filters BMP. Spread granular filters in uniform layers according to the design.

4. Install riprap. If riprap is dumped, hand place any rocks that need to be moved to fit the design.

Maintenance of Riprap on Stream Banks

Inspections should be made of all sites immediately after the first rainfall following installation of riprap. This is particularly important in areas where riprap that is displaced during the storm would impact culverts. Thereafter, riprapped sites should be checked following large storms, especially those which are near or exceed the storm frequency used in the design. Displaced riprap should be removed from its downstream location and new riprap placed according to the specifications above.

Outlets

General Considerations for Outlets

1. How and when to use a riprapped outlet should be made based on criteria given in the Stabilized Outlets BMP.

2. The outlet structure should be designed in conjunction with the conveyance system (i.e. pipe, outlet of a Sediment Basin, etc.) from which the water is outletted. There should be no overfall from the end of the pipe/outlet to the outlet structure (i.e. the pipe/outlet should not be suspended above the outlet structure).

overfall

no overfall

3. The outlet structure should be in place before water is released from the conveyance system.

4. Additional protection may be required on the opposite bank or downstream to prevent in-stream erosion.

5. There should be no overfall from the end of the apron to the receiving channel streambed.

Stone Size Selection for Outlets

1. The median stone diameter, d_{50}, in feet, shall be determined from the formula:

$$d_{50} = \frac{0.02}{TW} \frac{Q}{D_o}^{4/3}$$

Where TW is tailwater depth above the invert of the culvert in feet,

Q is the pipe discharge in cfs for the conduit design storm, or the 25-year storm, whichever is greater, and

D_o is the maximum inside culvert width in feet.

2. Fifty percent by size of the riprap mixture should be larger than the median size stone designated as d_{50} and 50% should be smaller. The largest stone size in the mixture should be 1.5 times the d_{50} size. The riprap should be reasonably well-graded.

Outlet Dimensions
Refer to Exhibit 8.

1. **Length**: The length of the apron, L, should be determined using the following formula:

$$L_a = \frac{1.7\,Q}{D_o^{3/2}} + 8D_o \quad \text{for culverts flowing up to 1/2 full.}$$

$$L_a = \frac{3.0\,Q}{D_o^{3/2}} \quad \text{for culverts flowing at or above 1/2 full}$$

Where Q and D_o are as described above.

2. **Width**: Where there is a well-defined channel downstream of the apron, the bottom width of the apron should be at least equal to the bottom width of the channel. The structural lining should extend at least one foot above the tailwater elevation, but no lower than two-thirds of the vertical conduit dimension above the conduit invert.

Where there is *no* well-defined channel immediately downstream of the apron (i.e. as may apply to Sediment Basins) width, W, of the outlet end of the apron should be as follows:

For tailwater elevation greater than or equal to the elevation of the center of the pipe:

$$W = 3D_o + 0.4L_a$$

For tailwater elevation less than the elevation of the center of the pipe:

$$W = 3D_o + L_a$$

Where L_a is the length of the apron determined from the formula above and D_o is the culvert width.

The width of the apron at the culvert outlet should be at least three times the culvert width.

3. The side slopes should be 2:1 or flatter.

4. The bottom grade should be level (0.0%).

5. There should be no overfall from the end of the apron to the receiving channel streambed.

6. There should be no overfall at the end of the apron or at the end of the culvert.

7. There should be no bends or curves at the intersection of the conduit and apron.

Stone Size and Gradation

1. The median stone diameter, D_{50}, in feet shall be determined from the formula,

$$D_{50} = \frac{0.02}{TW} \frac{Q}{D_o}^{4/3}$$

Where Q and D_o are as defined under apron dimensions and TW is tailwater depth above the invert of culvert in feet.

2. The largest stone size in the mixture shall be 1.5 times the D_{50} size. The riprap shall be reasonably well graded.

3. Gabions or precast cellular blocks may be substituted for riprap if the D_{50} size calculated above is less than or equal to the thickness of the gabions or concrete revetment blocks. See the Shoreline/Slope Stabilization BMP.

Design Example Problem:

Given: a maximum inside culvert width, D_o of 1.5 ft., a flow (Q) of 14/5 cfs, and a tailwater elevation, TW, of 0.7 feet, determine the appropriate design dimensions of the apron (h_a and W), and the D_{50} stone size.

Solution:

Using $L_a = \frac{1.7Q}{D_o^{3/2}} + 8D_o$

$$= \frac{1.7\,(14.5)}{(1.5)^{3/2}} + 8(1.5)$$

L_a = 25.4 feet, rounded up = 26 feet

Since TW < 0.5 D_o , use $W = 3D_o + L_a$

$$= 3(1.5) + 26$$

W = 30.5 feet, rounded up = 31 feet

Using $D_{50} = \frac{0.02}{TW} \frac{Q}{D_o}^{4/3}$

$$= \frac{0.02}{0.7} \frac{14.5}{1.5}^{4/3}$$

D_{50} = 0.58 feet, converted and rounded = 7 inches

Maintenance

Inspections should be made of all sites immediately after the first rainfall following installation of riprap. This is particularly important in areas where riprap that is displaced during the storm would impact culverts. Thereafter, riprapped sites should be checked following large storms, especially those which are near or exceed the storm frequency used in the design. Displaced riprap should be removed from its downstream location and new riprap placed according to the specifications above.

Exhibits

Formulas included in this BMP were taken from the Rhode Island Soil Erosion and Sediment Control Handbook, Rhode Island Dept. of Env. Mgt., 1989.

Exhibit 1: Streambank stabilization using Riprap. MDNR Construction Project Evaluation Manual, 1987, and Rhode Island Soil Erosion and Sediment Control Handbook, as adopted from Connecticut Guidelines for Soil Erosion and Sediment Control, Connecticut Council on Soil and Water Conservation, 1985.

Exhibit 2: Length and Height of Riprap. MDEQ, Surface Water Quality Division.

Exhibit 3: Maximum depth of Flow for Riprap-lined Channels. "Design of Stable Channels with Flexible Linings", Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975.

Exhibit 4: Distribution of Boundary Shear Around Wetted Perimeter of Trapezoid Channels. "Design of Stable Channels with Flexible Linings", Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975.

Exhibit 5: Angle of Repose for Riprap Stone. Virginia Erosion and Sediment Control Handbook, Virginia Soil and Water Conservation Commission, 1980.

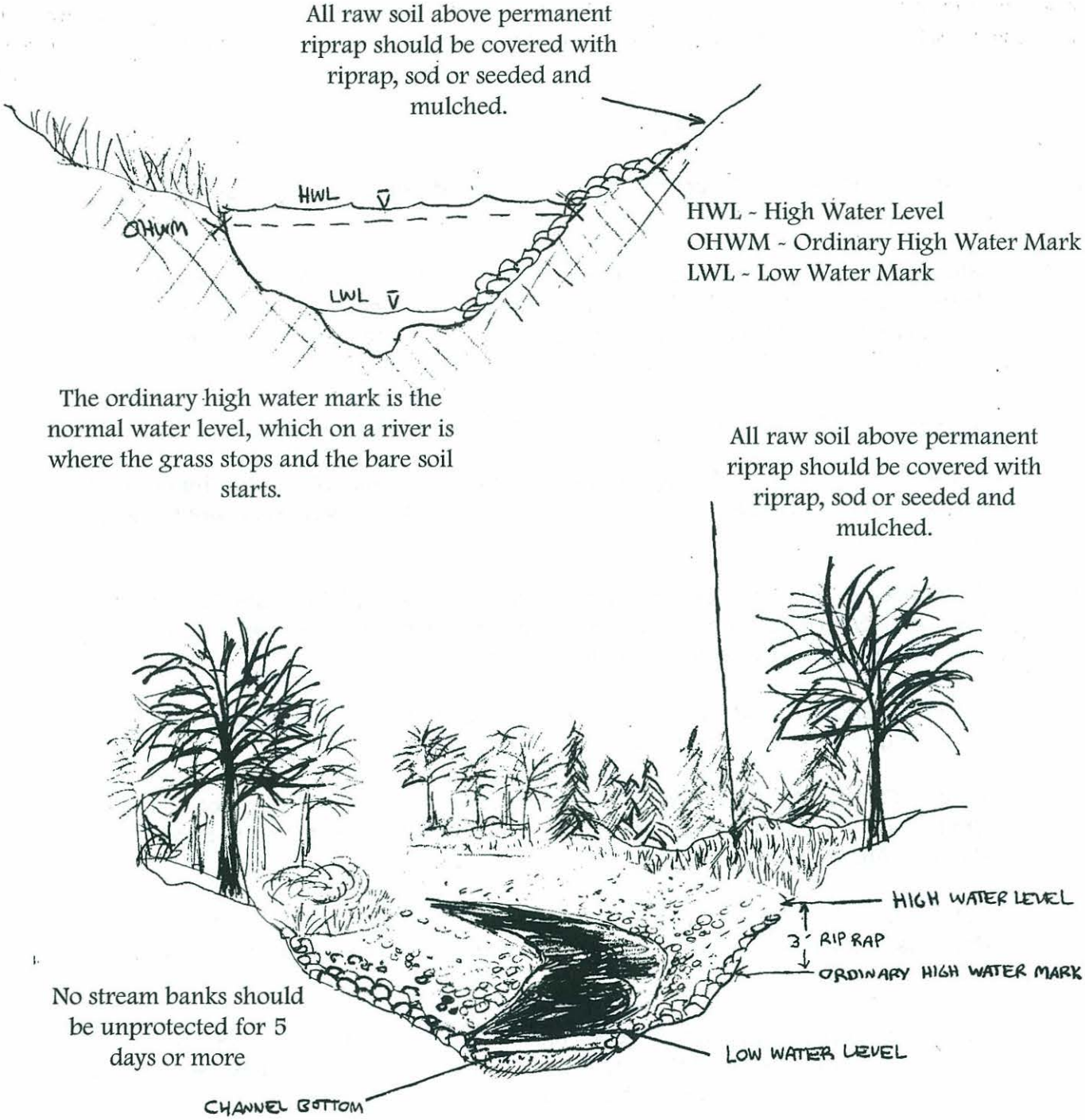
Exhibit 6: Ratio of Critical Shear on Sides to Critical Shears on Bottom. "Design of Stable Channels with Flexible Linings", Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975.

Exhibit 7: Ratio of Maximum Boundary Shear in Bends to Maximum Bottom Shear in Straight Reaches. Virginia Erosion and sediment Control Handbook, Virginia Soil and Water Conservation Commission, 1980.

Exhibit 8: Configuration of Conduit Outlet Protection where there is no well defined channel downstream. Standards for Soil Erosion and Sediment Control in New Jersey, New Jersey Soil Conservation Committee, 1980.

Exhibit 1

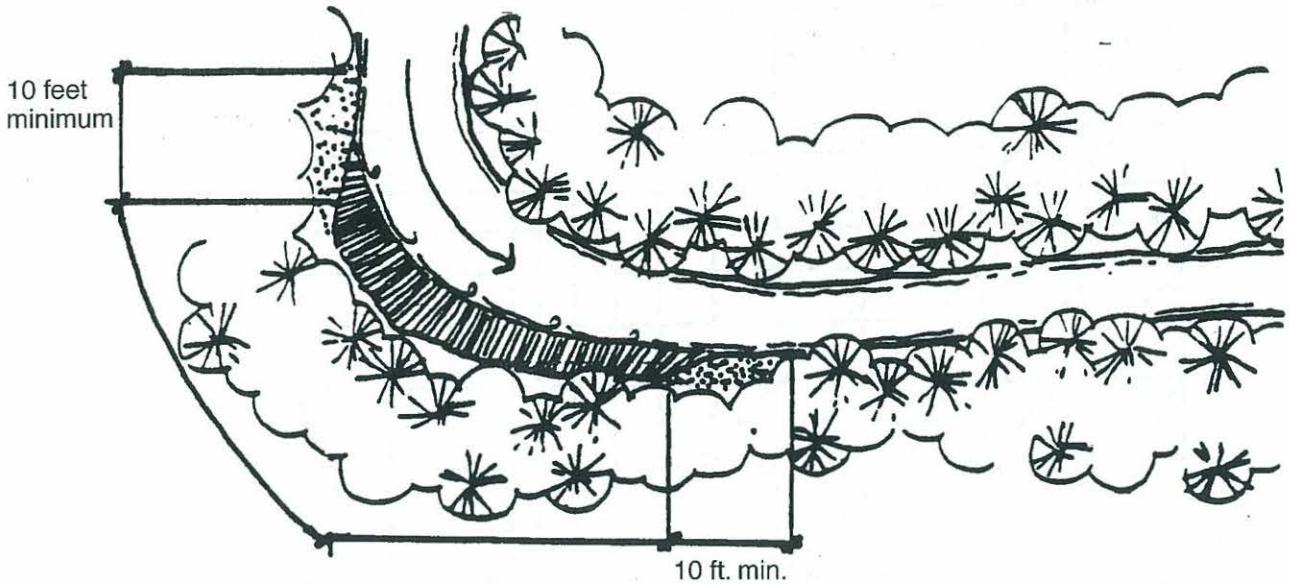
Ordinary High Water Mark



Source: Michigan Department of Environmental Quality, Land and Water Management Division, 1997.

Exhibit 2

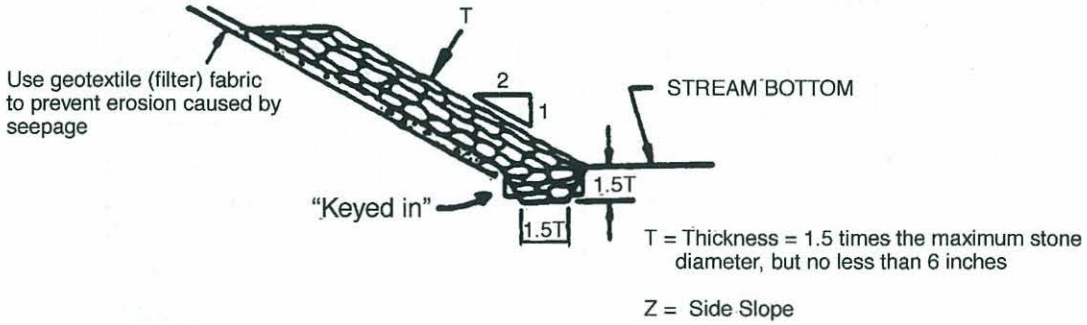
Riprap Placement: Length, Thickness, Height



Length to stabilize: cut bank, plus a minimum of 10 feet on both sides.

Height to stabilize: usually three feet above the Ordinary High Water Mark; can be less on hydrologically stable streams.

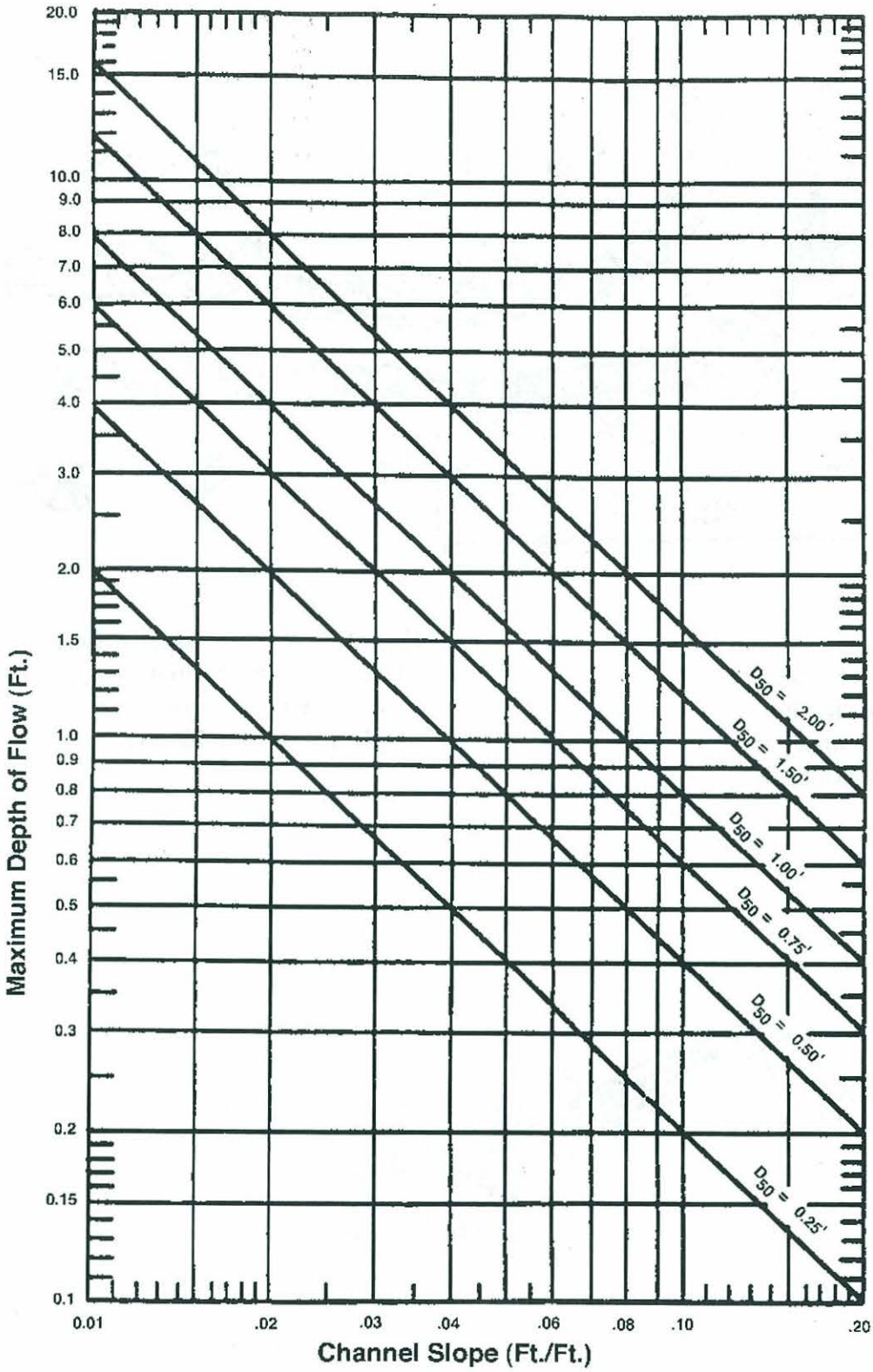
"Keying in"



Sources: Top: Construction Project Evaluation Manual. Michigan Department of Environmental Quality, Land and Water Mangement Division. Redrawn 1997. Bottom: Rhode Island Soil Erosion and Sediment Control Handbook, as adopted from the Connecticut Guidelines for Soil Erosion and Sediment Control, Connecticut Council of Soil and Water Conservation, 1985. Redrawn 1997 by MDEQ.

Exhibit 3

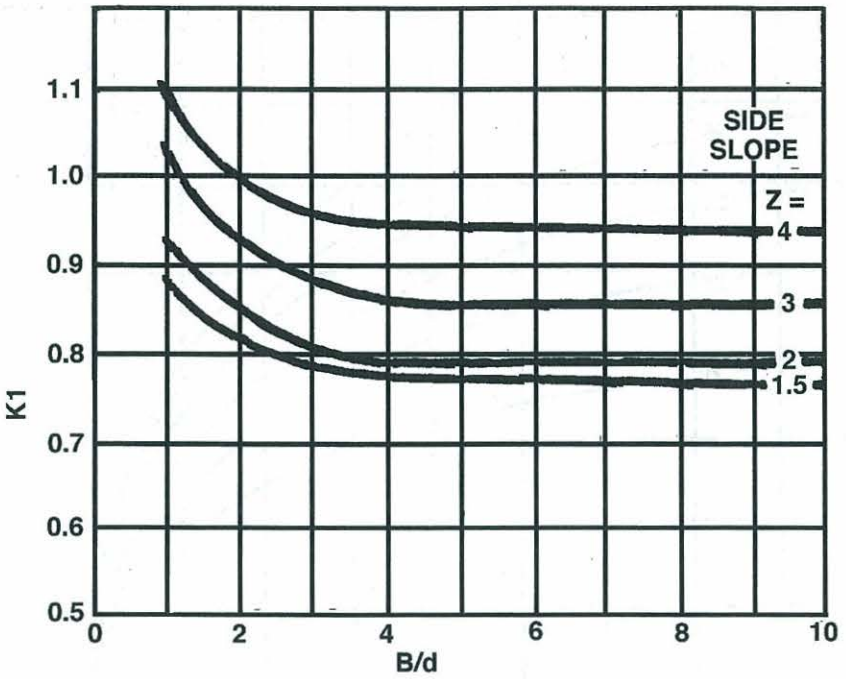
Maximum Depth of Flow for Riprap-Lined Channels



Source: Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 4

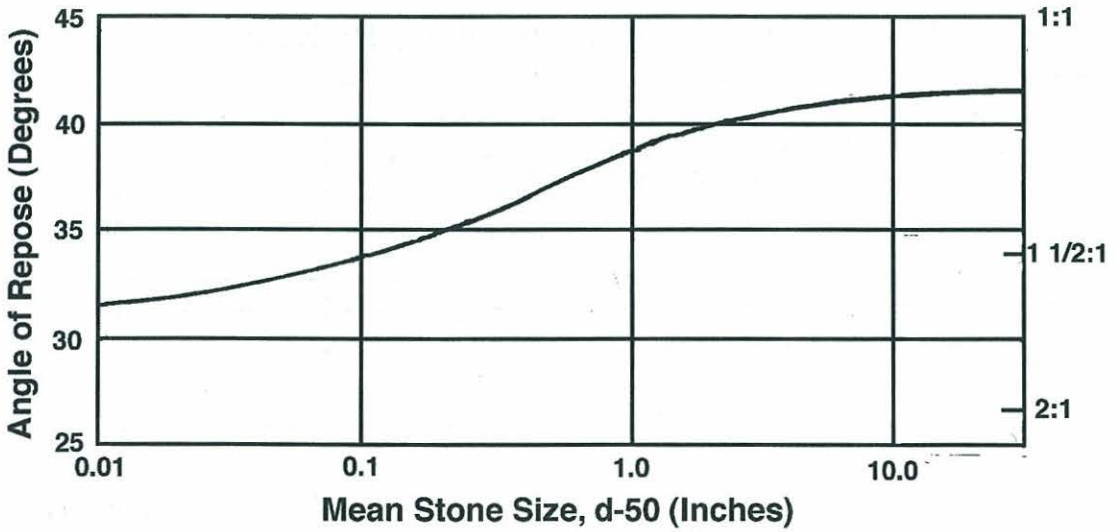
Distribution of Boundary Sheer Around Wetted Perimeter of Trapezoidal Channels



Source: Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 5

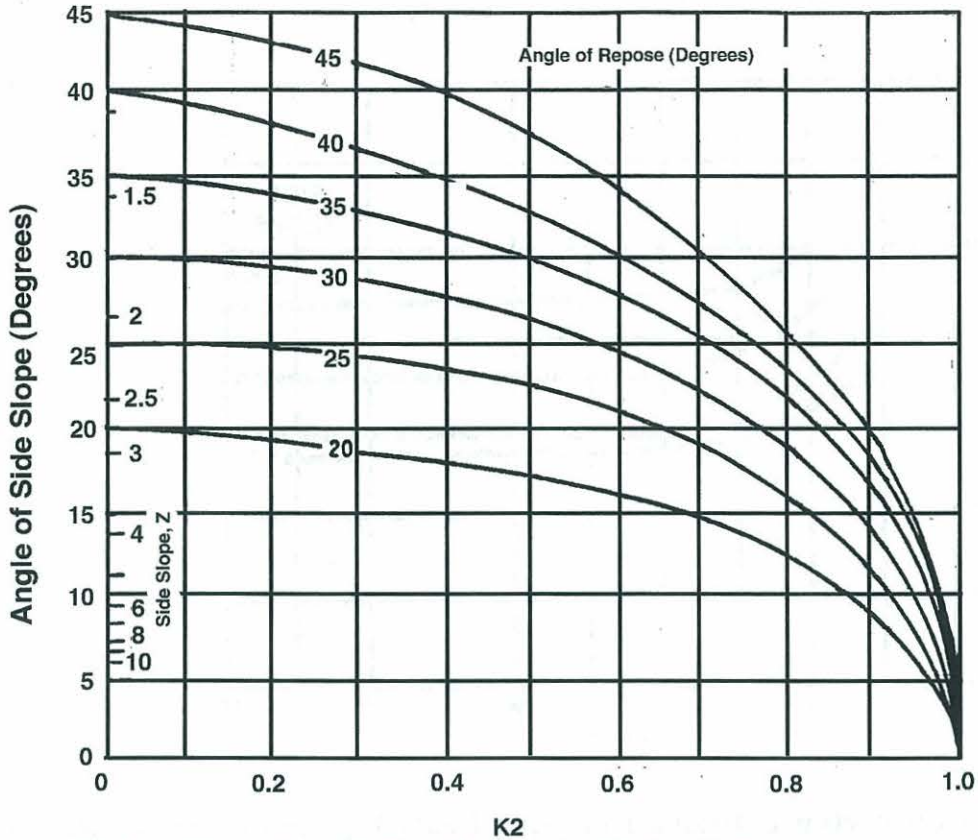
Angle of Repose for Riprap Stones



Source: Virginia Erosion and Sediment Control Handbook, Virginia Soil and Water Conservation Commission, 1980, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 6

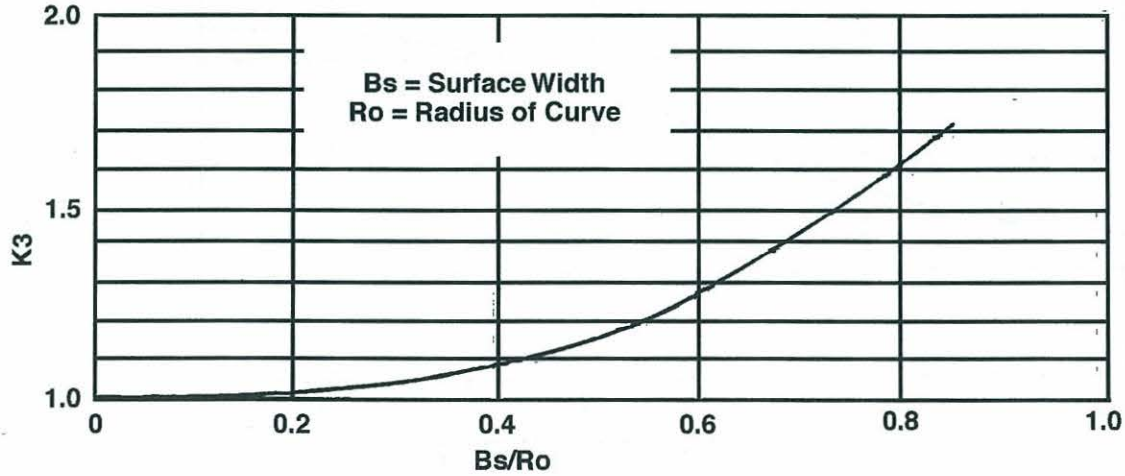
Ratio of Critical Shear on Sides to Critical Shear on Bottom



Source: Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 7

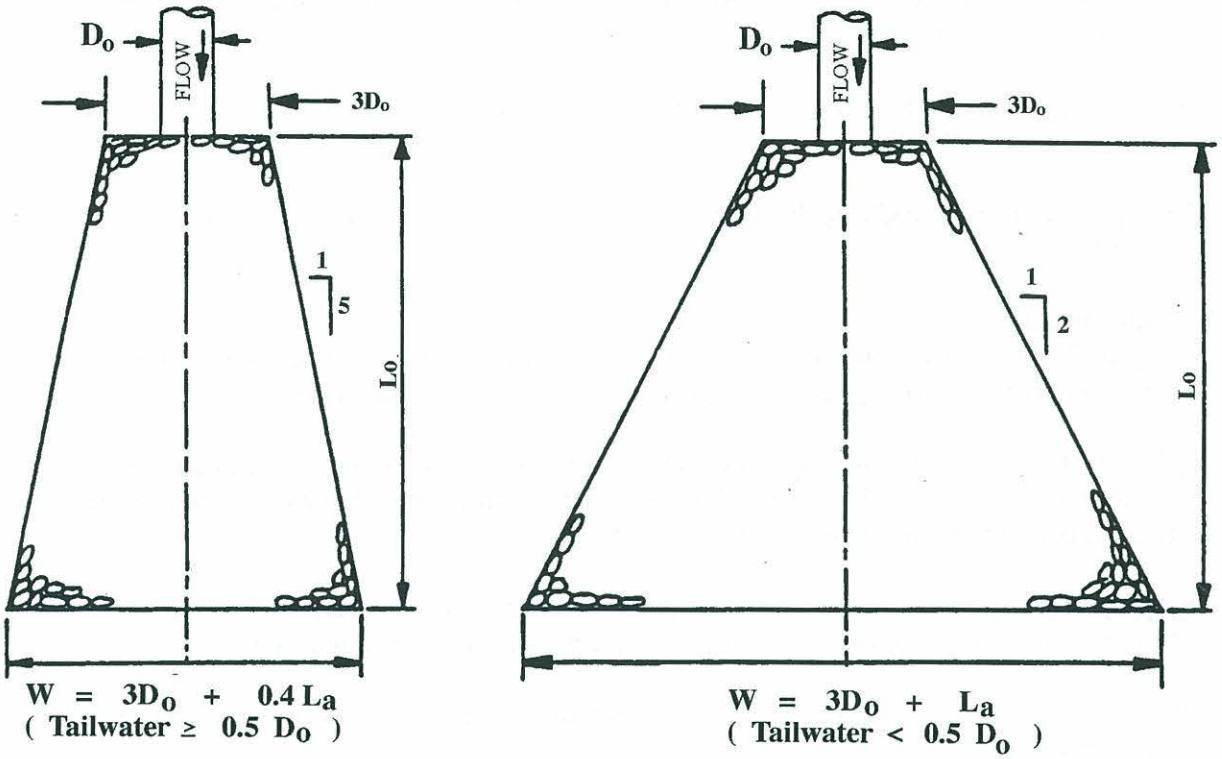
Ratio of Maximum Boundary Shear in Bends to Maximum Bottom Shear in Straight Reaches



Source: Virginia Erosion and Sediment Control Handbook, Virginia Soil and Water Conservation Commission, 1980, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 8

Configuration of Conduit Outlet Protection Where There is no Well-Defined Channel Downstream



Source: Standards for Soil Erosion and Sediment Control in New Jersey, New Jersey Soil Conservation Committee, 1980, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Design Considerations:
Stabilized outlets should be designed by registered professional engineers.

The specific type of outlet needed depends on the velocity of the water being discharged, the pollutants in the water and the type of soil. The following is a brief discussion of several types of outlets, most of which are BMPs.

Conveyance Outlets:

1. Grassed Waterway or swale. Used most often in rural areas where flows are 6 cfs or less and water is not laden with sediment or other pollutants.

2. Stone Filters. Used at the outlets of small Sediment Basins and other areas where flows are maintained at low velocities.

3. Stormwater Conveyance Channels. Used in both urban and rural areas to contain flows at non-erosive velocities.

Water Storage Outlets:

1. Sediment Basins are used on construction sites where water is laden with sediment. They can serve as outlets for Diversions and areas of bare soils and concentrated runoff.

2. Infiltration Basins are used in areas where the water is such that it would not contaminate groundwater, and where soils are such that water will infiltrate into the ground. They should be used as one of the final stops in a "treatment train."

3. Detention/Retention Basins are used on many development sites, as well as in-stream, to obtain an in-stream hydrology that is similar to the pre-construction conditions.

4. Oil/Grit Separators are used in urban areas and industrial sites where oil and grit is contained in the runoff.

5. Wet ponds and wetlands. Like infiltration basins, these are used as the "final treatment" in a series of BMPs, where water up-slope/up-stream has been treated with other BMPs.

Conduits:
Outlets from stormwater basins, sediment basins and any other conduit structures which release water to watercourses, should be designed as part of the structural BMP. Conduits which release water into watercourses should be stablilized with riprap to three feet above the ordinary high water mark. Follow specifications in the Riprap BMP.

Outlet Protection:
The maximum allowable velocity at the outlet should be determined using Table 1, below. When the velocity at the outlet exceeds the allowable velocity given in Table 1, riprap outlet protection should be used to dissipate energy. Follow specifications in the Riprap BMP.

Maintenance

All of the BMPs cited in the section above require regular maintenance. Follow the maintenance

Buffer/Filter Strips

Updated September, 1997

Description

A buffer/filter strip is a vegetated area adjacent to a waterbody (i.e. river, stream, wetland, lake). The buffer/filter area may be natural, undeveloped land where the existing vegetation is left intact, or it may be land planted with vegetation. Its purpose is to protect streams and lakes from pollutants such as sediment, nutrients and organic matter, prevent erosion, provide shade, leaf litter, and woody debris. Buffer/filter strips often provide several benefits to wildlife, such as travel corridors, nesting sites and food sources.

For the purposes of this BMP, a buffer/filter strip is a combination of 1) a *buffer* of vegetation between human land use and a stream, and 2) a *filter*, to trap sediment and absorb sheet flow. The buffer is usually comprised of trees, the buffer provides shade, leaf litter, woody debris, erosion protection, and often serves as wildlife habitat. The filter strip is an area of dense grass at least 20 feet wide designed specifically to remove pollutants from stormwater runoff from sheet flow off adjacent land, through filtering and infiltration. Although vegetative filters designed as specified in this BMP can be expected to provide significant pollutant removal, overall water quality will not be protected if a filter stirp is not used in conjunciton with a buffer along the stream corridor.

To protect water quality, a buffer/filter at least 100 feet wide should be preserved or created around all waterbodies and wetlands, with strip widths increasing with increasing slope. Research shows that when the buffer is less than 100 feet, stream quality begins to diminish. If a 100-foot buffer/filter strip is not feasible, or if wildlife habitat is of interest, refer to the specifications section of this BMP for additional information.

Special Considerations: Natural or Wild and Scenic Rivers may have special buffer/filter strip restrictions, depending on their designation (see Exhibit 1). Contact the MDNR, Forest Management Division, Natural Rivers Program staff for further information.

Other Terms Used to Describe

Vegetative Filter

Pollutants Controlled and Impacts

Several researchers have measured >90% reductions in sediment and nitrate concentrations; buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but are relatively ineffective in removing dissolved phosphorus (Gilliam, 1994).

Application

Land Use

Applicable to all land uses adjacent to waterbodies.

Soil/Topography/Climate

This practice is especially important on and adjacent to steep slopes. Natural buffer strips are essential in maintaining the shade and stream temperatures of coldwater streams.

When to Apply
Natural buffer/filter strips should be identified and protected before any development occurs on a site. At the watershed level, buffer/filter strips could be identified during community land use planning (i.e. during master plan development, development of parks, or greenways, etc.) or as part of efforts to identify and protect specific land uses, such as prime farm land. At the site level, buffer/filter strips should be incorporated into the overall plan for the site, and protected during construction.

Where to Apply
Adjacent to all watercourses and wetlands.

Relationship With Other BMPs

Natural buffer/filter strips should be identified prior to any Land Clearing operations.

BMPs may be needed upslope of a buffer/filter strip if: 1) runoff directed to the buffer/filter cannot enter as sheet flow, or 2) protection of the buffer from excess sediment is needed to maintain the integrity of the buffer.

Specifications

Planning Considerations to Preserve Buffer/Filter Strips:
Buffer/filter strips which are able to remain as undisturbed native vegetation should be delineated on preliminary and final site plans. *To protect water quality*, preserve natural buffer areas a total *minimum width of 100 feet* along all water courses and wetlands, with widths increasing with increasing slope. This is recommended to maintain shade, uptake pollutants and absorb sheet flow (i.e. stormwater that is not concentrated at a single point and causes erosion). While the 100-foot width is consistent with stream research studies (see Exhibit 6) and is the policy of most forest managers as a means to protect water quality, if wildlife habitat is of particular interest, see the Exhibit 1 for information on buffer/filters which protect water quality and wildlife habitat.

Management of the Buffer: The Three-Buffer Zone System
Scheuler (1995) promotes the use of a buffer/filter system made up of three zones, each of which has a different width, function and management scheme. The total minimum width of the three zones is 100 feet and includes the floodplain.

- The *streamside zone* is usually made up of mature trees which provide shade, leaf litter, and woody debris to the stream, as well as erosion protection. The minimum width of this zone is 25 feet. Land uses allowed in this zone are limited to footpaths, and well-designed watercourse crossings (for utilities, roads, etc.). See the Watercourse Crossings BMP to help in designing sound watercourse crossings.
- The *middle zone* extends from the outer edge of the streamside zone and protects the stream's ecosystem by providing a larger protective area between the stream and upland development. Ideally, this zone will also be made of mature trees and will be a minimum of 50 feet, with widths increasing to ensure the 100-year floodplain, adjacent steep slopes and protected wetlands are included. The width of this zone may also increase as the stream order increases. Uses allowed in this zone include bike paths and other low-impact recreational uses and stormwater BMPs.
- The *outer zone* is the zone between the middle zone and the nearest permanent structure (e.g. house or building). This is the filter part of the buffer/filter system. In residential areas, this

zone is usually a grassy backyard. The zone is a minimum of 20 feet in width, with widths increasing with increasing slopes and with the amount of sediment and/or nutrients the filter is expected to treat. Septic systems and permanent structures are restricted in this zone. In urban areas or areas directly adjacent to pavement, this area should be a managed filter strip to maximize pollutant removal.

Incorporating Stormwater BMPs in the Buffer/Filter:
Buffer/filter strips are not capable of treating all stormwater generated in a watershed. (Schueler states that a buffer/filter system can treat runoff from less than 10% of the contributing watershed). Therefore, stormwater BMPs must be used to protect the streamside buffer zone and the stream itself.

The designer should evaluate all the possible paths of flow into the buffer/filter strip. If any flow paths are expected to exceed sheetflow or otherwise cause erosion, then BMPs are needed upslope. If land is limited, the BMPs may need to be installed in the upper or middle zones.

Example problem: A designer determined that stormwater would enter the buffer/filter strip from a new development at three points: 1) a parking lot curb cut draining half of a parking lot, 2) parking lot overland flow draining the other half of a parking lot; and 3) building roof drains. The designer determined that the water leaving the parking lot would do so as sheet flow and cause no erosion in the buffer/filter strip.

Example Solution: Since the parking lot curb cut would cause concentrated flow into the buffer/ filter strip, the designer added two more curb cuts to the design to break up the flow. He designed the parking lot so that the buffer/filter would be located 3 to 6 inches lower than the pavement to prevent sediment deposits from blocking inflow to the filter strip. He also included installing a layer of stone at the outlets of the curb cuts to slow the water. To address the concentrated flow from the building roof drains, he included a rock-lined splash apron below the drains, and below it, some dense vegetation. Due to limitations in the land available, these BMPs were installed in the outer zone of the buffer/filter strip.

Planning Considerations for Creating Buffer/Filter Strips:
Re-establishment of buffer/filter strips is possible if urban land is being reclaimed, if sites of environmental contamination are being cleaned up, or if greenways are being established as part of a greenways program or recreation enhancement program. Under these and other re-establishment conditions:

1. Conduct a site evaluation to determine:
   - the drainage characteristics. Depending on drainage, it may be necessary to use other BMPs. Note that concentrated flows can be minimized by limiting the drainage area to less than 5 acres.
   - percentage slope and length of slope.
   - type of soil and soil stability. Sloughing soils, will require additional BMPs to ensure stability of the slope.

2. Determine all of the possible uses of the newly developed buffer strip and incorporate those uses into the design. For wildlife considerations, see Exhibit 1.

3. Select vegetation based on the site characteristics determined uses and the three-zone

concept. For vegetative mixtures for the outer zone, see Exhibit 2.

4. **Buffer/filter strips are not effective methods for treating concentrated flow.** Determine flow patterns onto the buffer/filter strip and incorporate BMPs to ensure stormwater enters the buffer/filter strip as **sheet flow**.

Installing Buffer/Filter Strips:

1. Install any BMPs needed upland.

2. Prepare the site. If it is necessary to clear and grade land, follow specifications in the Land Clearing and Grading Practices BMPs. *Never grade to the edge of a watercourse without using filter fencing or other BMPs to protect the watercourse.* Any use of soil amendments such as fertilizer should be based on soil tests and follow the Soil Management specifications.

3. Refer to the Seeding, Sodding, Mulching and Trees, Shrubs and Ground Covers BMPs, as appropriate to the vegetation selected.

4. Maintain any temporary upland BMPs until vegetation "takes." Grass should be a minimum height of 4 inches and 90 percent ground cover before temporary upland BMPs are removed (i.e. the site should be stable).

5. Consider using mulch between trees and shrubs to keep soil on site.

6. Avoid spraying the buffer strip with pesticides; consider alternatives in the Integrated Pest Management BMP.

7. Protect the buffer/filter from damage by equipment and traffic. Do not use the buffer/filter strip as a roadway.

Maintenance

All Zones:

Periodic inspections should be done to ensure that concentrated flows have not developed, and to make sure the vegetative cover is maintaining its effectiveness. If the integrity of the buffer/filter strip is jeopardized by upland erosion, or if concentrated flows are creating rills or gullies up-slope of the strip, additional BMPs may need to be installed. If the buffer strip is being jeopardized by stream bank erosion, then the cause of the bank erosion needs to be investigated and actions taken to address the causes. Damaged strips should be repaired as soon as possible. Strips damaged due to construction upslope of the buffer/filter should be replanted, as necessary, after the cause of the damage is assessed and any other BMPs needed are implemented.

In buffer/filter strips used by wildlife—but especially in the streamside zone—avoid using herbicides to control weeds. Refer to the Pesticide Management BMP for other options.

Streamside Zone and Middle Zone:

Natural woody buffer/filter strips should be left undisturbed, except for the uses listed in the management section of this BMP (pages 2 and 3). Do not use heavy equipment in this area.

To replace or repair damaged trees, refer to the Tree Protection and Trees, Shrubs and Ground Covers BMP.

The Outer Zone:

- If sediment enters the filter strip in amounts which cannot be removed by hand, or in amounts which damage the filter strip, additional upland BMPs will likely need to be installed.
- Remove sediment in this zone when sediment begins to build up. Reseed if necessary.
- If the filter was designed for nutrient removal, remove any harvested vegetation (grass clippings, leaves, etc.) and dispose of outside the buffer/filter strip.
- If grass fails to grow in newly established filter strips, determine the reasons for failure before reseeding. The Lawn Maintenance BMP includes information on unhealthy turf. Spot seed applications when only small areas are affected. If insects are damaging the filter strip, explore integrated pest management techniques in the Pesticide Management BMP to protect any wildlife using the filter strip.
- Mowing should be done to help control weed growth, prevent the growth of woody plants, and help the filter maintain its effectiveness. Mow no lower than six inches to allow vegetation to provide filtering of sediment, organic matter, nutrients, and pesticides. If the strips are used by nesting birds, do not mow until after July 15. To maintain winter cover for wildlife, do not mow after September 1.
- *During the establishment year,* clip to control undesirable plants such as Canadian thistle and milkweed. Clip high (6 inches) to prevent damage to the permanent seeding. Clip between July 15 and August 15. If needed, clip twice during the summer. Use chemical controls only after all non-chemical methods have been considered.
- *After the establishment year*, only spot clipping (or spot chemical treatment, if necessary) should be done, rather than clipping or otherwise treating the entire strip. If noxious weeds develop, clip in the spring to prevent weed seeds from dispersing. Otherwise, clip between July 15 and August 15 to protect any nesting wildlife.

Exhibits

Exhibit 1: 1997 Literature Review of Buffer/Filter Strips for Wildlife and Water Quality. MDEQ, Surface Water Quality Division.

Exhibit 2: Vegetative Widths for the Outer Zone. USDA Soil Conservation Service Technical Guide.

Exhibit 3: Vegetative Mixtures for the Outer Zone. USDA Soil Conservation Service Technical Guide.

Exhibit 4: 1993 Literature Review on Buffer/Filter Strip Widths. MDEQ, Surface Water Quality Division.

Exhibit 5: References used in developing the BMP.

Exhibit 6: Michigan's Natural Rivers System. List of rivers designated or proposed under the Natural Rivers program.

Exhibit 1

For Wildlife Corridors That Also Protect Water Quality

For wildlife corridors that also protect water quality, consider the following:

- Rudolf and Dickenson (1990) found that reptiles and amphibians were more abundant in buffers 99-313 feet than 0-82 feet.

- Dicken and Huntly (1987) found abundant signs of squirrels in buffers greater than 165 feet, but virtually none in zones narrow than 99 feet.

- Dicken and William (1988) found small mammals to be more abundant in narrower streamside areas with well developed herbaceous vegetation compared to wider zones with sparse vegetation.

- Burk et al (1990) found that turkeys were significantly less when buffers were less than 150 feet.

- Premo (1995) found that a 50-foot zone of intact vegetation is too narrow to support most breeding species of birds. He also found that in hardwood riparian buffers/filters, mammal use was heaviest closest to the river and decreased out to 400 feet and leveled off; in conifer riparian buffer/filters, mammal use was fairly high near the river but peaked at 400 feet, and therefore, sections of 400-foot buffer/filter may be needed in coniferous riparian zones to optimize use by mammals.

Exhibit 2

The Outer Zone: Grass/Sod Filter Widths

Length of Slope	Percent Slope															
	0.2	0.3	0.4	0.5	1.0	2.0	3.0	4.0	5.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0
	Width - Feet															
100	20	20	20	20	20	20	20	20	30	40	50	50	50	60	60	60
200	20	20	20	20	20	20	20	30	40	40	50	50	60	60	60	60
300	20	20	20	20	20	20	30	40	40	50	50	60	60	60	60	60
400	20	20	20	20	20	20	30	40	50	50	50	60	60	60	60	60
500	20	20	20	20	20	20	30	40	50	50	60	60	60	60	60	60
600	20	20	20	20	20	20	30	40	50	50	60	60	60	60	60	60
700	20	20	20	20	20	20	30	40	50	50	60	60	60	60	60	60
800	20	20	20	20	20	20	30	40	50	50	60	60	60	60	60	60
900	20	20	20	20	20	20	30	40	50	50	60	60	60	60	60	60
1000	20	20	20	20	20	20	30	40	50	60	60	60	60	60	60	60
1100	20	20	20	20	20	30	30	40	50	60	60	60	60	60	60	60
1200	20	20	20	20	20	30	40	40	50	60	60	60	60	60	60	60
1300	20	20	20	20	20	30	40	50	50	60	60	60	60	60	60	60
1400	20	20	20	20	20	30	40	50	50	60	60	60	60	60	60	60
1500	20	20	20	20	20	30	40	50	50	60	60	60	60	60	60	60
1600	20	20	20	20	20	30	40	50	60	60	60	60	60	60	60	60
1700	20	20	20	20	20	30	40	50	60	60	60	60	60	60	60	60
2000	20	20	20	20	20	30	40	50	60	60	60	60	60	60	60	60

Source: USDA Soil Conservation Service Technical Guide, #326.

Exhibit 3

Vegetative Mixtures for the Outer Zone

Soils: Well and moderately well drained sand and loamy sand (coarse textured soils)

Seeding Mixtures	Rates Lbs./Acre	Suitability Sediment Filter Wind	Water
Red Fescue Ryegrass	20 5		X
Smooth Brome	15		X
Switchgrass	8	X	
Switchgrass Tall or Intermediate Wheatgrass	4 8	X	
Tall or Intermediate Wheatgrass	15	X	

Soils: Well and moderately well drained, moderately coarse to moderately fine textured soils (sandy loam, loam, silt loam, and clay loam)

Seeding Mixtures	Rates Lbs./Acre	Suitability Sediment Filter Wind	Water
Reed Canarygrass	6		
Reed Canarygrass Tall Fescue	4 8		X
Smooth Brome	15	X	X
Smooth Brome Tall Fescue	8 12	X	X
Switchgrass	8	X	
Switchgrass Tall or Intermediate Wheatgrass	4 8	X	
Tall Fescue	20	X	X
Tall or Intermediate Wheatgrass	15	X	

1/ Double seeding rates.

(continued)

Exhibit 3 (Continued)

Vegetative Mixtures for the Outer Zone

Soils - Well and moderately well drained clay and silty clay (fine textured soils)

Seeding Mixtures	Rates Lbs./Acre	Suitability Sediment Filter Wind	Water
Reed Canarygrass	6	X	X
Reed Canarygrass Tall Fescue	4 8	X	X
Smooth Brome	15	X	X
Smooth Brome Tall Fescue	8 12	X	X
Switch Grass	8	X	
Tall Fescue	20	X	X
Tall or Intermediate Wheatgrass	15	X	X

Soils - Somewhat poorly drained or poorly drained soils without artificial drainage.

Seeding Mixtures	Rates Lbs./Acre	Suitability Sediment Filter Wind	Water
Reed Canarygrass	6	X	X
Switchgrass 2/	8	X	
Tall Fescue	20	X	X

* The following legumes may be added to the grass mixtures: 6#-8# alfalfa or 3#-4# of birdsfoot trefoil and/or 2# of sweet cover.

1/ Double seeding rates.

2/ Use species tolerant of wetter soils.

Source: USDA Soil Conservation Service Technical Guide #393

Exhibit 4

1993 Literature Review of Buffer/Filter Widths

SOURCE	FACTORS REVIEWED	FINDINGS/RECOMMENDATIONS
Aubertin West Virginia	turbidity, nutrients	Used 10-20M (32.8 feet - 65.6 feet) buffers in study. Both turbidity & nutrients increased during and after logging.
Brazier Oregon	temperature	80' Buffer was necessary to maintain temperature and 55' was necessary for 90% of that temperature or angular canopy density
Erman California	stream invertebrates	Streams with a buffer strip less than 30M (98.4') showed same response as stream logged without buffers. Changes were caused by decreased canopy density, increased primary production, increased stream flows, increased temperature and increased sediment.
Graynoth New Zealand	stream invertebrates	Streams with buffer strip less than 30M showed same response as stream logged without buffers. Changes were caused by decreased canopy density, increased primary production, increased stream flows, increased temperature and increased sediment.
Corbett Pennsylvania	turbidity, sedimentation	1978 Report recommended 23-30M (75.4'-98.4') Buffers 1981 Report recommended 30M (98.4') Buffers 1990 Report recommended 100 feet or 1 1/2 times the average tree length
Farrish Louisiana	soil erosion	**Buffers did not stop gully erosion** that was initiated upslope of buffer. All 1,584 sites reviewed had developed gullies.
Verry 1986 Minnesota	stream flow	Clearcutting hardwoods increased annual stream flow 9 to 20 cm (a 30 to 80 percent increase). It took 12 to 15 years to return to preharvest levels
Verry 1992 Minnesota	large woody debris, temperature, water depth, cover, stream flow	Recommend 2 tree lengths, typically 150 feet, as a leave zone beginning at the top of the bank. Cut only 25% of basal area in second tree length.
Oklahoma State University	Habitat	
-Rudolph & Dickenson, 1990	reptiles/amphibians	More abundant in buffer 99 - 313' than 0-82 feet.
-Dicken & William 1988	small mammals	More abundant in narrower streamside areas with well developed herbaceous vegetation compared to wider zones with spare vegetation
-Dicken & Huntly 1987	squirrels	Abundant signs of squirrel in buffers wider than 165' but virtually none in zone narrower than 99'
-Burk et. al. 1990	turkeys	Turkeys were significantly less when buffers were less than 150'
Hesser Pennsylvania	trout production, sedimentation, temperature	A recommendation of one and one-half chains (100') on both sides of river was made from a literature review. Increased zones may be necessary for sensitive areas.

Exhibit 5

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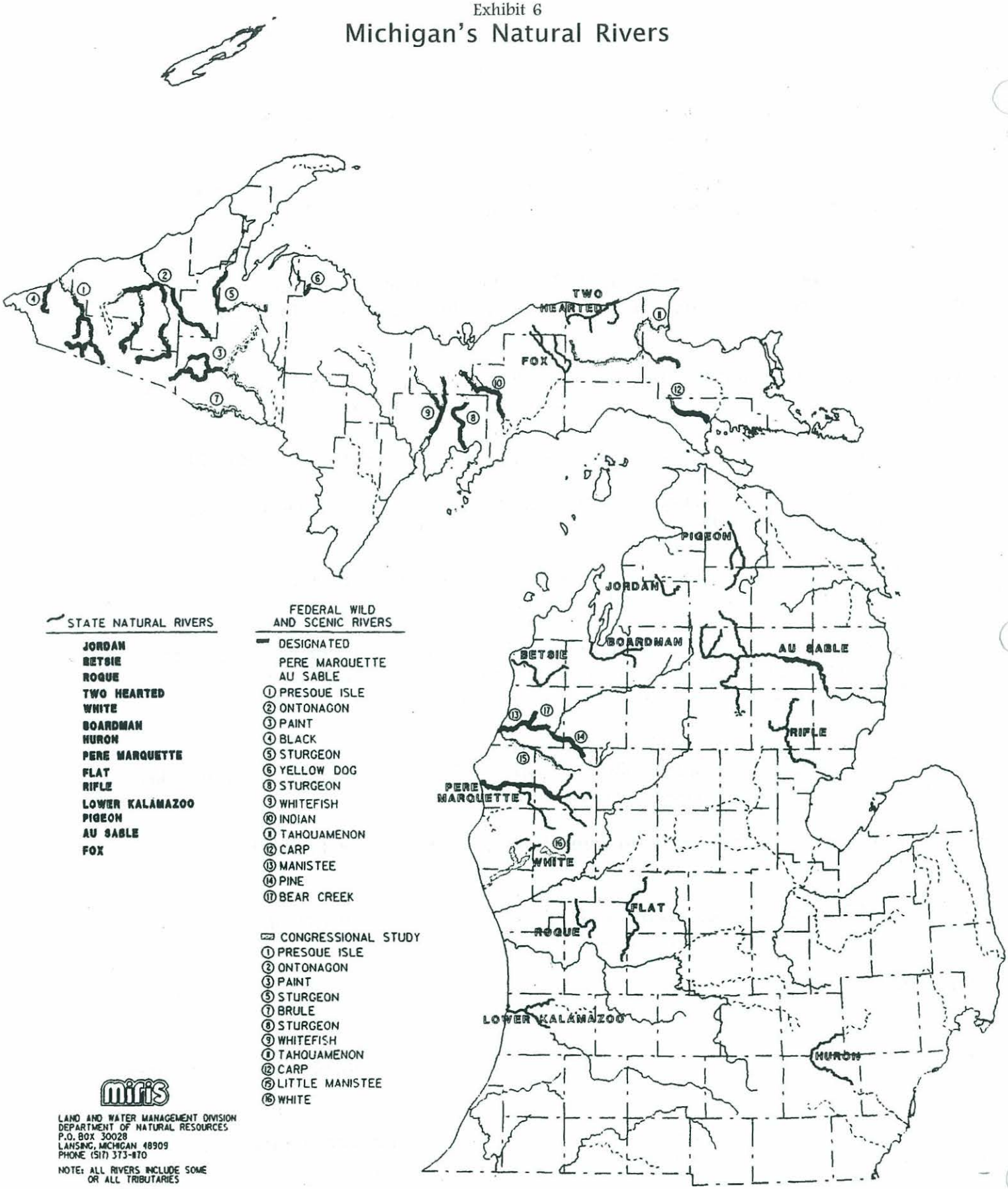
Exhibit 6

Michigan's Natural Rivers



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Construction Barriers

Description

Construction barriers are fences, signs and other means used on a construction site to:

-confine equipment and personnel to the immediate construction area, thus minimizing the destruction of vegetation and reducing the potential for erosion and compaction.

-protect trees and their root zones against abrasion and soil compaction. It takes 20-30 years for newly planted trees to provide the benefits of mature trees.

-prevent unnecessary access to structural BMPs

-protect sensitive areas, such as water bodies and newly seeded areas

-restrict access of unauthorized persons and vehicles.

Other Terms Used to Describe

Fencing

Pollutants Controlled and Impacts

Confining construction activities to a specific site will limit the amount of soil exposed to wind and rain. Effective confinement may also eliminate unnecessary or excessive regrading or revegetation of slopes or raw areas.

Application

Land Use
Use at all construction areas where earth changes are taking place. Land uses include transportation (highway work), urban (drain work, private, commercial and industrial developments), and golf courses.

Soil/Topography/Climate
This practice can be used anywhere, but is particularly important on erodible soils and steep slopes.

When to Apply
Apply this practice prior to the start of construction and as needed throughout the duration of the project. Some barriers, such as vehicle deterrent barriers, may remain in place after project completion.

Where to Apply
Apply anywhere confinement or protection of persons, property or natural resources is needed.

Relationship With Other BMPs

Construction barriers are used to protect critical erosion areas (see Critical Area Stabilization) and to prevent unwanted access by vehicles, equipment and people. It is a component BMP used with many other soil erosion control practices.

Specifications

Planning Considerations:

1. Barriers used to separate the construction area from pedestrian thoroughfares, or used to alert personnel about the existence of hazardous conditions, should be stable and easily discernible.

2. Keep barriers outside the drip line of any trees which will remain intact during and after the construction project. (The drip line is the area from the trunk outward to the a point at which there is no longer any overhanging vegetation). Pounding barriers into the ground within the drip line of trees may cause root damage and weaken the tree. Follow specifications in the Tree Protection BMP.

3. Signs should *not* be nailed or otherwise posted on trees.

4. In large open areas susceptible to wind, consider protecting sprigged or seeded areas with fencing.

5. Barriers are particularly important around detention, retention, and Sediment Basins, and dams (including cofferdams). At a minimum, barriers in these areas should include signs which warn people of potential dangers. Fencing may also be needed, depending upon the slope steepness, outlet flows, depth of water, etc.

   Select appropriate structures for the intended use:

   Temporary structures:
   Temporary fences can be made out of snow fence or the orange plastic fencing which is commonly used in construction areas. Silt fences can also be used as temporary barriers where safety is not a consideration. (See the Filters BMP).

   Permanent structures:
   Permanent fences may be constructed of wood, plastic, synthetic fabric, plastic or any other appropriate material.

   Cyclone-type fences with secure gates and locks should be used around dangerous areas such deep basins.

   Snow fences can be used to prevent pedestrian access and to control wind erosion.

Construction Considerations:

1. Signs should be constructed out of durable materials and printed legibly.

2. Construct the fence following specifications for the type of fence being installed. Be sure all posts are sturdy, and all material is suitable for the intended use. One source of specifications for standard wire, suspension, electric and permanent power fences is the Soil Conservation Service Technical Guide, specifications for Fencing (#382).

3. All fences used as filters should be implemented following specifications in the Filters BMP.

After Construction:

1. Remove all temporary construction barriers. Before leaving the site, inspect all permanent barriers to ensure they are in good working order, and repair where necessary.

2. When removing tree protection barriers, check to make sure the tree is still in good health. Trees which are severely damaged should be removed and replaced. See the Tree Protection BMP for information on replacing trees, and techniques on how to properly repair damaged roots and limbs.

Maintenance

Barriers should be inspected and maintained on a regular basis. Damaged signs and fences should be repaired or replaced immediately.

Grading Practices

Description

Grading is reshaping the ground surface to planned grades determined by engineering survey evaluation and layout. This BMP includes basic grading concepts, as well as specific types of grading practices that can be used to reduce erosion. Grading plans are discussed in the BMP Guidebook.

Other Terms Used to Describe

Rough Grading
Contour Grading
Special Grading Practices
Land Smoothing

Pollutants Controlled and Impacts

Proper grading practices help to improve surface drainage and reduce the amount of soil which erodes from a site.

Application

Land Use
Construction sites

Soil/Topography/Climate
Grading should compliment the natural configuration of the landscape. Where possible, the depth of grading should be controlled to prevent exposing extensive amounts of subsoil. Topsoil should be removed, stockpiled and re-spread over the graded area.

When to Apply
Apply whenever earth moving or construction activities produce grades which may increase erosive velocities or off-site sedimentation.

Where to Apply
This practice applies on any areas which require grading.

Relationship With Other BMPs

Diversions should be considered to prevent runoff from causing erosion on the exposed soil. To prevent off-site sedimentation, control measures such as Filters (filter fences), Grade Stabilization Structures and Sediment Basins may need to be installed at the lower perimeter of the site. Staging should be done to reduce the size of the area being exposed. (See the Staging and Scheduling BMP).

Specifications

The following is modified from the "North Carolina Erosion and Sediment Control Planning and Design Manual."

Planning Considerations:

1. Develop a **grading plan** to help establish drainage areas, direct drainage patterns, and decrease runoff velocities. The grading plan should follow the guidance in the BMP Guidebook, including coordinating the grading plan with the soil erosion/sedimentation control plan and the stormwater plan.

2. Slopes which will be mowed should not be steeper than 3:1.

3. Grading should be done in stages according to the implementation schedule. See the Staging and Scheduling BMP.

4. Protect spoil piles following specifications in the Spoil Piles BMP.

5. To ensure even settling, any fill to be used should be free of objectionable material such as logs, rocks and stumps. Do not use frozen or mucky material for fill.

6. Do not place fill adjacent to a channel bank where it can create bank failure or result in deposition of sediment downstream.

7. The exposed area should be stabilized with vegetation, crushed stone, riprap or other ground cover as soon as grading is completed or when work is interrupted for 30 working days or more. Use mulch (see Mulching BMP) to stabilize areas temporarily where final grading must be delayed. Slopes in excess of 2:1 should be stabilized following the specifications in the Critical Area Stabilization BMP.

During Grading:

1. Following the grading plan, construct all erosion and sedimentation control practices.

2. Remove vegetative matter in accordance with Land Clearing specifications. Remove topsoil and store in temporary Spoil Piles until final grading. Temporary spoil piles adjacent to wetlands or streams should be protected to prevent erosion.

3. Do not grade to the edge of watercourses. If a natural Buffer/Filter Strip cannot be left, construct a berm or place filter fencing adjacent to the watercourse/wetland. (See Filters BMP).

4. Divert runoff to stabilized areas, according to the grading plan.

5. Where possible, contour the grade to follow the natural contour of the land.

6. Finish grade and compact according to the intended use of the area. See the appropriate BMP for additional information on the finish grading procedures and the degree of compaction needed.

7. Except on roadway side slopes, use one of the surface roughening techniques described below to retain water, increase infiltration and facilitate vegetative growth. See Exhibit 1.

Stair-step grading. This method should be done on slopes steeper than 3:1 which have material soft enough to be bulldozed and which will not be mowed. The vertical cut should be less than the horizontal distance and should not exceed 2 feet in soft material and 3 feet in rocky material. The horizontal position of the "step" should be sloped toward the vertical up-hill wall.

Grooving. This method can be done on any area which can safely accommodate disks, tillers, spring harrow, or the teeth of a front-end loader bucker. In areas which will not be mowed, use equipment to create grooves perpendicular to the slope. Grooves should not be less than 3 inches deep, nor more than 15 inches apart. In cuts, fills, and areas that will be mowed, grooves should be less than 10 inches apart and not less than 1 inch deep.

Tracking. This method is done by running tracked machinery (such as bulldozers) up and down slopes to leave horizontal depressions in the soil. To avoid undue compaction of the soil, this method should only be done on sandy soils. Back-blading should not be done during the final grading operation.

8. Use proper Tree Protection techniques to maintain the health and integrity of the trees. Excavate as far away from the drip line as possible.

When **raising the grade** around an existing tree:

1. A well can be created around the tree(s) just outside the drip line to retain the natural soil in the area of the feeder roots

2. A dry well can be constructed around the trunk with space to allow the trunk to grow. The well should be designed to allow drainage within the well and around the root system inside the drip line. See exhibit 2.

When **lowering the grade:**

Protect trees by constructing a tree wall made of large stones, brick, building tile, or concrete block or cinder block. The wall should be designed to provide for drainage through the wall. See exhibit 3.

See the Tree Protection BMP for specifications on how to repair damaged tree roots and limbs.

After Construction:

Stabilize all areas with vegetation (See vegetative BMPs) or Slope/Shoreline Stabilization structures, where appropriate.

Maintenance

Desired gradients will have to be maintained until the proposed land use is established with a structure, pavement, or vegetation. In addition, maintenance should be done on any BMPs installed in association with the grading.

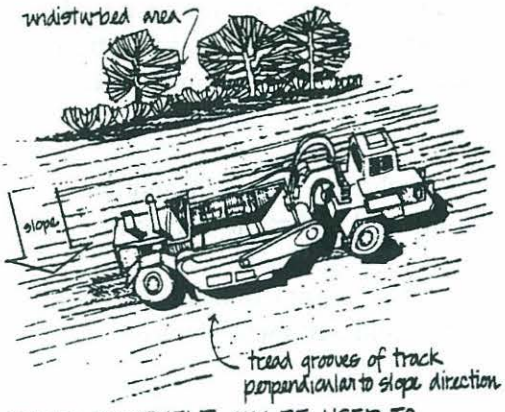
Exhibits

Exhibit 1: Surface Roughening Techniques. Includes two diagrams from the Michigan Soil Erosion and Sedimentation Control Guidebook. Also, grooving, as modified from the Virginia SWCC (copied from the North Carolina Erosion and Sedimentation Control Planning and Design Manual).

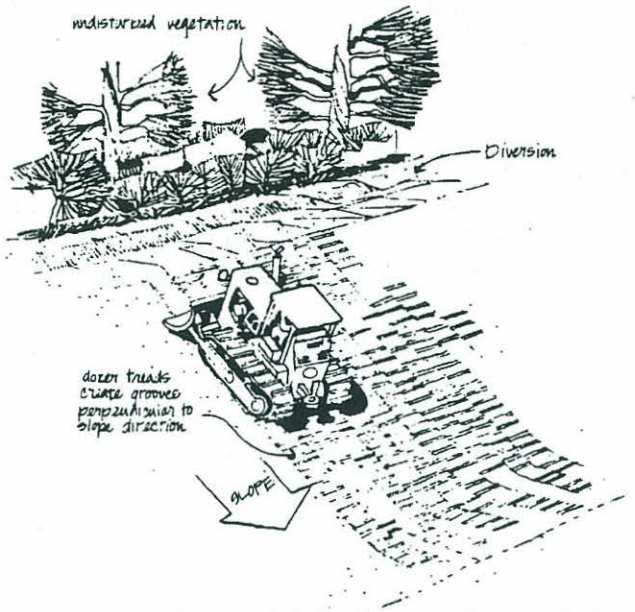
Exhibit 2: Tree Well. Adapted from the Virginia Erosion and Sediment Control Handbook. Copied from Connecticut Guidelines for Soil Erosion and Sediment Control.

Exhibit 3: Tree Wall. Originally from the Virginia Erosion and Sediment Control Handbook. Copied from Connecticut Guidelines for Soil Erosion and Sediment Control.

Exhibit 1
Surface Roughening Techniques

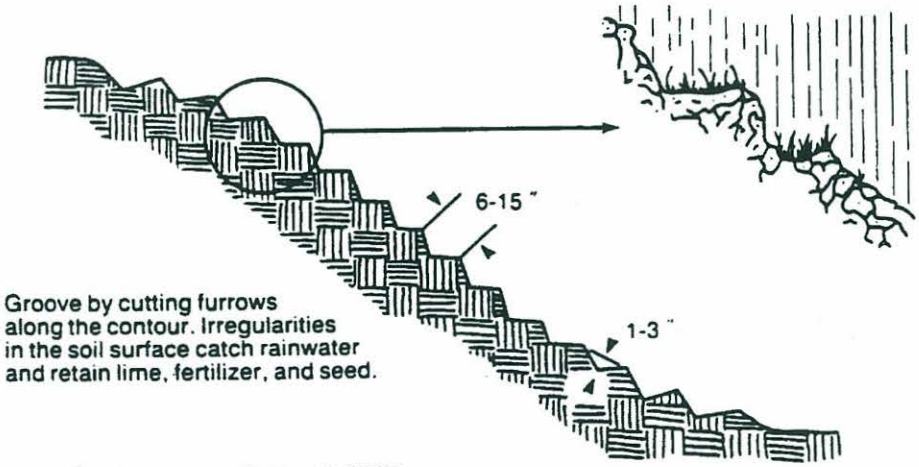


HEAVY EQUIPMENT CAN BE USED TO MECHANICALLY SCARIFY SLOPES



UNVEGETATED SLOPES SHOULD BE TEMPORARILY SCARIFIED TO MINIMIZE RUNOFF VELOCITIES

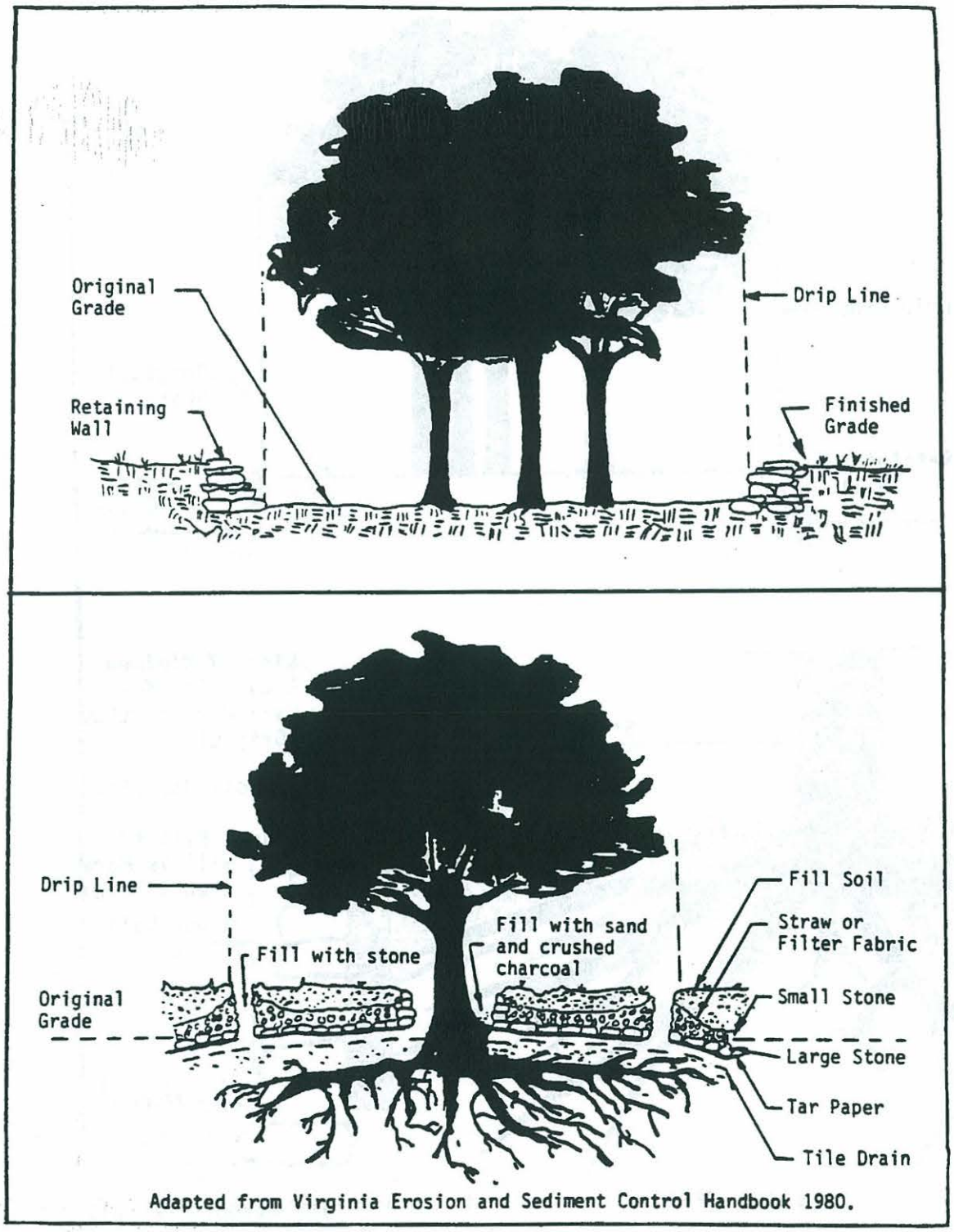
Source: Michigan Soil Erosion and Sedimentation Control Guidebook



Grooving slopes (modified from Va SWCC).

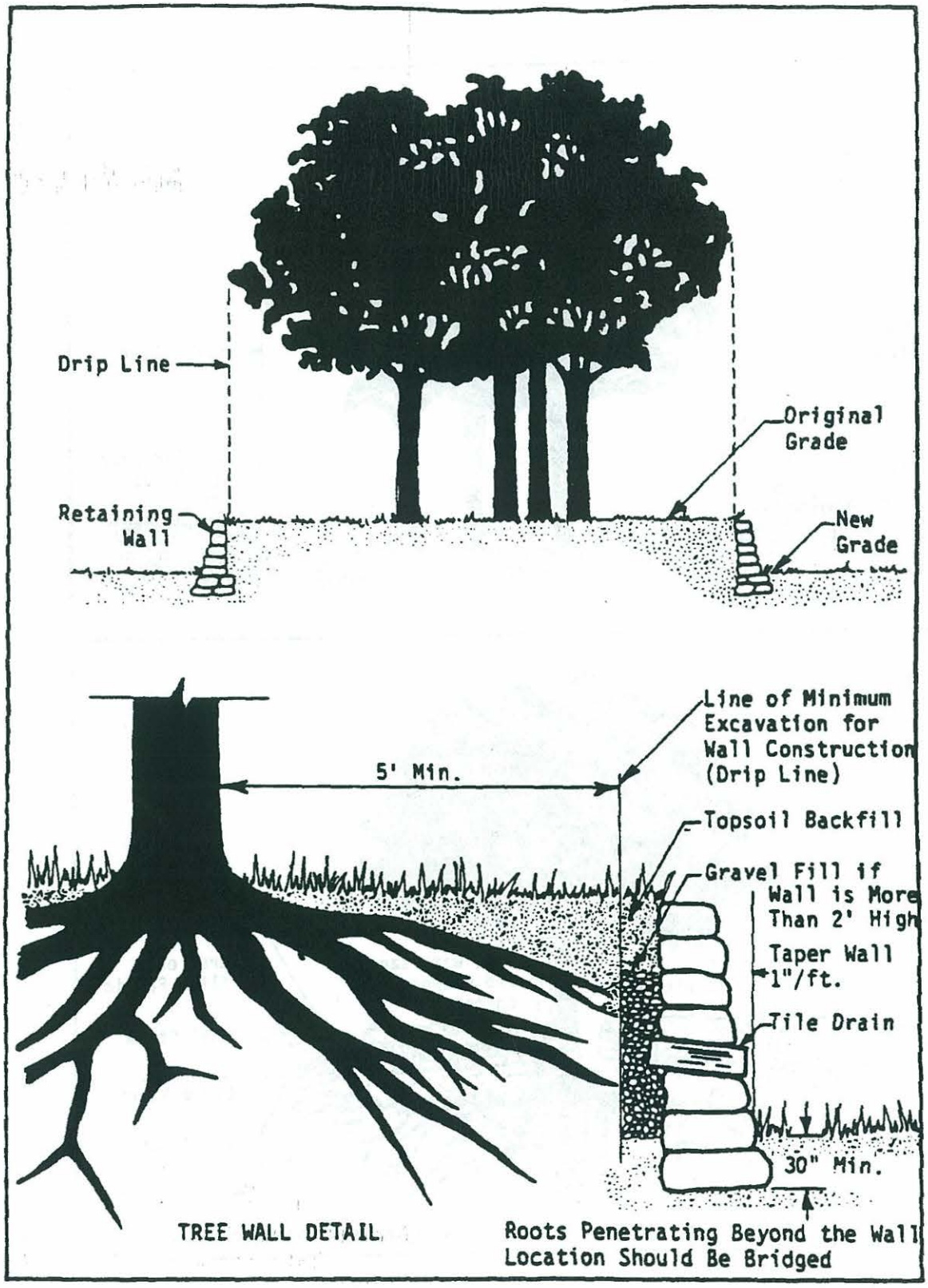
Source: North Carolina Erosion & Sediment Control Planning & Design Manual

Exhibit 2
Tree Well



Source: Connecticut Guidelines for Soil Erosion and Sediment Control

Exhibit 3
Tree Wall



Source: Virginia Erosion and Sediment Control Handbook, as copied from Connecticut Guidelines for Soil Erosion & Sediment Control.

Tree Protection

Description

Protecting trees during construction activities is done to preserve their health and ensure their vitality after construction.

Other Terms Used to Describe

Tree Preservation

Pollutants Controlled and Impacts

Trees should be considered for preservation because:

-They stabilize the soil and prevent erosion
-They reduce stormwater runoff by intercepting rainfall and promoting infiltration
-They moderate temperature changes, promote shade, and reduce the force of wind
-They provide buffers and screens against noise and visual disturbance, and provide some privacy
-They filter pollutants from the air and produce oxygen
-They provide a habitat for animals and birds
-They increase property values and improve site aesthetics

Application

Land Use
This practice is used most often on construction sites.

Soil/Topography/Climate
This practice is especially important in areas subject to windthrow, where trees removed in the upland area may cause a domino effect in the lower area. It is also important on highly erodible soils, where tree roots help stabilize soils and prevent erosion.

When to Apply
Apply during site evaluation before any construction is done on the site. During site evaluation, note where valuable trees are located and incorporate them into the overall construction design.

Where to Apply
Apply anywhere trees are in need of protection.

Relationship With Other BMPs

Tree protection should be done before any Land Clearing or Grading Practices are done. Construction Barriers are often used in conjunction with tree protection.

Specifications

Note that much of the information below was derived from the North Carolina Erosion and Sediment Control Planning and Design Manual.

Planning Considerations:
When selecting trees to be protected, consider:

1. Tree vigor. Preserve healthy trees. Sick trees or those damaged beyond repair can be left for wildlife, or removed. Trees lacking vigor include those with dead branches, small annual twig growth, stunted leaf size, sparse foliage, and pale foliage color. Trees with hollow or rotten trunks also should be removed.

2. Tree age. Older trees are usually more aesthetically pleasing, but often require more maintenance than younger trees.

3. Tree species. Protect trees which are most suitable for the site development.

4. Tree aesthetics. Protect trees which are aesthetically pleasing.

5. Wildlife benefits. Protect trees which are preferred by wildlife for food, cover or nesting. Evergreens are important for cover during the winter months. Hardwoods are more valued for food. A mix of evergreens and hardwoods is usually most beneficial.

Design Considerations:
When designing a construction site in wooded areas, consider:

1. Leaving critical areas (such as floodplains, steep slopes and wetlands) with as many desirable trees as possible in their natural condition.

2. Locating roadways, storage areas and parking areas away from valuable trees.

3. Selecting trees to be preserved before siting roads, buildings, or other structures.

4. Minimizing trenching in areas with trees. Multiple utilities should be placed in the same trench.

5. Equipment, structural materials, topsoil and fill dirt should never be stored in the drip line of the tree.

6. When the construction plan calls for lowering or raising the grade around trees, see the specifications for tree wells and tree walls in the Grading Practices BMP.

Implementation:
See Exhibit 1 for examples of several types of tree protection methods.

1. Never excavate, traverse, or fill closer than the drip line of trees to be saved.

2. Trees which will be preserved should be marked with a bright color paint or surveyor's ribbon applied in a band circling the tree at a height visible to equipment operators.

3. (Construction) Barriers for tree protection should never be placed within the drip line of the tree.

4. Don't cut roots in the drip line.

5. Never nail boards or wire to the trees, as this will make them more susceptible to disease, insect damage and decay. As a last resort, a tree trunk can be armored with burlap wrapping and 2-inch studs wired vertically no more than two inches apart to a height of five feet encircling the trunk.

After Construction:

Once construction is complete, you can remove all temporary tree protection devices. Inspect all trees to ensure they are in good health. Repair all damaged roots and branches:

1. Repair roots by cutting off the damaged areas and painting them with tree paint. Spread peat moss or moist topsoil over exposed roots.

2. Repair damaged bark by trimming around the damaged area (as shown in Exhibit 2). Taper the cut to provide drainage. Paint with tree paint.

3. Cut off all damaged tree limbs above the tree collar at the trunk or main branch. Use three separate cuts to prevent bark from peeling off healthy areas of the tree. (See Exhibit 2).

4. Trees which are severely damaged should be removed and replaced with similar species, with trunk diameters at least 2 inches.

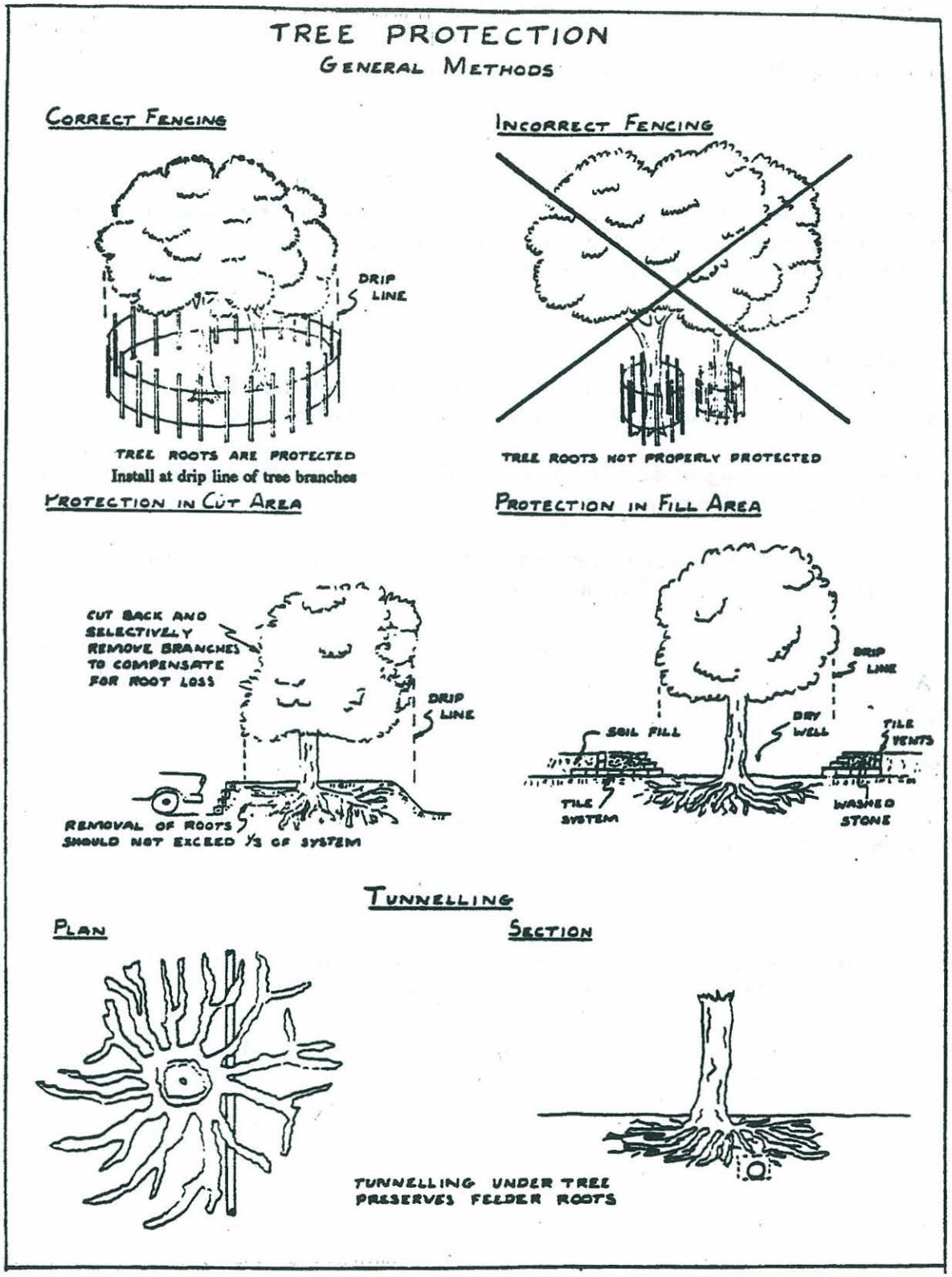
5. Soil over the root zone which has become compacted should be aerated by punching holes in it with suitable equipment.

Exhibits

Exhibit 1: Tree Protection, General Methods, Detail TP-1. Construction Project Evaluation Manual. MDNR, Land and Water Management Division.

Exhibit 2: Repairing Damaged Tree Limbs. North Carolina Erosion and Sediment Control Planning and Design Manual.

Exhibit 1



Source: Construction Project Evaluation Manual. Michigan Department of Natural Resources, Land and Water Management Division.

Critical Area Stabilization

Description

Critical area stabilization is stabilizing areas which are highly susceptible to erosion by implementing one or more vegetative or structural BMPs. For the purposes of this BMP, critical areas include areas with highly erodible soils, long or steep slopes, droughty soils, excessively wet soils, soils that are very acidic or alkaline, slopes immediately adjacent to waterbodies or wetlands, fill areas and areas subject to concentrated flows.

Other Terms Used to Describe

High-Risk Erosion Areas
Critical Area Seeding

Pollutants Controlled and Impacts

Protecting critical areas is one of the most effective means of preventing sediment from entering surface waters. Properly established vegetation used to protect critical areas will also help absorb nutrients and reduce flows from steep slopes.

Application

Land Use
Applicable to all land uses.

Soil/Topography/Climate
This practice is particularly important on soils that are excessively wet, droughty, or which are subject to erosion even during a light to moderate rainfall.

When to Apply
Critical erosion areas should be identified during the planning stages of the project or proposed earth change activity. All possible measures should be taken not to disturb these areas. If it is necessary to disturb these areas, attention should be given to protecting them immediately.

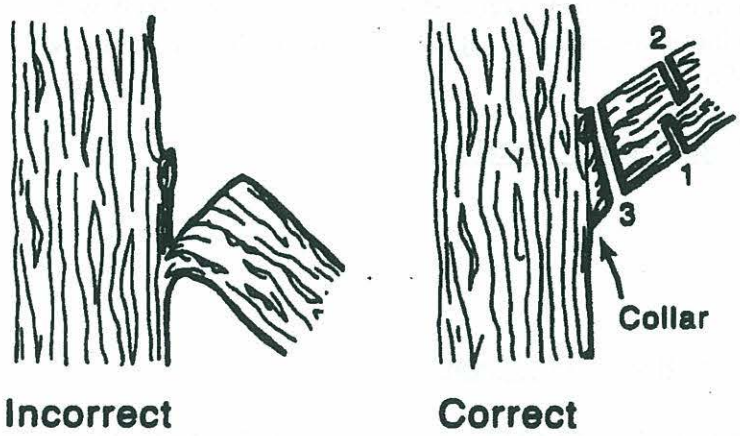
Where to Apply
Apply on any area which is difficult to stabilize.

Relationship With Other BMPs

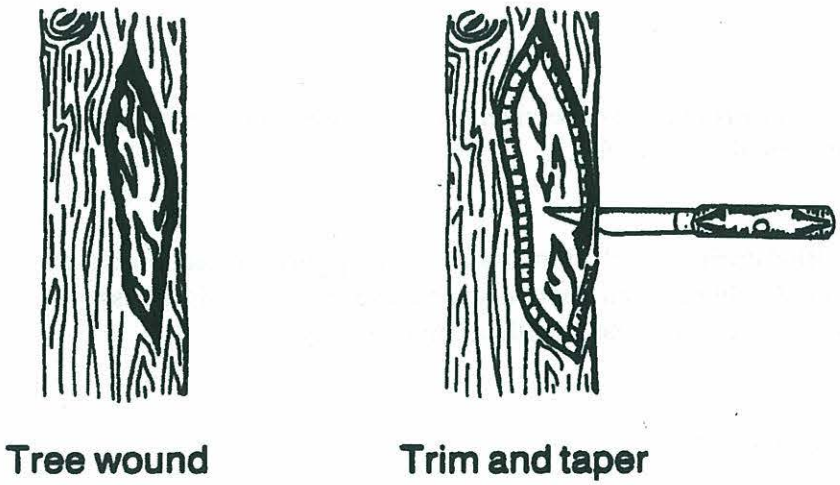
See the "Specifications" section, below.

Exhibit 2

Repairing Damaged Tree Limbs



Trim bark wounds with a tapered cut, then apply tree paint.



Prune damaged branches with three cuts to avoid peeling bark from the tree trunk when limb falls.

Source: North Carolina Erosion and Sediment Control Planning and Design Manual

For structural practices:
Follow the procedures in the selected BMP.

Design and Implementation:
The proper design and implementation of all BMPs used to stabilize critical areas should be done according to the specifications in the selected BMPs.

Maintenance

For vegetative practices:
Periodic inspections should be scheduled to ensure the vegetation is maturing correctly and staying in place.

Once the vegetation is well established:

1. Consideration should be given to removing Construction Barriers. In some areas, it may be beneficial to leave the barriers in place.

2. Vegetation should continue to be watered, when appropriate, to a depth of 1 inch into the sod bed. Water uniformly. See the Lawn Maintenance BMP.

3. Vegetation should be mowed according to its intended use. Follow the mowing specifications in the Lawn Maintenance BMP.

4. Soil testing should be done periodically to determine if the soil requires additional fertilizer or lime. Follow specifications in the Soil Management BMP.

5. Pesticides should only be used following specifications in the Pesticide Management BMP.

6. Spot Seeding should be done as needed on small damaged areas.

For structural practices:
Follow maintenance procedures in the "Maintenance" section of each structural BMP.

Specifications

Planning Considerations:

For vegetative practices:

1. All critical areas should be protected from pedestrian access using Construction Barriers.

2. If possible, divert concentrated flows away from critical areas, at least until the vegetation is established. Follow specifications in the Diversions BMP.

3. Select and apply seed and legumes according to specifications in the Seeding BMP. Be sure to select plant species which are tolerant to the site condition.

4. Mulching should be done on seeded areas according to specifications in the Mulching BMP.

5. Sodding should be done according to the Sodding BMP to stabilize areas quickly. Rows of sod can be alternated with rows of seeded areas to stabilize the area more quickly.

6. Dune/sand areas should be stabilized following specifications in the Dune/Sand Stabilization BMP.

7. Trees, shrubs and ground covers should be selected and planted based on the Trees, Shrubs and Ground Covers BMP. Note that Soil Conservation Service soil surveys include species of trees, shrubs and ground covers that work well in each soil texture.

For structural practices:

1. Consider using Grade Stabilization Structures to take concentrated flows from one elevation to the other.

2. Consider using Riprap on slopes adjacent to watercourses and wetlands, and Slope/Shoreline Stabilization on steep slopes and slopes adjacent to cut and fill slopes. The Slope/Shoreline Stabilization BMP includes information on seawalls/retaining walls, revetments, and gabions.

3. Consider using terraces or benches to slow runoff velocities.

4. Consider using Buffer/Filter Strips to control erosion resulting from sheet flow.

5. Subsurface Drains may be needed where water movement may cause seeps or soil slippage. Grassed Waterways may need to be tiled to ensure the vegetation is established.

Site Preparation:

For vegetative practices:

1. Soil tests should be done to determine the nutrient and pH content of the soil. Depending on the results of soil tests, Soil Management may be necessary to adjust the soil pH to between 6.5 and 7.0 (for most conditions). All soil deficiencies should be addressed following the Soil Management specifications.

2. Follow the site preparation sections in the BMPs being used for vegetative establishment.

Stream Bank Stabilization

updated September, 1997

Description

This BMP discusses the thought process that should be used when eroding stream banks are deemed in need of stabilization. Emphasis is placed on stabilization at the watershed level first, then individual sites. Several systems of BMPs are discussed, with reference to specific BMPs. Emphasis is given to "softer", less rigid structures.

In all aspects of stream bank erosion—from source and cause identification to design and implementation of BMPs—people are encouraged to work with Department of Environmental Quality (DEQ) Nonpoint Source staff in Surface Water Quality Division, or with other stream bank experts.

Note that all stream bank stabilization activities will require permits from the Department of Environmental Quality, Land and Water Management Division. For a discussion on the use of gabions, seawalls and retaining walls, groins, shoreline revetments, and breakwalls, see the Slope/Shoreline Stabilization BMP.

Other Terms Used to Describe

Armoring
Revetments
Riprapping (Note that Riprap is a separate BMP)
Soil Bioengineering/Bioengineering
Stream Bank Protection

Pollutants Controlled and Impacts

Stabilizing stream banks can:

* Prevent the loss of land or damage to utilities, roads, buildings or other facilities adjacent to a watercourse, and prevent the loss of stream bank vegetation,
* Reduce sediment loads to streams,
* Maintain the capacity of the stream channel,
* Improve the stream for recreational use or as habitat for fish and wildlife, and
* Control unwanted meander of a river or stream.

Application

Land Use
This practice is applicable to all land uses.

Soil/Topography/Climate
The site-specific stream bank practices used will be partially dependent upon the types of soils present, the slope of the bank, gradient of the river, flow, and uses of the watercourse.

When to Apply
The appropriate time to apply stream bank erosion controls is dependent upon the method used. Some seasonal limitations are included in the specifications of referenced BMPs.

Where to Apply
Apply this practice in areas where stream banks are eroding.

Relationship With Other BMPs

Geotextile materials (Filters) are often used underneath Riprap.

Specifications

Since each reach of a watercourse is unique, stream bank protection techniques must be selected on a site-by-site basis; the specifications for each technique differ. The following is guidance which can be used to determine appropriate stream bank erosion control practices.

Planning Considerations:
It is important to remember that streams are dynamic. Even without human influence streams may meander, and in the process, cause banks to erode. Therefore, not all eroding banks are "bad" and in need of repair. In fact, the wrong system of BMPs installed in the wrong place may cause more damage downstream (and therefore to the entire stream system) than leaving the stream in its natural state. For example, "hard structures" like large riprap or gabions, placed on one eroding bank, can displace the stream's energy downstream to a previously stable bank, causing the downstream bank to erode. If this downstream bank is also stabilized with a hard structure, the stream's energy may be moved further downstream to another previously stable bank, and so on.

So before stabilizing stream banks, consider the cause of the stream bank erosion. If the banks are eroding due to a natural meander, then it may be best to leave the bank alone. If the banks are eroding due to fluctuations in hydrology, the hydrologic fluctuations should be addressed before the banks are stabilized.

Once the cause of erosion is addressed, determine the goal in stabilizing the stream banks. Some banks are stabilized to protect buildings and land. Others are stabilized to keep soil from entering the stream and to allow angler access to the stream. The purpose for stabilizing the banks and the users of the stream will help determine the type of structures needed.

Once the above concerns have been addressed, then it is important to work with agencies with expertise in stream bank erosion techniques to address stream bank erosion at the watershed level. Looking at the entire watershed will help prioritize bank stabilization efforts. If you are only interested in site-specific alternatives, please turn to "Methods" on page 5.

1) compile land use data on the watershed to determine if there is a direct link between land use and soil erosion. For example, land in livestock production can be a source of sediment if the livestock have direct access to the stream. If land uses are being converted from agriculture to urban, the increased impervious areas may cause increased flows to the stream, which may scour stream banks and cause erosion. Put simply, land uses can help pinpoint potential sources of erosion.

The DEQ, Land and Water Management Division's Michigan Resource Information System (MIRIS) database contains information on the soils, land uses, streams, roads and other features in watersheds throughout the state. Keep in mind that as of the date of this printing, MIRIS data was based mostly on 1978 land use data. Many Soil Conservation District offices also have land use data (often based in part on the MIRIS). Several universities have sophisticated land use decision-making ca-

pabilities (which may include MIRIS data), as well as the capabilities to determine future land uses based on current trends.

Other important sources of land use information include topographic maps of the area, soil maps (if available), and aerial photos. These will show the pattern of the river as it meanders through the watershed. Comparing recent aerial photos to historic photos will also help determine if the river is widening, meandering or otherwise in a state of change.

2) Field verify the data. Because land uses change, it is important to field verify land use data in order to ensure decisions are made based on current and accurate information. This is particularly important in rapidly developing areas. Field verify data by walking or canoeing the entire river, or, if granted permission by property owners, by walking the stream banks. If you're not familiar with the river or stream, contact the DEQ, Surface Water Quality Division or Land and Water Management Division, or DNR, Fisheries Division to find out if the stream is wadable. In National Forest Service lands, contact the US Forest Service. These and other agencies will likely have some information on the stream you're interested in.

When you go out in the field, take a measuring tape, clipboard, pencil or waterproof pen, and multiple copies of the attached worksheet (Exhibit 1). A camera is also important when discussing site-specific conditions with other people. On wadable streams, take hip boots or waders. Use the attached worksheet while noting the specific areas of stream bank erosion. Note soil type and any log jams, construction activities, eroding road crossings, and improper stream access (e.g. cows in the water, areas where people have accessed the river for recreational opportunities, etc.). Where possible, measure the length and height of the eroded stream banks.

Back in the office, incorporate your visual observations with the land use data. Ideally, this will be done by incorporating your notes into the land use database.

3) Estimate the magnitude of the erosion and all potential sources of erosion. Sources of sediment to the stream may include angler access, livestock access, or poorly maintained or improperly designed road crossings. The magnitude of the erosion can be determined by ranking each site as severe, moderate or minor, using the attached field sheet (Exhibit 1). Use of the Universal Soil Loss Equation is discussed in an appendix of the Guidebook of BMPs.

4) Rank the sites. At its simplest, ranking sites can be based on addressing the most severe sites first and working from upstream to downstream, including tributaries. Another alternative is to rank sites based on four criteria: 1) degree of impact (severe, moderate, minor); 2) the cost of installing the system of BMPs needed; 3) landowner willingness to cooperate; and 4) "demonstration-ability." (i.e. amount of public visibility). "Demonstration-ability" is important if you plan to solicit volunteers or funding for stabilization efforts. This site ranking method was used in the Bear Creek watershed, Kent County.

5) Determine appropriate options for the high priority sites. Use the information gathered on land use and from visual observations (including photos) to evaluate stream bank stabilization alternatives. The BMPs selected should also help to achieve the overall goals for the watershed (such as improving fish habitat or providing greater recreational access). Review the scenarios below, the various Methods on page 5, and then contact stream bank experts to discuss site-specific options.

Stream Bank Stabilization Scenarios:
The following hypothetical scenarios illustrate various alternatives for stream bank stabilization:

Scenario 1: Visual observations show several minor stream bank erosion sites. Erosion was determined to be caused by stream flow. The amount of human influence on flow is low (i.e. it is naturally "flashy" versus flashiness caused by increased flow from urbanization). The decision in this case is to leave the eroding banks alone.

Scenario 2: Comparing aerial photos from 1938 and 1990 shows that the stream hasn't meandered much, yet there are hundreds of banks along the stream that are bare, mostly due to angler and canoeist access. The stream is a high quality trout stream and local people hold the river in high esteem. Since sediment is detrimental to trout habitat, the decision was made to stabilize stream banks in this watershed, providing access via stairways and canoe landings, and restricting access via practices such as fencing and brush mulch. Since the greatest reduction in sediment load will be gained by stabilizing severe sites, the most severe banks will be stabilized first, going from upstream areas, downstream. If more money becomes available, then moderate sites would be stabilized, again, starting upstream.

Scenario 3: The predominant land use is urban. Severe erosion is observed downstream of the urban area. In this hydrologically unstable area a stormwater management plan will be developed in conjunction with or prior to stream bank stabilization to reduce extreme hydrologic fluctuation and velocities. In this example, the decision was also made to work on an ordinance which would address stormwater practices to prevent additional flows to the stream.

Scenario 4: The predominant land use is agricultural. Moderate and severe bank erosion is occurring at several livestock access areas. In this example, cattle exclusion systems, including fencing and alternative watering areas, were designed and implemented in conjunction with stream bank stabilization techniques.

Scenario 5: Visual observations and historical aerial photographs show the stream to be relatively stable. Most of the adjoining land is rural/agricultural but is expected to experience 35% growth in the next 15 years: therefore, additional flows to the stream are expected. Two new road crossings are causing severe erosion downstream of the crossings. The decision was made to stabilize the banks downstream of the new crossings with structures which help absorb some of the energy from stream flow (see soil bioengineering structures, below). The decision was also made to work with the road commission so that future road designs would be done such that downstream areas are not impacted. An ordinance to provide on-site detention/retention of stormwater from the newly constructed area was also proposed.

Other Things to Consider
In selecting site-specific options to stabilize eroding stream banks, consult the Michigan Department of Environmental Quality (Surface Water Quality Division or Land and Water Management Division), local Conservation District, or other agencies or consultants experienced in stream bank erosion control. Also, be sure to check Exhibit 2 to see if your river is included on the list of Natural or Wild and Scenic Rivers. These rivers have special restrictions, depending on their designation. Contact the MDEQ, Natural Rivers Program staff for further information on the types of stream bank practices that can be used in Natural Rivers.

It is also important to get input from the people who may use the watercourse at the specific site in need of stabilization, (i.e. river boat guides, anglers, canoeists, etc.). Consider working through a local watershed steering committee, if available. These committees include representatives from a variety of backgrounds and interests.

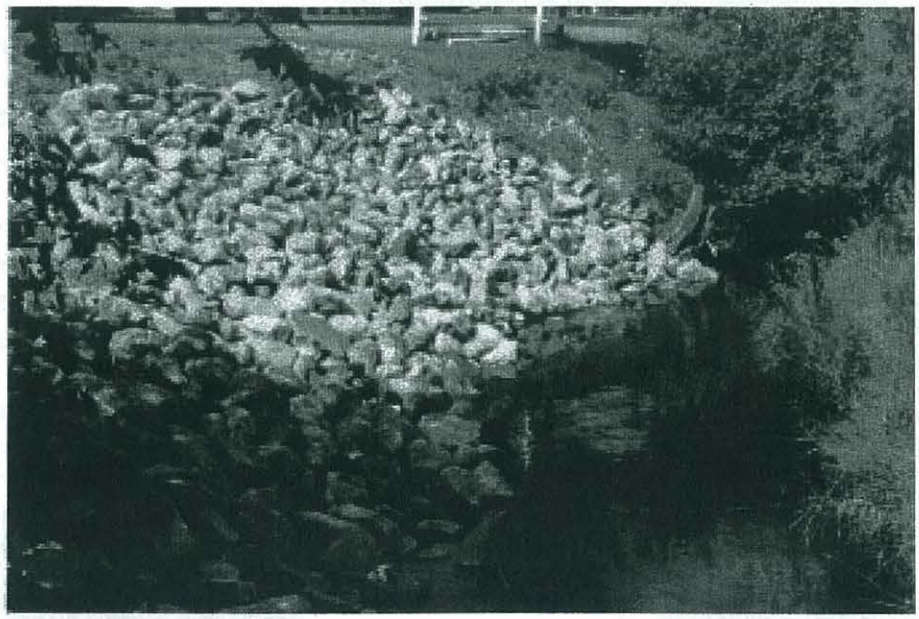
NOTE: While considering BMP options, remember that no removal of sediment bars, snags, stumps, debris drifts, trees, brush or similar material should be done unless absolutely necessary, and upon approval by the MDEQ, Land and Water Management Division. This in-stream cover is necessary for channel diversity and aquatic habitat.

Methods:

There are numerous methods available to stabilize stream banks. Rather than discuss all of them or any of them in detail, below is a discussion of the most common practices.

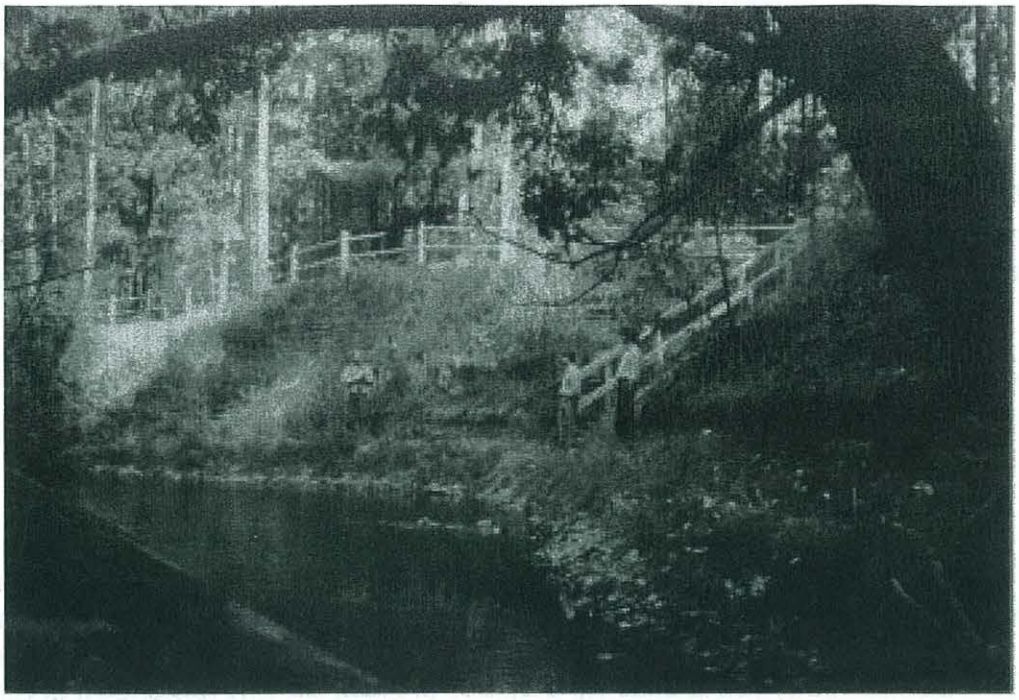
Riprap:

Riprap is one of the more commonly used stream bank stabilization techniques. It is a permanent cover of rock used to stabilize stream banks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows. It is generally used on stream banks at the toe (bottom) of the slope, with other structures placed up-slope to prevent soil movement. It is often a component of many soil bioengineering techniques. Specifications for riprap used in stream bank stabilization is discussed in the Riprap BMP.



Picture 1, above: The bank was stabilized with rock riprap from the toe (bottom) of the bank to the top of bank. This may be needed on streams with unstable hydrology (i.e. "flashy" streams), and where banks have groundwater seeps. Source: North Branch Chippewa River Nonpoint Source Project.

The Department supports the use of natural fieldstone for riprap; only natural fieldstone is allowed in rivers designated under the Natural Rivers program. The use of vegetation in conjunction with riprap is encouraged to "soften" stream bank structures.



Picture 2, right: Riprap was placed to 3 feet above the ordinary high water mark and a portion back-filled with soil. Log terraces were placed on the bank and the bank was seeded. This approach can be used on top of fish lunker structures and on banks where stream flows are relatively stable. Also note the fence and stairway to direct recreationist access. Source: Boardman River Nonpoint Source Project.

Soil Bioengineering:
Soil bioengineering is a method of using vegetation to stabilize a site with or without structural controls. Some refer to bioengineering as softening the traditional rock-the-bank approach because non-invasive vegetation is used to blend the site into its surrounding landscape. Bioengineering techniques may be as simple as using stop-logs to form terraces, then seeding exposed soil to help prevent soil movement. Techniques also include using fascines (long bundles of willow or dogwood), with layers of brush, along with individual plantings.

Picture 3, left, shows a fascine, brush layering and live stakes. **Picture 4, below,** shows new growth from a live stake. Source: Whetstone Creek Nonpoint Source Watershed Project.

Chapter 18 of the USDA Soil Conservation Service (now Natural Resource Conservation Service (NRCS)) Engineering Field Handbook is one of the most comprehensive sources of information on soil bioengineering. Chapter 18 describes soil bioengineering as a combination of biological and ecological concepts to arrest and prevent shallow slope failures and erosion. Rather than duplicate NRCS' efforts to describe soil bioengineering techniques here, people interested in exploring soil bioengineering are encouraged to work with the NRCS, MDEQ, and other agency staff familiar with bioengineering practices.

As another example of a system of practices used to stabilize a bank, refer to Picture 2. In addition to riprap, seed and log terraces, the system of BMPs on the bank in Picture 2 included fencing to direct foot traffict, and a set of stairs.

Maintenance

A maintenance plan should be included with all site plans. The maintenance plan should indicate when inspections of the site will be made and who will be responsible for needed maintenance. Site inspections, conducted to ensure the stream bank structures are staying in place, are particularly important within the first few months of installation, and following storm events which result in bank-full streams. More specific maintenance procedures can be found in the referenced BMPs.

Exhibits

Exhibit 1: Field Data-Entry Form which can be used in the stream bank erosion inventory, Northwest RC&D Council. (This type of approach has been used to identify and rank eroding sites on the Muskegon, Au Sable, Pine and Betsie Rivers).

Exhibit 2: Michigan's Natural Rivers System. List of rivers designated or proposed under the Natural Rivers program.

Field Data-Entry Form for Stream Bank Erosion Inventory

This form is intended to be used to compare the severity of eroding stream banks within a watershed. Results can be used to help prioritize stream bank stabilization efforts. Fill in all known information. Where provided, fill in the appropriate number per each category, then total the "points" on the last page.

Date: _____
County: _____
Stream: _____
Observer: _____

SITE LOCATION:
Township Name: _____ No. _____ Range ____ Sec. ____
Bank (right or left, looking downstream): _____
Property Owners: _____
Other info re: location: _____
Accessibility for machinery/materials (good/bad)
Access Problems:_____

SITE NUMBER: _____

MEAN WIDTH OF RIVER: _____
(no points)

CONDITION OF BANK:

	5	Toe and upper bank eroding
	3	Toe undercutting
_____	1	Toe stable, upper bank eroding
	5	Length of eroding bank > 50 ft.
	3	Length of eroding bank 20-50 ft.
_____	1	Length of eroding bank < 20 ft.
	5	Side slope vertical 1:1
	3	Side slope 2:1, 3:1
_____	1	Side slope 4:1 or flatter

PROBLEM TREND

	5	Increasing
_____	1	Decreasing or stable

(continued, next page)

DEPTH OF RIVER

	1	> 3 feet
_____	2	< 3 feet

VEGETATIVE COVER

	5	Vegetative cover 0-50%
	3	Vegetative cover 50-80%
_____	1	Vegetative cover 80-100%

MEAN HEIGHT OF BANK

	5	Mean height of bank > 20 ft.
	3	Mean height of bank 10-20 ft.
_____	1	Mean height of bank < 10 ft.

SOIL TYPE OR TEXTURE

	3	Sand
	2	Gravel
	2	Stratified
_____	1	Clay or loam

APPARENT CAUSE OF EROSION

	1-Light access traffic
	1-Obstruction in river
	1-Bank seepage
	1-Gullying by side channels
	2-Bend in river
	3-Road-stream crossing, grade/shoulder runoff
	3-Moderate access traffic
	5-Heavy access (foot, horse, etc.) traffic
_____	5-Construction site erosion

_____ TOTAL POINTS: more than 36 — severe
30-36 — moderate
less than 30 — minor

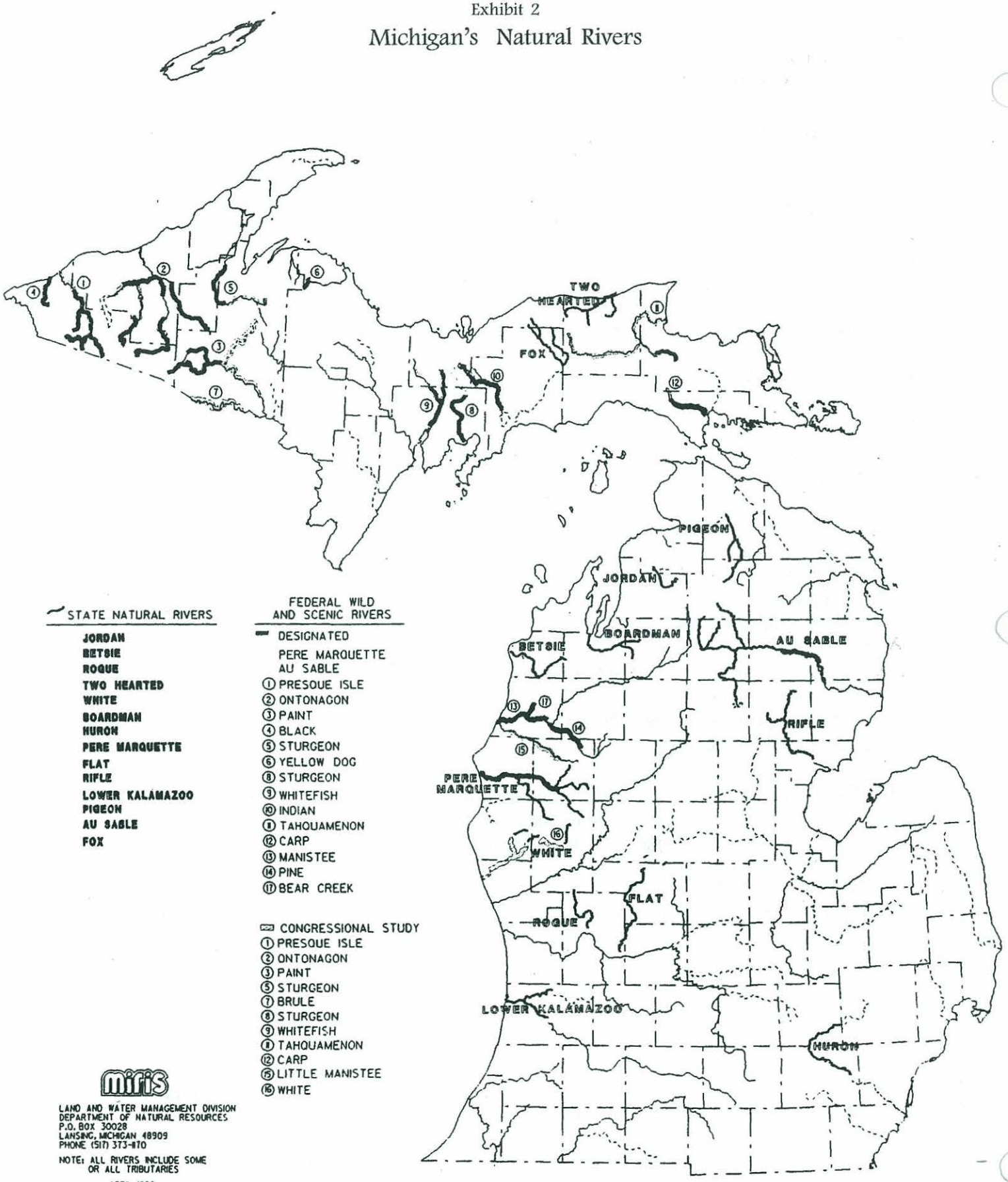
RECOMMENDED TREATMENT
Describe a potential system of BMPs for the site:

NOTE: Sketch location on a separate sheet, showing any unusual circumstances. Also, provide black-and-white or color photograph, if possible.

Source: Modified from the inventory sheet used in the Upper Manistee Stream Bank Erosion Inventory.

Exhibit 2

Michigan's Natural Rivers



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WETLAND ASSESSMENT REPORT

ENBRIDGE PIPELINES, INC. TALMADGE CREEK OIL SPILL PROJECT

FREDONIA TOWNSHIP

CALHOUN COUNTY, MICHIGAN

Prepared for:

Enbridge Pipelines, Inc.

August 2010

URS

URS Corporation
3950 Sparks Drive SE
Grand Rapids, Michigan 49546

URS Project No. 12942585

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SECTIONONE Introduction

A wetland delineation was performed by URS Corporation staff on behalf of Enbridge, Inc in support of the excavation of contaminated soils associated with the Talmadge Creek oil spill. Approximately 2.84 acres of proposed excavation area located in Fredonia Township, Calhoun County, Michigan was delineated for the proposed excavation of contaminated soils. The proposed excavation area is located in Fredonia Township within Calhoun County, Michigan. See **Figure 1** for a Site Location Map.

On July 30, 2010, Mr. Brendan Earl, Environmental Scientist for URS Corporation, conducted a wetland delineation of approximately 6.61 acres of proposed excavation area. The wetlands were overlaid onto available maps of the proposed project area. **Figure 3** is included as the Wetland Delineation Map.

The wetland delineation was completed using guidance manuals and procedures set forth by the Michigan Department of Natural Resources and Environment (MDNRE) and the United States Army Corps of Engineers (USACE). Methods and procedures used for this delineation are in accordance with Part 303, Wetlands Protection, of Act 451 Natural Resources and Environmental Protection Act (NREPA), as amended (1994). A permit is required for any dredging, draining, filling, or maintained use or development activities within regulated wetlands as defined by Part 303.

SECTIONTWO Methodology

2.1 MAP RESOURCE INVESTIGATION

Soil surveys, aerial photographs, topographic maps, MDNRE's Wetland Inventory maps, and National Wetlands Inventory (NWI) maps were reviewed prior to conducting the field work for indications of surface water, wetlands, physical features, and hydric soils within the study areas.

2.2 CRITERIA FOR WETLAND INVESTIGATION

The wetland investigation was performed in accordance with the USACE *Wetlands Delineation Manual* (1987), the USACE *Draft Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region* (2008), and the MDNRE *Michigan Wetland Identification Manual* (2001). The USACE Manual follows a three-parameter approach to making wetland determinations and generally requires that one positive wetland indicator from each parameter (vegetation, soil, and hydrology) be found on the site to make a wetland determination. The MDNRE Manual generally requires positive indicators for hydrophytic vegetation and wetland hydrology. Evidence of wetland hydrology can be supported by observed hydric soils in the wetland. A summary of the vegetation, soils, and hydrology within the study area are discussed in the following paragraphs.

Methods and procedures used for this delineation are in accordance with Part 303, Wetlands Protection, of Act 451 the Natural Resources and Environmental Protection Act (NREPA), as amended (1994). Wetlands were classified in accordance with the U.S. Fish and Wildlife Service based on Cowardin et al.'s *Classification of Wetlands and Deepwater Habitats of the United States* (1979). Although procedures for making wetland determinations in the field are standardized, wetlands are often transitional areas between aquatic and upland habitats. Wetland delineations were made using the parameters as defined in the USACE Manual and MDNRE Manual and the best professional judgment of the field personnel at the time of the delineation. The wetland boundaries may be subject to final field delineation and verification by the MDNRE.

2.2.1 Hydrophytic Vegetation

Dominant plant species observed in the wetlands within the study area were identified and the wetland indicator status for each species was determined from the *National List of Plant Species that Occur in Wetlands: North Central-Region 3* (USFWS, 1988). The indicator status

designates the probability of a given plant species to occur in regional wetlands. According to the USACE Manual, an area has hydrophytic vegetation when more than 50 percent of the dominant plant species present have a wetland indicator status of OBL, FACW+, FACW, FACW-, FAC+, or FAC.

2.2.2 Hydric Soils

A hydric soil is a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation. A hydric soil may either be drained or undrained, although a drained hydric soil may not continue to support hydrophytic vegetation. According to the MDNRE Manual, when a hydric soil supports hydrophytic vegetation and the area has indicators of wetland hydrology, the soil is referred to as a wetland soil. Hydric soils are typically determined by soil colors at diagnostic depths. Soil pits are excavated to a depth of approximately 16 inches with a sharpshooter shovel. Soils are then visually analyzed using the Munsell® Soil Color Charts (2000). Munsell chroma values of two or less with mottles or inclusions and/or gleyed colors commonly indicate the presence of hydric soils. Other field indicators of hydric soils are aquic moisture regime, organic streaking in sand, histic epipedons, reducing soil conditions, and iron and manganese concretions.

2.2.3 Hydrologic Indicators

Indicators of wetland hydrology are usually present in areas that are periodically inundated or have soils saturated to the surface at some time during the growing season. Areas that are inundated or saturated for sufficient duration tend to develop hydric soils and support vegetation typically adapted for life in anaerobic conditions. These indicators of wetland hydrology include drainage patterns, drift lines, sediment deposits, water marks, and visual observation of saturated soils, surface water, or inundation. Water supply to the wetlands in the study area depends on precipitation, runoff, and groundwater recharge. Hydrologic indicators observed in the study area were noted during the field investigation.

SECTIONTHREE Results and Conclusions

On July 30, 2010, Mr. Brendan Earl, Environmental Scientist for URS Corporation, conducted a wetland delineation of approximately 6.61 acres of the proposed excavation area. One regulated wetland was identified within the project area. Approximately 2.84 acres of Wetland A will be impacted by the excavation activities. **Figure 1** is a Site Location Map and **Figure 3** is a map of the Wetland Delineation boundaries. Photographs of the wetlands are included in **Appendix A**. Additional details of the vegetation, hydrology, and soils within the study area are available in the attached Field Data Sheets **Appendix B**.

3.1 MAP RESOURCE INVESTIGATION

According to the *Calhoun, Michigan* 7.5-minute United States Geological Survey (USGS) quadrangle (1985), elevations in the proposed excavation are, as identified on U.S. Geological Survey (USGS) topographic maps, range from 920 to 930 feet above sea level. Topography in the excavation area ranges from mostly flat to slightly sloping. The slope ranges from 0 to 6 percent. The topographic map is included as **Figure 1.**

NWI maps were reviewed for the presence of wetlands within the proposed project area. The NWI map includes four wetland complexes of which one is composed of bottomland forest (PFO), one is a scrub/shrub habitat (PSS), and two are emergent wetlands (PEM). However, the wetland complexes located on the NWI map that were field verified were the emergent and forested wetland habitats within the project area. The NWI map is included as **Figure 4.**

Floodplains within the project area are located along Talmadge Creek. The Floodplain map is included as **Figure 5**.

Soil survey data, as described in the *Web Soil Survey of Calhoun County, Michigan* (USDA, 2009), was reviewed for the presence of hydric soils within the study areas. A summary of the soil types located within the proposed project area is included in **Table 1**. There are ten soil types mapped to the project area and three of those soils are listed on the Hydric Soils List from *the Soil Survey Geographic (SSURGO) database for Calhoun County, Michigan.*

3.2 FIELD INVESTIGATION

One wetland was delineated within the project area. Wetland A is an emergent and forested wetland along Talmadge Creek. Wetland A will be impacted with approximately 2.84 acre of

impact by excavation activities. The delineated wetland area and its associated positive wetland indicators are described in the following paragraphs. Additional details regarding the wetland are available in the Field Data Sheet (**Appendix B**). The location, area and type of wetland are depicted in **Figure 2**.

3.2.1 Description of Wetlands

Wetland A is located along the north bank of Talmadge Creek and into the forest upstream of the spill area. Wetland A includes a marginal emergent (PEM) wetland complex located along the north bank of Talmadge Creek downstream of the spill area and a forested wetland fringe (PFO) located upstream of the spill area.

Vegetation within the PEM area includes reed canary grass (*Phalaris arundinacea*, FACW+), narrow leaf cattail (*Typha angustifolia*, OBL), spotted joe-pye-weed (*Eupatoriadelphus maculatus*, OBL), sensitive fern (*Onoclea sensibilis*, FACW), marsh fern (*Thelypteris thelypteroides,* FACW+), water hemlock (*Cicuta maculata*, OBL), gray dogwood (*Cornus racemosa*, FAC), Virginia creeper (*Parthenocissus quinquefolia*, FAC-), and boneset (Eupatorium perfoliatum, FACW+). Hydrology indicators include drainage patterns and saturated soils. Soils in the PEM wetland were highly contaminated due to the oil spill, therefore, no samples were collected however, soil appeared to be a clay loam from 0-16 inches.

Vegetation within the PFO area includes sensitive fern (*Onoclea sensibilis*, FACW), reed canary grass (*Phalaris arundinacea*, FACW+), gray dogwood (*Cornus racemosa*, FAC), silky dogwood (*Cornus amomum* FACW+), green ash (*Fraxinus pennsylvanica*, FACW), and Virginia creeper (*Parthenocissus quinquefolia*, FAC-). Hydrology indicators include approximately 4-inches of inundation, saturated soils, and drainage patterns. Soils in the PFO wetland area were highly contaminated due to the oil spill, therefore no samples were collected, however, soil appeared to be a loam from 0 to 16 inches.

3.3 CONCLUSIONS

On July 30, 2010, Mr. Brendan Earl, Environmental Scientist for URS Corporation, conducted a wetland delineation of approximately 6.61 acres of the proposed excavation area. One regulated wetland was delineated within the project area.

Approximately 2.84 acres of Wetland A will be impacted by the excavation activities. This wetland was an emergent and forested wetland associated with Talmadge Creek. Please be advised that the physical characteristics of the project area can change and are dependent on factors such as weather, drainage alterations, and the time of the year the wetland delineation was performed. Additionally, due to health and safety concerns and site accessibility issues present at the time of the delineation the extent of the wetland impacts may change.

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URS has been a worldwide provider of comprehensive environmental and other specialized consulting and engineering services for more than 100 years. The Corporate Headquarters for URS is in San Francisco, California. The company has more than 200 offices in 20 countries, and is staffed by over 30,000 professional and support personnel.

Mr. Brendan Earl, Environmental Scientist for URS performed the wetland delineation, data acquisition and reporting. Mr. Brendan Earl is a qualified environmental professional with extensive environmental experience and training from the URS office located in Grand Rapids, Michigan.

Sincerely,

URS Corporation Great Lakes

Kas Permoff for

Sherry Slocum
Manager, Ecological Services Group

Brendan Earl
Environmental Scientist

Figures

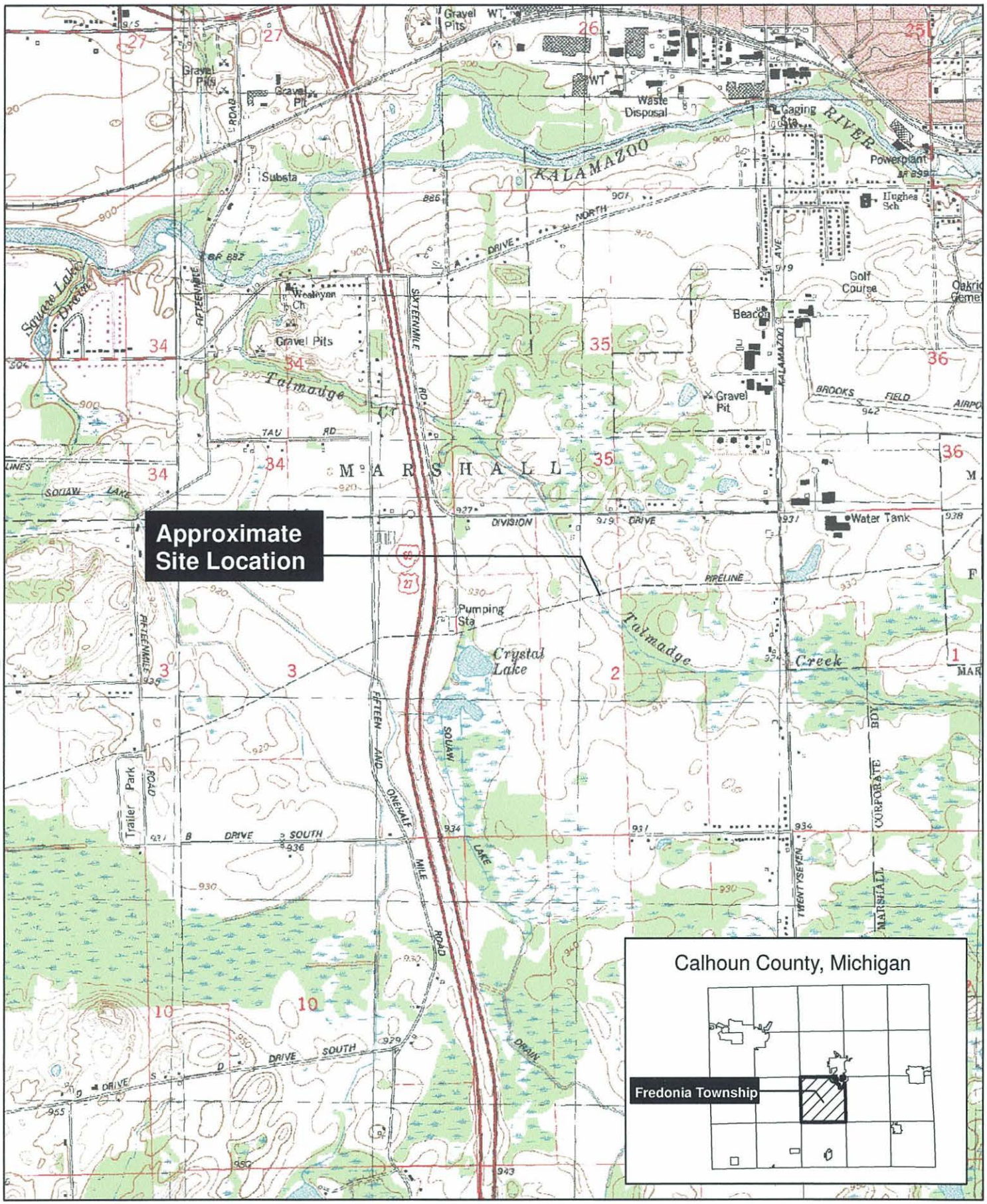

Figure 1. Site Location and USGS Topographic Map

Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan

Township 03S Range 06W Section 2

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

ENBRIDGE

0 0.03 0.06 0.09 0.12 Miles

Enbridge Energy, Limited Partnership
MP 608 - Marshall, MI

Release Area Site Base Map

DATE ISSUED: July 31, 2010	
DATE REVISED:	
SCALE: 1:1,000	
DRAWN BY: NMS/JPM	
SERIES:	

FIGURE 2

Figure 3.
Wetland Delineation Map

Talmadge Creek | URS Wetland Delineation | Wetland Impact | Spill Area

N

Enbridge Inc.,Talmadge Creek Oil Spill, Fredonia Township, Michigan

Township 03S
Range 06W Section 2

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

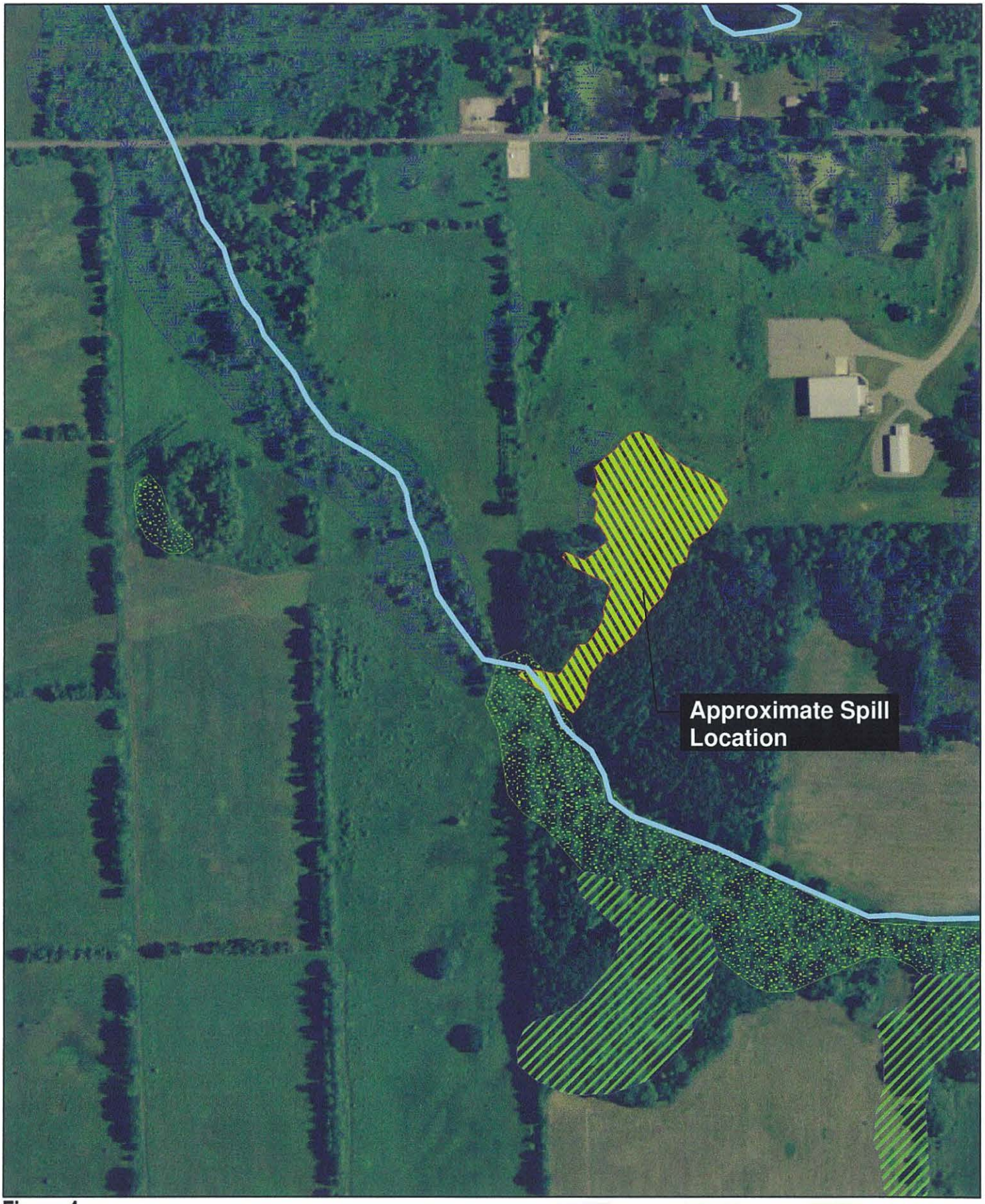

Figure 4.
National Wetland Inventory (NWI) Map
Enbridge Inc.,Talmadge Creek Oil Spill, Fredonia Township, Michigan

Talmadge Creek | Emergent | Forested | Scrub-Shrub | Spill Area

N

Township 03S
Range 06W Section 2

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

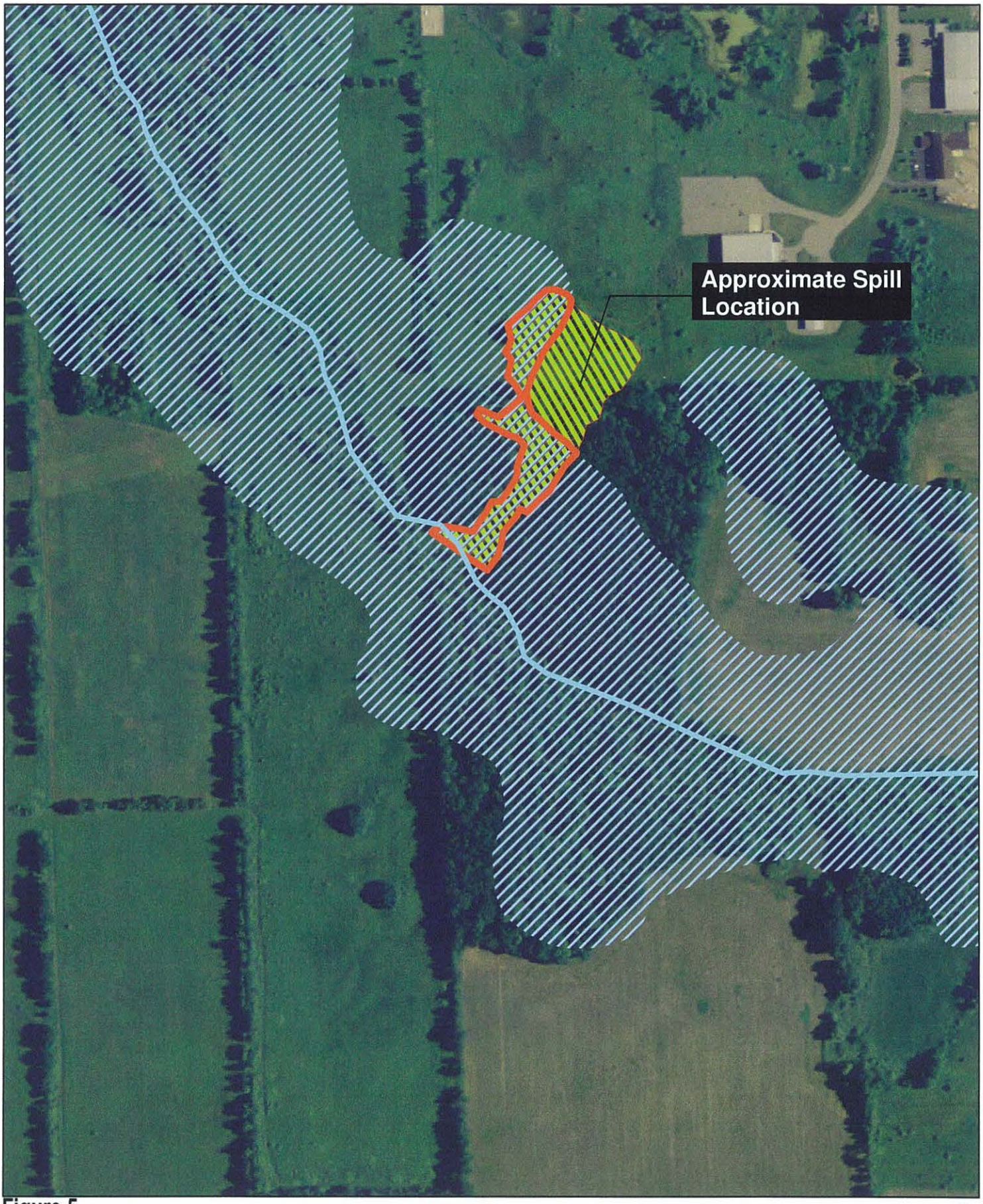

Figure 5.
FEMA FIRM Floodplain Map

Talmadge Creek | 100 Yr Floodplain Impact | Spill Area | 100 Yr. Floodplain

N

Enbridge Inc.,Talmadge Creek Oil Spill, Fredonia Township, Michigan

Township 03S
Range 06W Section 2

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

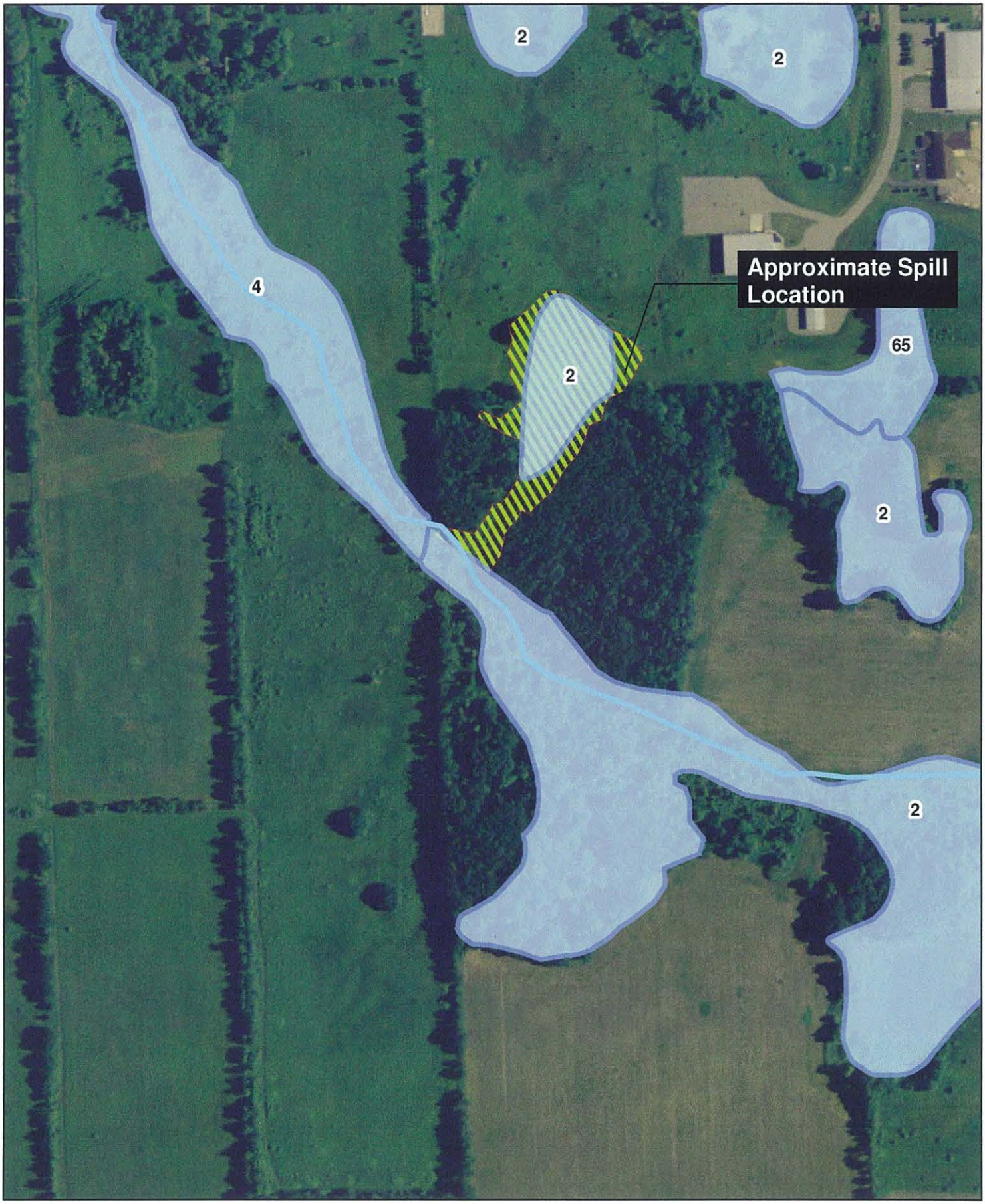

Figure 6. Soil Survey Map

Talmadge Creek | Hydric Soils | Spill Area

N

Enbridge Inc.,Talmadge Creek Oil Spill, Fredonia Township, Michigan

Township 03S
Range 06W Section 2

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

Tables

TABLE 1

SOILS MAPPED TO THE PROPOSED PROJECT AREA
Enbridge Pipelines, Inc. Talmadge Creek Oil Spill

Soil Symbol	Soil Unit	Brief Description of Soil Unit	Hydric? (Y/N)
2	**Houghton Muck**	**This soil has 0 to 2 percent slopes. This soil is very poorly drained and has no frequency of flooding and frequent ponding.**	**Y**
4	**Adrian Muck**	**This soil has 0 to 2 percent slopes and is very poorly drained. There is no frequency of flooding and frequent ponding and moderately high water capacity.**	**Y**
13B	Spinks loamy sand	This soil has 0 to 6 percent slopes and is well drained. The soil is not flooded or ponded and has high available water capacity.	N
14B	Bronson sandy loam	This soil has 0 to 6 percent slopes and is moderately well drained. This soil has no frequency of flooding or ponding and high available water capacity.	N
16B	Oshtemo sandy loam	This soil has 0 to 6 percent slopes and well drained. This soils is not flooded or ponded, and has high available water capacity.	N
16C	Oshtemo sandy loam	This soil has 6 to 12 percent slopes and is well drained. The soils is not flooded or ponded and has high available water capacity.	N
25A	Kalamazoo loam	This soil has 0 to 2 percent slopes. This soil is well drained, is not flooded or ponded, and has high available water capacity.	N
25B	Kalamazoo loam	This soil has 2 to 6 percent slopes. This soil is well drained, is not flooded or ponded, and has high available water capacity.	N
43B	Brandy sandy loam	This soil has 1 to 4 percent slopes and is somewhat poorly drained. This soil has high available water capacity and no frequency for flooding or ponding.	N
44A	**Matheron loam**	**This soil has 0 to 3 percent slopes and is somewhat poorly drained. This soil is not flooded or ponded, and has high available water capacity.**	**Y**

Notes:
1. Soil Symbol, Soil Unit, and Soil Description as obtained from the *Web Soil Survey of Calhoun County, Michigan*
2. Hydric soils as listed on Hydric Soils list from *the Soil Survey Geographic (SSURGO) database for Bureau County, Illinois.*

APPENDIX A Photographs

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
1	7/30/10

Direction Photo Taken:

North

Description:

Wetland A – PEM wetland associated with Talmadge Creek

Photo No.	Date:
2	7/30/10

Direction Photo Taken:

Northwest

Description:

Wetland A – PEM wetland associated with Talmadge Creek

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
3	7/30/10

Direction Photo Taken:

East

Description:

Wetland A – PEM wetland associated with Talmadge Creek

Photo No.	Date:
4	7/30/10

Direction Photo Taken:

West

Description:

Wetland A – PEM wetland associated with Talmadge Creek

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
5	7/30/10

Direction Photo Taken:

Northwest

Description:

Wetland A – PEM wetland associated with Talmadge Creek

Emergent Wetland vegetation.

Photo No.	Date:
6	7/30/10

Direction Photo Taken:

Southwest

Description:

Wetland A – PEM wetland associated with Talmadge Creek

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
7	7/30/10

Direction Photo Taken:

West

Description:

Wetland A – PEM wetland associated with Talmadge Creek

Photo No.	Date:
8	7/30/10

Direction Photo Taken:

South

Description:

Wetland A – PEM wetland associated with Talmadge Creek

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
9	7/30/10

Direction Photo Taken:

Northeast

Description:

Wetland A – PEM wetland associated with Talmadge Creek

Photo No.	Date:
10	7/30/10

Direction Photo Taken:

East

Description:

Wetland A – PEM wetland associated with Talmadge Creek

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
11	7/30/10

Direction Photo Taken:

West

Description:

Wetland A – PEM wetland associated with Talmadge Creek

Photo No.	Date:
12	7/30/10

Direction Photo Taken:

Northeast

Description:

Wetland A – PEM wetland associated with Talmadge Creek

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
13	7/30/10

Direction Photo Taken:

North

Description:

Wetland A – PEM wetland associated with Talmadge Creek

Photo No.	Date:
14	7/30/10

Direction Photo Taken:

South

Description:

Wetland A – PFO wetland

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
15	7/30/10

Direction Photo Taken:

West

Description:

Wetland A – PFO wetland

Photo No.	Date:
16	7/30/10

Direction Photo Taken:

Southwest

Description:

Wetland A – PFO wetland

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
17	7/30/10

Direction Photo Taken:

East

Description:

Wetland A – PFO wetland

Photo No.	Date:
18	7/30/10

Direction Photo Taken:

Southeast

Description:

Wetland A – PFO wetland

URS

PHOTOGRAPHIC LOG

Client Name:	Site Location:	URS Project No.
Enbridge, Inc.	Talmadge Creek Oil Spill, Fredonia Township, Michigan	12942585

Photo No.	Date:
19	7/30/10

Direction Photo Taken:

East

Description:

Wetland A – PFO wetland

Photo No.	Date:
20	7/30/10

Direction Photo Taken:

Southeast

Description:

Wetland A – PFO wetland

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Enbridge Line 6B City/County: Marshall/Calhoun Sampling Date: 7/30/10

Applicant/Owner: Enbridge Pipelines, Inc. State: MI Sampling Point: A

Investigator(s): B. Earl Section, Township, Range: S2, T03S, R06W

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave

Slope (%): _____ Lat: _____ Long: _____ Datum: _____

Soil Map Unit Name: disturbed soils NWI classification: PEM/PFO

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology Y significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** Yes X No _____
Hydric Soil Present?	Yes X	No _____	
Wetland Hydrology Present?	Yes X	No _____	If yes, optional Wetland Site ID: Wetland A

Remarks: (Explain alternative procedures here or in a separate report.)

Wetland A is located within the Enbridge Line 6B oil spill impact area and has been disturbed greatly with oil contaminants. Soils within the wetland were disturbed and a sample was not readable.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X Surface Water (A1)
- ___ High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- X Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes X	No _____	Depth (inches): 4
Water Table Present?	Yes _____	No _____	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes X	No _____	Depth (inches): _____

Wetland Hydrology Present? Yes X No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants.

Sampling Point: A

Tree Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Fraxinus pennsylvanica	60	Y	FACW
2.			
3.			
4.			
5.			
6.			
7.			
	60% = Total Cover		

Sapling/Shrub Stratum (Plot size: 15 ft)			
1. Cornus racemosa	25	N	FAC
2. Cornus amomum	40	Y	FACW+
3.			
4.			
5.			
6.			
7.			
	65 = Total Cover		

Herb Stratum (Plot size: 5 ft)			
1. Eupatorium perfoliatum	5	N	FACW+
2. Typha angustifolia	15	Y	OBL
3. Eupatoriadelphus maculatus	10	N	OBL
4. Onoclea sensibilis	20	Y	FACW
5. Thelypteris thelypteroides	10	N	FACW+
6. Cicuta Maculata	20	Y	OBL
7. Phalaxis arundinacea	20	Y	FACW+
8.			
9.			
10.			
11.			
12.			
	100 = Total Cover		

Woody Vine Stratum (Plot size: 30 ft)			
1. Parthenocissus quinquefolia	30	Y	FAC-
2.			
3.			
4.			
	30% = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	45	x 1 = 45
FACW species	155	x 2 = 310
FAC species	25	x 3 = 75
FACU species	0	x 4 =
UPL species	0	x 5 =
Column Totals:	225 (A)	430 (B)

Prevalence Index = B/A = 1.91

Hydrophytic Vegetation Indicators:

- ___ Rapid Test for Hydrophytic Vegetation
- X Dominance Test is >50%
- X Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-16	—		—				clay-loam	Soils disturbed by oil spill - saturated with oil, no sample was readable

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- ___ Dark Surface (S7) **(LRR K, L)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No ____

Remarks:

DEQ MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY • LAND AND WATER MANAGEMENT DIVISION

CREDIT CARD TRANSACTION AUTHORIZATION FOR ONE-TIME TRANSACTIONS

INSTRUCTIONS: Print or type entries clearly. Carefully read and complete the entire authorization form. Mail the completed form to the appropriate Land and Water Management Division office that you are authorizing to charge your account. For security purposes, do not e-mail or fax this form. If you have questions about completing this form, call the phone number provided by the Land and Water Management Division office you are authorizing to charge your account.

TYPE OF CREDIT CARD	☒ MASTERCARD ☐ VISA ☐ DISCOVER
CREDIT CARD HOLDER NAME (as it appears on the card)	Barbara R. Williams
STREET ADDRESS	27777 Franklin Rd, Suite 2000
CITY, STATE, ZIP	Southfield, Mi 48034
TELEPHONE NUMBER	(248) 204-4951 ext
E-MAIL ADDRESS (optional)	renee-williams@URSCORP.com
CARD HOLDER SIGNATURE	Barbara R. Williams
TOTAL AMOUNT TO BE CHARGED	$100.00
CREDIT CARD NUMBER	5 5 5 0 0 8 0 0 0 0 5 7 0 5 4 4
CVV2 (this is a 3 digit number on the back of the credit card)	0 4 8
EXPIRATION DATE	8/11

RETAIN A COPY FOR YOUR RECORDS

STATE OF MICHIGAN USE ONLY

PERMIT FILE NUMBER (S)		AOBJ
PERMIT FILE NUMBER (S)		AOBJ
PERMIT FILE NUMBER (S)		AOBJ
RECEIVED BY		
DATE RECEIVED		
RESUBMISSION OF PAYMENT	☐ YES ☐ NO	

Attachment D

Preliminary Threatened and Endangered Species Survey

United States Department of the Interior

FISH AND WILDLIFE SERVICE
East Lansing Field Office (ES)
2651 Coolidge Road, Suite 101
East Lansing, Michigan 48823-6316

IN REPLY REFER TO:

July 30, 2010

Mr. Steven Wolf
U.S. Environmental Protection Agency
Region 5
25089 Center Ridge Road
Westlake, Ohio 44145

Re: Request for Emergency Consultation for the Response to the Kalamazoo River Oil Spill, Calhoun and Kalamazoo Counties, Michigan

Dear Mr. Wolf:

We are responding to your request for an emergency consultation pursuant to section 7 of the Endangered Species Act (Act) of 1973, as amended. 50 CFR §402.05 provides Federal agencies the ability to consult in an expedited manner in situations involving an act of God, disaster, casualties, etc., and includes response activities that must be taken to prevent imminent loss of human life or property.

We understand that new road construction through forested riparian areas may be necessary to provide access for oil spill clean up. Forested riparian areas within southern Michigan may provide habitat for the federally endangered Indiana Bat (*Myotis sodalis*). Although there are no documented records of Indiana bats in the vicinity of the action, complete survey information is lacking, and maternity colonies may be present. As a result, efforts should be made to protect habitat, if possible.

The summer range of Indiana bats in Michigan includes the southern half and most of the western coastal counties of the Lower Peninsula. Suitable habitat typically consists of highly variable forested landscapes in riparian, bottomland and upland areas composed of roosting trees. In Michigan, Indiana bats area often found in palustrine forested wetlands with an open understory. Roost trees generally are large (greater than 9 inches in diameter), dead, dying, or live trees with peeling or exfoliating bark, which allows the bat to roost between the bark and bole of the tree. Favored roost trees are usually exposed to the sun. Female Indiana bats typically form colonies that use several alternate roost trees in addition to primary roost trees. Individual bats are known to travel up to 7.8 kilometers (4.8 miles) between roosts in a single night and at least 2 to 4 kilometers from roost trees while foraging. We have enclosed additional information concerning the distribution, life history, and habitat requirements of the Indiana bat.

The following recommendations are provided to help minimize adverse effects of the proposed action and document any actions taken:

- Modify road locations, as feasible, to avoid areas of suitable habitat,

- Within areas of suitable habitat, avoid removal of dead, dying, or live trees with peeling or exfoliating bark that are larger than 9 inches in diameter,

- Determine the approximate location, total size, and configuration of forested areas cut for access road construction and provide that information to the Service once the response action is completed,

- Report to the East Lansing Field Office (517 351-2555) any observations of bat mortalities, or bats exiting cut trees.

We conclude that the process of oil spill containment and clean up may affect Indiana bat, but should not jeopardize the species. Once the oil spill is under control, we request that you initiate consultation with our office. In addition, we request that you provide our office a description of the emergency, a justification for the expedited consultation, and an evaluation of the response to and the impact of the emergency on Indiana bat and its habitat.

We appreciate the opportunity to cooperate with the U.S. Environmental Protection Agency. If you have any questions regarding these comments, please contact Jack Dingledine of this office, at (517) 351-6320 or jack_dingledine@fws.gov.

Sincerely,

Jack Dingledine
Acting Field Supervisor

cc: Chris Hoving, MDNRE, Wildlife Division, Lansing, MI

Bat Life History

Since listing as endangered in 1967, the range-wide Indiana bat population has declined by nearly 60%. Several factors have contributed to its decline including the loss and degradation of suitable hibernacula, human disturbance during hibernation, pesticides, fragmentation of forest habitat, and loss and degradation of forested habitat, particularly stands of large, mature trees.

In Michigan, summering Indiana bats roost in trees in riparian, bottomland, and upland forests from approximately April 15 to September 15. Indiana bats may summer in a wide range of habitats, from highly altered landscapes to intact forests. Roost trees are typically found in patches of forests of varying size and shape, but have also been found in pastures, hog lots, fence rows, and residential yards.

Male Indiana bats are dispersed throughout the range in the summer, roosting individually or in small groups, but may favor areas near hibernaculum. In contrast, reproductive females form larger groups, referred to as maternity colonies. Female Indiana bats exhibit strong site fidelity to summer roosting and foraging areas, tending to return to the same summer range annually to bear their young. These traditional summer sites are essential to the reproductive success and persistence of local populations.

Indiana bats are known to use a wide variety of tree species for roosting, but structure (i.e., crevices or exfoliating bark) is probably most important in determining if a tree is a suitable roost site. Roost trees generally are dead, dying or live trees (e.g. shagbark hickory and oaks) with peeling or exfoliating bark which allows the bat to roost between the bark and bole of the tree, but Indiana bats will also use narrow cracks, split tree trunks and/or branches as roosting sites. Southern Michigan maternity roost trees are typically in open areas exposed to solar radiation. Roost trees vary considerably in size, but those used by Indiana bat maternity colonies usually are large relative to other trees nearby, typically greater than 9 inches dbh. Male Indiana bats have been observed roosting in trees as small as 3 inches dbh.

Maternity roosts of the Indiana bat can be described as "primary" or "alternate" based upon the proportion of bats in a colony consistently occupying the roost site. Maternity colonies typically use 10–20 different trees each year, but only 1–3 of these are primary roosts used by the majority of bats for some or all of the summer. It is not known how many alternate roosts must be available to assure retention of a colony within a particular area, but large, nearby forest tracts appear important. Although the Indiana bat appears to be adaptable to changes in its roosting habitat, it is essential that a variety of suitable roosting trees exist within a colony's summer area to assure the persistence of the colony.

Approved

MEMORANDUM

DATE: **October 14, 2011**
TO: **United States Environmental Protection Agency**
FROM: **Enbridge Energy, Limited Partnership**
Re: **Bucket Sheen Test SOP**

1.0 INTRODUCTION

This document outlines a standard operating procedure (SOP) for a Bucket Sheen Test that will be implemented concurrent with the oil recovery activities in the Kalamazoo River flood plain. This procedure is a modification of the Static Sheen Test from 40 CFR Appendix 1 to Subpart A of Part 435. The purpose of the test is to delineate potential sheen-producing sediments within non-submerged areas of polygons previously identified by submerged oil poling teams on flooded areas along the river bank. The data developed through the Bucket Sheen Test will be utilized to determine approximate volumes of impacted sediments within the polygons for remedial planning purposes.

2.0 WORK AREA MONITORING

- The test procedure will begin by visually delineating the non-submerged perimeter of the polygon.
- A sample grid will then be established over the non-submerged portion of the polygon which will include at least three nodes spaced at a maximum of 25 foot centers.
- A check valve sampling tool that consists of a drive head and a 3-inch diameter by 2-foot long, disposable, acetate sampling tube will be utilized to collect core samples from the sediment at each node location in the polygon. The sampling tube will be pushed or hammered into the sediment at each grid node to a depth of approximately 2 feet below grade. It will then be extracted from the borehole and uncoupled from the drive head. Recovery will be measured and the tube will be cut and opened with a cutting tool.
- The resulting sediment core will be sectioned into four 6-inch segments. A representative sample will be collected from each section (approximately two-thirds

of the segment) and placed into separate 5-gallon buckets of water. Each bucket shall be filled with approximately 12 inches of water collected at the river.

- Utilizing the standard poling technique, the sediment and water will be agitated in the bucket.
- Record observations of sheen following the approved *Overbank and Poling Reassessment Plan* (Poling Work Plan), (i.e. defined as none, light, moderate, heavy, and if globules are present according to the Submerged Oil Field Observation Flowchart in *Attachment A* of the Poling Work Plan). These observations will be recorded for use by the Outstanding Sites Characterization and Reconciliation (OSCAR) team.
- For the purpose of this SOP, the Bucket Sheen Test will be evaluated on the presence or absence of petroleum sheen and any petroleum sheen observed will result in a failure. If the Bucket Sheen Test fails at the perimeter of the polygon, additional sediment core samples will be collected to determine the vertical and horizontal extent of petroleum impacts beyond the polygon. This information will be used to estimate the volume of potentially impacted sediment.
- Viewing points above the test container should be made from at least three sides of the test container and at numerous viewing angles from horizontal to ensure observation of any evidence of free oil.
- Detection of a silvery or metallic sheen or gloss, increased reflectivity, visual color, iridescence, or an oil slick on the water surface of the test container surface shall constitute a demonstration of free oil. These visual observations include patches, streaks, or sheets of such altered surface characteristics.
- Each sediment core will be logged and its location will be recorded with the YUMA GPS device.

If gross contamination is observed in the bucket, the test will be stopped and the water and sediment will be containerized for proper transport and disposal. If sheen is observed in the bucket, the sheen will be collected using absorbent material. The water will then be decanted onto the ground and any remaining sediment will be returned to the borehole. If no sheen is observed, the water will be decanted onto the ground and the sediment returned to the borehole.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Overbank Oil Recovery Standard Operating Procedures

Prepared for United States Environmental Protection Agency / Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: May 27, 2011

Approved: June 8, 2011

Approved

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Approved

LIST OF ACRONYMS

Enbridge	Enbridge Energy, Limited Partnership
GPS	global positioning system
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MDEQ	Michigan Department of Environmental Quality
SCAT	Shoreline Cleanup Assessment Technique.
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
WTTD	Waste Treatment, Transportation and Disposal Plan

Approved

1.0 INTRODUCTION

The purpose of this Overbank Oil Recovery Standard Operating Procedure (SOP) is to provide general guidance to the ongoing recovery operations of overbank oil resulting from the July 2010 Enbridge Line 6B MP 608 pipeline release in Marshall, Michigan. This SOP addresses overbank oil recovery operations for the sites identified as requiring response activities by Enbridge Energy, Limited Partnership (Enbridge), the United States Environmental Protection Agency (U.S. EPA) and the Michigan Department of Environmental Quality (MDEQ).

This SOP expands upon the approved National Oceanic and Atmospheric Administration (NOAA) Shoreline Cleanup and Assessment Technique (SCAT) Cleanup Recommendations as presented in the September 14, 2010 Kalamazoo River/Enbridge Spill – Cleanup Recommendation Methods. The purpose of this SOP is to remove and recover free oil and oil that is likely to mobilize to the river. Additional investigation and remediation efforts will be conducted at sites identified for oil recovery at a later date and will follow the requirements of the MDEQ consent order.

2.0 SITE SELECTION

The selection of sites for overbank oil recovery using the outlined techniques will be jointly determined by Enbridge, the U.S. EPA, and the MDEQ based on current observed site conditions and the results of the reassessment process. Specific application of one or more of the presented oil recovery procedures will depend upon a number of factors including:

- Site access and logistics;
- Type(s) of remaining oil;
- Ecological setting/sensitivity, and
- Physical setting of the area (wetlands, wood, vegetative cover, etc.).

Overbank locations will be delineated and flagged prior to recovery operations. Areas of concern (i.e. sensitive areas, priority areas, hotspots) will be clearly marked. All boundaries (pre and post removal) will be documented using global positioning survey (GPS) equipment capable of sub-meter accuracy. This information, along with photographs and field notes,

will be recorded. Concurrence of the agencies with the locations delineated will be obtained prior to commencement of operations.

All response activities will be communicated to and coordinated with the U.S. EPA and the MDEQ prior to mobilization. Oil recovery activities will be conducted in a manner that is safe, and that minimizes the potential to contaminate adjacent areas included the migration of contaminants deeper into the soil. Appropriate personal protective equipment (PPE) will be worn and appropriate measures, including decontamination will be developed and implemented to protect un-impacted areas. All generated waste will be safely handled, containerized, transported, and disposed of pursuant to the approved Waste Treatment, Transportation and Disposal Plan (WTTD).

3.0 OVERBANK OIL RECOVERY PROCEDURES

The following approved oil recovery methods are described in the September 14, 2010 Kalamazoo River/Enbridge Spill – Cleanup Recommendation Methods:

- Manual removal (raking, shoveling, hand);
- Vegetation removal;
- Low pressure cold water flushing, and
- Sorbent material (booms, snares).

In addition to the above approved methods, the following techniques are proposed. These may be used as standalone options or in combination:

- Mechanical soil removal;
- Vacuum removal, and
- Organic sorbents.

3.1 Mechanical Soil Removal

The use of small excavators may be employed at sites where the area of a maximum of oil recovery makes manual recovery inefficient. The maximum depth of excavation will not exceed 6 inches. Small excavators will be used to scrap soil and vegetation to remove oil and oil saturated media. Consideration will be given to minimize impact to the site by the excavator during both access and oil recovery. Excavators will avoid wetlands and sensitive

areas. Mats will be used as applicable to minimize disturbance to the soil. Care will be taken to minimize the impact to woody vegetation.

The oily material will be containerized and transport to Frac Tank City for proper characterization and disposal pursuant to the approved WTTD.

3.2 Vacuum Removal

The use of vacuum devices to remove oil and oil saturated media may be employed at sites. Vegetation will be cleared from the area to be vacuumed and oil and oily soil will be collected using a portable vacuum or other suction device. Areas accessible by land may utilize truck mounted vacuum units.

All oiled soil and debris will be double bagged or drummed and transport to Frac Tank City for proper characterization and disposal pursuant to the approved WTTD.

3.3 Organic Sorbent Application

The use of organic oil sorbent material (peat) may be employed at sites to remove free oil. Vegetation will be cleared from around identified location and the selected sorbent will be by applied by hand and gently raked into the oiled areas. The applied sorbent will remain for a minimum of 24 hours for absorption. Following 24 hours, the area will be examined to determine if additional treatment is needed.

All used sorbent will be removed using rakes and/or vacuum and will be double bagged or drummed and transport to Frac Tank City for proper characterization and disposal pursuant to the approved WTTD.

Enbridge Line 6B MP 608 Pipeline Release

Marshall, Michigan

Supplement to Source Area Response Plan

and

Supplement to Response Plan for Downstream

Impacted Areas

Referred to as

Operations and Maintenance Work Plan

Enbridge Energy, LP

Revised: October 17, 2010

Enbridge Line 6B MP 608
Marshall, Michigan
Supplement to Source Area Response Plan
and
Supplement to Response Plan for Downstream Impacted Areas
Referred to as
Operations and Maintenance Work Plan

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Acronyms and Abbreviations

Company	Enbridge Energy, Limited Partnership
GPS	Global Positioning System
MDNRE	Michigan Department of Natural Resources and Environment
NA	Not Applicable
QC	Quality Control
SAR	Source Area Response Plan - A workplan describing interim response actions designed to protect navigable waters from the crude oil release.
SCAT	Shoreline Cleanup Assessment Technique also known as SCAT Assessment or SCAT Process – A systematic approach that uses standard terminology to collect data on impacted areas, support decision-making for cleanup; reference HAZMAT Report No. 2000-1; Office of Response and Restoration, Hazardous Materials Response Division, National Ocean Service, National Oceanic & Atmospheric Administration, Shoreline Assessment Manual – Third Edition, August 2000.
SCAT Team	A team of qualified individuals using SCAT, organized and reporting to the UC and comprised of representatives from USEPA, (as the FOSC), MDNRE (as the SOSC and state NRDA trustee), NOAA or USFWS (as federal NRDA trustees) and Company to assess impacted areas and recommend cleanup methods and priorities. At least one member should have sufficient expertise in wetland and aquatic ecology to evaluate the sensitivity of impacted areas.
SOP	Standard Operating Procedure

1.0 Introduction

This document is a supplement to the existing Source Area Response Plan (SAR) and Response Plan for Downstream Impacted Areas (RPDIA). The information in this supplement addresses items "j" (For submerged oil and oil-contained sediments, remediate all impacted areas in and along Talmadge Creek, the Kalamazoo River, and Morrow Lake by October 31, 2010) and "k" (Perform operation and maintenance activities as directed by the EPA until otherwise notified by the EPA. Such operations and maintenance activities may include, but are not limited to: boom deployment, sorbent deployment, vacuum recovery, silt curtain development, aqua barriers, coffer dam construction, excavation at all impacted areas (including shoreline) in and along Talmadge Creek, the Kalamazoo River, and Morrow Lake, and long-term sampling of existing and potential drinking water sources) in EPA's supplemental order for Enbridge Energy, LP, dated September 23, 2010. The primary focus of this supplement is to describe the ongoing Operation and Maintenance (O&M) activities that will be required at the Marshall site under the EPA Order. This supplement is commonly referred to as the O&M Plan.

2.0 Shoreline Operating & Maintenance Activities

The Shoreline Cleanup Assessment Technique (SCAT) process was a multi-step process that included an initial assessment of areas affected by the release and procedural clean-up recommendations based on the Cleanup Recommendation Methods that were developed by the Environmental Advisory Group. Several independent inspections followed the cleanup before SCAT teams re-assessed each segment to confirm that the clean up was completed in accordance with the initial recommendations.

During the SCAT re-assessment phase, teams identified areas that could not be fully remediated using the Cleanup Recommendation Methods such as areas of saturated soil. The location and extent of these remaining oiled areas was documented using the SCAT Re-assessment Operation and Maintenance (O&M) Form with the intent of cataloging those areas which may require additional remediation and/or monitoring following the completion of the SCAT process in ecologically sensitive locations.

The O&M Inspection Tracking table (Attachment A) was developed by combining the data from the SCAT Re-assessment O&M Form and the EPA Inspector comments from the final Oil Recovery Reports. This list of potential O&M areas was further refined by the O&M group inspectors (EPA and Enbridge) that inspected and assessed each potential O&M area. The O&M group inspectors developed the maintenance codes and applied them to each O&M area.

Enbridge used the maintenance codes and site specific data to develop the tentative monitoring protocol. The monitoring protocol is designated as tentative because it is likely that the O&M areas will change over time as operations and seasonal events change these areas. Therefore, this table will be a working document that is updated regularly to accurately reflect the conditions at each O&M area. Recommended changes to the table will be submitted to the U.S. EPA for review and approval prior to implementation.

Inspections of each O&M area will take place at intervals as designated by the tentative monitoring protocol. Enbridge inspectors will complete the inspections along designated portions of the river. The O&M Monitoring Inspection Tracking form will be used by the inspectors to track the progress of inspections and record the information gathered during each

inspection within their designated areas. The information from the inspectors will be compiled into one tracking spreadsheet and distributed to the U.S. EPA and MDNRE on a weekly basis and will include proposed changes to the approved plan. The possibility exists that additional areas will be added to the table over time. These include: areas discovered by field crews, areas called in by landowners that are investigated and verified, and areas that may transition from the submerged oil group. This last category may include locations along the river where residual oil remains after submerged oil remediation techniques have been exhausted.

During the Talmadge Creek restoration project, features such as underflow dams were installed to capture any residual oil and contain it prior to reaching the river. In addition, hay bales and/or other containment structures, as approved by the U.S. EPA, have been placed just upstream of these dams to contain any oily sediment that may be released during restoration activities. Since these features may remain for a period of time after that particular project comes to an end and the crews that have been maintaining these areas may no longer be available, these locations may also be added to the O&M Inspection Tracking table. The same O&M tracking and follow up process will be implemented on the Talmadge Creek area as well.

The O&M group inspectors developed the maintenance codes and applied them to each O&M area. Enbridge used the maintenance codes and site specific data to develop the tentative monitoring protocol. The monitoring protocol is designated as tentative because it is likely that the O&M areas will change over time as operations and seasonal events change these areas. Therefore, this table will be a working document that is updated regularly to accurately reflect the conditions at each O&M area. Inspections of each O&M area will take place at intervals as designated by the tentative monitoring protocol. Enbridge inspectors will complete the inspections, along with EPA oversight, on designated portions of the river. The O&M Inspection Form will be used by the inspectors to track the progress of inspections and record the information gathered during each inspection within their designated areas. The information from the inspectors will be compiled into one tracking spreadsheet and distributed to the U.S. EPA and the DNRE. If the inspectors deem that the O&M procedures need to be enacted at a particular location, a contractor crew will be dispatched to carry out the prescribed procedures. A follow-up inspection will be performed after the prescribed procedures have been completed.

3.0 Submerged Oil Recovery/Oil Contaminated Sediments

3.1 Ceresco Dam Dredging & Permanent Recovery of Submerged Oil and Oil-Contaminated Sediments at Priority Locations

O&M will be performed for the recovery and/or containment of known (including, but not limited to, previously identified low and medium priority submerged oil locations) and newly identified submerged oil and oil-contaminated sediments in accordance with the *Work Plan for Ceresco Dam Dredging and Permanent Recovery of Submerged Oil and Oil-Contaminated Sediments at Priority Locations*. This *Work Plan* is an attachment to the *Supplemental Modification of the Response Plan for Downstream Impact Area & The Source Area Response Plan Strategy and Tactics for Permanent Recovery of Submerged Oil & Oil-Contaminated Sediment* submitted September 26, 2010.

A tool box is described in the *Work Plan* that describes techniques for submerged oil recovery, which include dredging, vacuum recovery, and sediment agitation (e.g., pneumatic aeration, manual raking, and water flushing). As part of the O&M process, additional locations of submerged oil may be identified where it is appropriate to use these oil recovery techniques. New locations that are candidates for permanent recovery will be evaluated using the same qualitative assessment criteria utilized to establish the previously identified priority locations approved by EPA. Near-term containment will be installed prior to recovery activities as described in the *Work Plan.*

There are additional sites identified as having moderate to low priority for submerged oil. For these sites, Operations will need to conduct an assessment for the most feasible course of action; including containment, maintenance codes, inspection frequency, and priority code reassessment. This will require visits to each of the sites by the Operations Section. After the site visits are complete, the O&M Inspection Tracking spreadsheet will be updated to allow entry of the additional sites into the operations and maintenance program.

If a newly identified submerged oil site is not appropriate for permanent recovery as determined by the submerged oil task force, then it will be included in the O&M table for inspection and

follow-up. If submerged oil recovery techniques at a known site prove not to be effective, then these locations will also be added to the O&M table. All submerged oil priority sites will be inspected and signed off by the EPA before October 31, 2010 unless outstanding issues are identified. Any sites with outstanding issues will be transferred directly to the Operations and Maintenance Branch for additional recovery and to the O&M Tracking spreadsheet, following approval of the EPA. All priority sites that have been signed off by EPA and Enbridge will be inspected by the Operations and Maintenance branch to determine whether additional maintenance and monitoring is required.

Site-specific conditions including environmental assessment evaluations will be addressed prior to execution of recovery operations. The QC procedure described in the *Work Plan* will be used to evaluate effectiveness of the permanent recovery. Approval from the U.S. EPA and MDNRE will be accomplished in accordance with the *Work Plan*.

More information about the submerged oil recovery process can be found in the work plan titled "Work Plan for Permanent Recovery of Submerged Oil and Oil-Contaminated Sediments at Priority Locations and Ceresco Dam Dredging As an Attachment to the Supplemental Modification of the *Response Plan for Downstream Impact Area and the Source Area Response Plan* Strategy and Tactics for Permanent Recovery of Submerged Oil & Oil-Contaminated Sediment" which was submitted to the U.S. EPA on October 7, 2010.

3.2 Talmadge Creek

An in-situ stream sediment basin (a.k.a. a sand or sediment trap) will be installed in the lower reach of Talmadge creek to trap and allow removal of coarse and fine sediment material. Sediment enters the creek from both natural events and human disturbances. Each causes suspension of materials into the water column which then get transported downstream where they eventually settle out at locations of reduced flow. The purpose of the sediment trap is to create an area of reduced flow, by increasing the volume or area that the creek is passing through, so that sediment/soil particles can fall out of suspension and become "trapped" in the deeper portions of the trap. The existing flume will be reconstructed immediately downstream and between its current location and the 48" culvert at A Drive.

The initial construction and clean-out of the existing flumes, check dams, and sediment traps will be done with an excavator or vacuum truck. The following shall be completed prior to constructing the sediment trap:

1. Construction of a work pad (equipment mats and/or temporary fill on geo-textile fabric) west of the creek set back a minimum of 10 feet from the re-established coir log banks of the creek.

2. Clean out of the existing sediment load above the existing flume (designed to trap oil sheen and pass water downstream from the middle of the water column) immediately upstream of A Drive (~99+30R).

3. Clean out the existing sediment load above the small rock check dam (~101+00R) immediately upstream of the creeks confluence with the Kalamazoo River.

4. Install the new flume, between the existing flume and the 48" CMP under A Drive. If there is insufficient space, remove the old flume and then construct the new flume in the furthest downstream location (so as to maximize the length of the proposed upstream sediment trap).

5. Remove existing flume, if not already completed as part of 4 above.

6. Ensure the upstream end of the flume is deep enough to allow the culverts to draw water from the middle of the water column.

7. Continue excavation of the sediment trap working from the downstream ending up at the upstream end (denoted as approximately 80 feet of "Initial Construction") making sure of the following:

    a. There is no excavation of any soil/bottom substrates within 3 feet of the coir logs on either side of the creek. Excavate only the interior/central portions of the creek.

b. Depth of excavation may range from 0 to 5 feet, 3 to 5 feet in the center of the trap, and will vary depending upon the composition of the bottom substrates and stability of the side slopes.

c. It is recommended that the trap first be excavated to a maximum depth of between 0-3 feet to start to make sure there are no impacts to the 3 foot "no dredge areas" at the outer edges of the creek. If the side slopes of this 3 foot "buffer" are stable, the trap can be further deepened.

8. Place staff gauges (marked up lathe stakes) in the creek channel at 4 different locations within the creek channel.

9. If the approximately 80 foot long "Initial Construction" trap fills at a rate requiring maintenance work more than twice a day, then the trap can be expanded an additional 27 feet (denoted as "Additional Expansion") to provide greater storage capacity.

Upon construction completion, the depth of sediment collecting in the sediment traps shall be recorded at each of the gauges at least twice a day and continue for at least the first two days following construction. Depending on the rate of sediment accumulation, the frequency that the gauges are read may be increased or decreased.

The trap shall be cleaned when the trap fills to at least 50% of its capacity and can be cleaned out more frequently, before the 50% capacity is reached, if equipment is available and disturbance to bottom substrates is minimized. The method for subsequent cleanings, either by vacuum or backhoe, will be determined pending the results of testing of the trapped sediment. All spoils will be trucked to an approved upland disposal site; no spoils are to be placed in wetland or other portions of the creek.

A record shall also be kept of the number of times the trap is cleaned and the volume of material removed. Once the sediment trap is no longer needed, the trap may be either left to fill in naturally over time and/or filled to its prior grade with 1-3" fieldstone. Removal of the existing flume will not occur without the approval of the U.S. EPA.

3.3 MP 26.25

MP 26.25 received considerable man-hours of aeration, flushing, and raking work between September 21, 2010, and October 15, 2010. Cells 1 through 3 were signed off by Carl Pellegrino of USEPA and Scott Swiech of Enbridge on October 6, 2010. Flushing continued on Cells 4 through 9 by the O&M group and on October 15, 2010, Paul Peronard of USEPA, Joe Kackos of Enbridge, and Bryan Sederberg of O'Brien's revisited MP 26.25. Paul Peronard and Joe Kackos signed off on the site and the removal site MP 26.25 is now considered complete.

4.0 Containment and Recovery Plan

4.1 Site Description and Location

O&M areas extend from the release point near Talmadge Creek (MP 0) to Control Point E 5 (MP 39.75) near Morrow Lake and have the potential to include other possible areas downstream of Morrow Lake Dam related to the release which may be discovered later. This entire area is defined as the Site. The following containment and recovery strategies may be applied to surface waters within Talmadge Creek and the Kalamazoo River (MP 2.1 to MP 39.75).

4.2 Goals and Objectives

- Monitor and assess the presence of mobile hydrocarbons on the surface waters within Talmadge Creek and the Kalamazoo River.
- Effectively and efficiently contain and remove surface hydrocarbons and oil-contaminated sediment from the surface waters within Talmadge Creek and the Kalamazoo River.
- Maintain the integrity and effectiveness of the installed containment and collection systems throughout the site.
- Demobilize and decontaminate containment equipment as it is removed from service.

4.3 Monitoring

Site monitoring from the release site to MP 39.75 will be completed utilizing Air Operations, watercraft, and land based observation. During the monitoring, crews will be observing river characteristics such as freezing, debris movement (organic material resulting from the fall season), checking for the presence of surface hydrocarbon (oil/sheen) as well as subsurface hydrocarbon migration (submerged oil). These inspections will also include visual inspection of the surface containment measures and will identify any deficiencies or issues with the systems.

- Air Operations: Weekly site over-flights including surface water inspections from an altitude of approximately 500’ above ground. The inspection team made up of Enbridge and EPA representatives will monitor for the presence of migrating surface hydrocarbons, organic debris as well as ice flow. Inspections will include identification of potential

source locations such as impacted shoreline or submerged oil sites. Photos of all control points will be taken as well as any observed hydrocarbons and ice flows. GPS coordinates will be taken and forwarded to the O&M and Contaminant and Recovery O&M Task Forces.

- Vessel Operations: Inspection of all control points will be completed per frequency requirements using river boats. These inspections will focus on the integrity of the containment systems as well as the presence of accumulated hydrocarbon/debris/ice within the containment systems.
- Land Operations: Shoreline crews will assess the effectiveness of the control points, mainly the collection and recovery points at each boom location as well as "ground truthing" of areas identified by Air and Vessel Operations.

Information gathered from the monitoring process will be relayed to the O&M and Contaminant and Recovery O&M Task Force. Continuous consultation with the O&M crews will be completed to ensure that a timely response to identified issues is completed.

4.4 Containment

Existing containment boom is presently being reconfigured and strengthened in order to provide effective containment during the fall/early winter months. These control points will need to withstand significant weather changes and debris accumulation. Reconfigured and strengthened containment boom will be monitored continuously during periods of river thaw when ice flow and high velocity river flows exist. If adverse conditions present themselves, (i.e., damaging ice flow or high velocity river flow during an ice melt) containment boom will be removed with notification provided to the U.S. EPA.

Control point refers to a location that can contain and collect surface hydrocarbons and debris and direct the collected material to a recovery point within the boom configuration. These sites span the entire width of the Kalamazoo River. Eighteen (18) control points currently exist. These control points consist of 18" or 12" containment boom with instream and shoreline anchors points. Marker buoys are attached to all instream anchors as well as the upstream lines on all shoreline anchor points. All control points contain a downstream collection and recovery

point, some are accessible by land based operations and some are accessible only by on water operations due to their remoteness. The deployment of booms on land to prevent oil migration overland due to precipitation events or ice melt will be evaluated and implemented as necessary and prudent.

Absorbent material such as absorbent boom, absorbent sweep, rope snare and pompoms will be used when required. Absorbent material would be installed to temporarily contain shoreline impacted areas until cleaning operations are complete. Containment booms will be lined with absorbent material when free oil/product is present. The use of absorbents on sheen is relatively ineffective; therefore, reliance on the containment boom (hard boom) will be the primary tool utilized. The proper installation of containment boom is the most effective way to collect and contain surface sheen/oil. Based on the monitoring, absorbents will be used when required.

Gabion Basket, Sediment Curtain and X-Tex Curtain monitoring and maintenance: This will be dependent on subsurface hydrocarbon accumulation and collection in these devices. Once hydrocarbon accumulation ceases, the units will be assessed and possibly removed. This could be as soon as early October or could span into late November. Removal of any containment devices will be performed only after approval from the U.S. EPA.

The Sediment and X-Tex curtains serve a dual containment purpose. These deployments contain surface boom as well as subsurface curtain. The surface boom will collect and contain surface product/sheen/debris and the curtain will collect and contain subsurface product and debris. All debris is directed (based on boom angle) to a downstream collection point where debris removal can be completed.

4.4.1 Current surface water control points: (as of October 15, 2010)

Eleven control points currently exist from the confluence of Talmadge creek and the Kalamazoo River to MP 39.75.

1. B 5 (Confluence of Talmadge and Kalamazoo, MP 2.1),
2. C 0.5 (MP 5.4),
3. MP 6,
4. C 5 (MP 14.8),
5. C 6 (MP 15.5),

6. D 3 (MP 19.4),
7. E 0.5 (MP 27),
8. E 1 (MP 29.4),
9. E 3 (MP 35.2),
10. E 4 (MP 37.75),
11. E 5 (MP 39.75).

4.4.2 Current O&M sites: (as of October 15, 2010)

1. C1 (MP 3.0),
2. C1 (MP 3.5 Island B),
3. C1 (MP 3.5 Island C),
4. C1 (MP 3.75 Island D),
5. C1 (MP 3.75 Island E),
6. C1 (MP 4.25 Island F),
7. C1 (MP 4.25 LDB),
8. C1 (MP 4.25 Island),
9. C2 (MP 5.0),
10. C2 (MP 5.25),
11. C2 ((MP 5.5-5.75),
12. C3 (MP 11.75),
13. C3 (MP 12.5),
14. C3 (MP 12.75),
15. C3 (MP 13.25),
16. C3 (MP 13.50),
17. C4 (MP 15 Island 1),
18. C4 (MP 15 Island 2),
19. C4 (MP 15 Diversion),
20. C4 (MP 15.25),
21. C4 (MP 15.50 RDB),
22. C4 (MP 15.50 Marsh),
23. C4 (MP 15.75 RDB),
24. C4 (MP 15.75 Culverts),
25. D3 (MP 17.75),
26. D3 (MP 18.0),
27. E4 (MP 36.75),
28. E4 (MP 37),
29. E4 (MP 37.75 LDB),
30. E4 (MP 37.75 RDB), and
31. E4 (MP 38).

4.4.3 Current Submerged oil sites: (as of October 15, 2010)

1. C1 (MP 5.75S),
2. C2 (MP 5.63),

3. C2 (MP 5.75N),
4. C3 (MP 12.5),
5. C4 (MP 15.25),
6. C4 (MP 15.5),
7. D5 (MP 21.5), and
8. E4 (MP 37-37.5).

4.4.4 Current subsurface sites: (as of October 15, 2010)

Five subsurface control points exist from the confluence of Talmadge creek and the Kalamazoo River to MP 39.75. These five points are: B 5 (MP 2.1), C4 Gabion Baskets (MP 12.5), D 1 Sediment Curtain (MP 17.75), D 1 Gabion Baskets (MP 18), E 4 X-Tex (MP 37.6 and MP 37.75)

4.4.5 O&M Control Point reduction plan (from October 16, 2010 to October 31, 2010)

Based on the above data, the proposed hard boom reduction plan is as follows.

Surface water control points: Of the existing eleven surface water control points, there is only one Control Point not on the scheduled list of ten sites to be remain in place and monitored until October 31, 2010.

Control Point C 5 (MP 14.8) remains in place as there are currently upstream operations. These operations require that vessel traffic be present on the river. The vessel pillow or wake, regardless of speed, may allow residual hydrocarbon sheen to wash off the banks and into the river. Additionally, there is downstream work at the South Mill Pond area. A deflection boom was installed to direct water flow into this area in order to aid flushing operations. With this deflection boom in place, Enbridge and EPA agreed to leave the C 5 Control Point in place to prohibit additional sheen from entering this work area.

Once upstream operations are completed, this Control Point will be removed. Expected time of completion of upstream activities is October 20, 2010.

The remaining ten control points were selected based on river characteristics (current, width, depth, substrate, vegetative presence, shoreline access, and shoreline anchor points), their

proximity to upstream areas that require additional work (shoreline or submerged oil sites) as well as proximity to residential areas or public access points. The remaining ten control points are:

1. B5 (MP 2.1),
2. C 0.5 (MP 5.4),
3. MP 6,
4. C 6 (MP 15.5),
5. D 3 (MP 19.4),
6. E 0.5 (MP 27),
7. E 1 (MP 29.4),
8. E 3 (MP 35.2),
9. E 4 (MP 37.75), and
10. E 5 (MP 39.75).

Current O&M sites: As these sites receive clearance approval from the EPA, the Hard Boom will be removed. Sorbent boom will then be placed and monitored at sheen locations, if present.

Expected time of completion of upstream activities is October 31, 2010.

Current Submerged oil sites: As these sites receive clearance approval from the EPA, the Hard Boom will be removed. Sorbent boom will then be placed and monitored, if required, to contain any residual sheen. Expected time of completion of upstream activities is October 27, 2010.

Current subsurface sites: These sites are to remain in place until all up stream work has been completed.

November 1st to Freeze up:

Dependent on the completion of in stream clean up (shoreline, submerged oil, etc) and based on the condition of the river, presence of hydrocarbon product/sheen, the control points will be further reduced to a total number of 8 sites.

1. B5 (MP 2.1),
2. C 0.5 (MP 5.4),
3. C 6 (MP 15.5),

4. D3 (MP 19.4),
5. E 1 (MP 29.4),
6. E 3 (MP 35.2),
7. E 4 (MP 37.75),
8. E 5 (MP 39.75).

MP 6 is to remain in place for one week after dredging operations to ensure no residual sheen is present. At this point the Control Point will be removed.

These Control Points will then be monitored daily for sheen hydrocarbon; all sheen and debris will be removed as required. Additionally, the boom will be cleaned of sediment and algae to reduce the appearance of dirty boom.

These Control Points are either in close proximity to vehicle access or vessel boat launch areas. As such, the only resource requirements will be vehicles, vessels, debris nets, bags, sorbent and crews. All debris bags will be hauled to the approved facilities. As no direct contact with hydrocarbon is present, these sites will not require any additional resources.

Any boom adjustments, repairs or change out will be forwarded to Contaminant and Recovery O&M Task Force for completion.

As winter approaches, ice build-up will occur. This ice build-up will severely reduce the integrity of all containment methods and will ultimately be the deciding factor on the removal of the Control Points. Final Control Point removal will be weather dependent and will most likely occur in late November or early December 2010.

If there are no significant rain falls and all upstream work is completed, all subsurface sites are to be removed. If a Control Point is not within proximity (0.25 mile) to subsurface sites, a temporary control point will be installed downstream to collect any residual sheen that may come off the sediment boom or gabion baskets. Once the materials from the subsurface location have been removed, the temporary Control Point will also be removed.

The order of removal will be:

1. B5 (MP 2.1) sediment boom only; Hard Boom will remain,
2. C4 Gabion Baskets (MP 12.5),
3. D 1 Sediment Curtain (MP 17.75),
4. D 1 Gabion Baskets (MP 18),
5. E 4 X-Tex (MP 37.6 and MP 37.75).

4.5 Recovery

Recovery of accumulated debris/hydrocarbon within the containment boom at each control point will be completed by manual labor. Hand tools will be used to recover the debris and hydrocarbon mixture. All materials will be placed into debris bags and handled and disposed of appropriately. Absorbents will be used if required (based on presence of free product). If warranted (significant free product volumes), mechanical skimming equipment will be used for recovery.

As ice accumulates in the containment boom, an assessment will be made to determine if ice recovery will be required. Once the ice volume becomes unmanageable or reduces the integrity of the containment boom, the containment systems will be removed and replaced.

4.6 Maintenance

O&M crews will inspect each control point on a regular basis and complete debris/product/sheen removal as required. Any boom adjustments or repairs will be completed by the Tech Services Group. Regular monitoring will be completed at each control point to assess containment effectiveness, evaluate debris removal techniques as well as to monitor the debris/ice build up. During the cold seasons, ice build up will occur. These build ups severely reduce the integrity of all containment methods and will ultimately be the deciding factor on removal and/or replacement of the systems.

Gabion Basket monitoring and maintenance includes regular visual inspection, removal, cleaning, restocking and reinstallation of the Gabion panels.

Final containment boom, sediment curtain and X-Tex curtain removal will be weather dependent, most likely late November or early December, 2010. The referenced containment items will only be removed after approval from the U.S. EPA.

4.7 Winter Monitoring

Monitoring of the entire site will be carried out during the winter months, utilizing Air Operations, Vessels (airboats) as well as land based observation as appropriate. Crews will observe river characteristics such as freezing (ice dams), debris movement (organic material resulting from the Fall season), and check for the presence of surface hydrocarbon (oil/sheen) and subsurface hydrocarbon migration (submerged oil). Based on these inspections, if surface hydrocarbons are present, winter containment may be required. If conditions are safe, this can be accomplished by means of ice slotting. The use of containment booms in the winter months is not advisable as the containment boom cannot withstand significant ice flows or ice shifting. The containment skirt on the boom also becomes ineffective once the ice depth exceeds 8-10 inches. Enbridge will contact the County Drain Commissioner and other regulatory bodies to identify the locations for historical ice dams to aid in identifying areas that are susceptible to the formation of ice dams. Observation will be made per frequency requirements at these identified locations, as well as other potential ice dam areas, to document ice buildup.

4.8 Spring Deployment

Spring monitoring will be carried out over the entire site by air, vessel as well as land operations. This monitoring will include a detailed inspection of the surface waters and shoreline areas within the site and will be completed throughout the spring breakup and melting period. Based on these inspections, additional surface and subsurface containment may be required. If surface containment is required, the following 7 sites have been identified as potential deployment locations:

B5 (confluence of Talmadge and Kalamazoo, MP 2.1), C 0.5 (MP 5.4), C 6 (MP 15.5), D 3 (MP 19.4), E 3 (MP 35.2), E 4 (MP 37.75), E 5 (MP 39.75).

Subsurface containment may also be installed based on the monitoring and assessment activities. The locations of these sites would be based on the observations made by the monitoring team as well as the locations of any identified subsurface concerns.

4.9 Erosion Control and Minimization

A natural approach to minimizing and controlling erosion on the banks of the Kalamazoo River will be employed for bank stabilization to prevent excessive and/or unnatural sedimentation to the river. In general shear stresses along most of the banks of the Kalamazoo River are very low with erosion and degrading of river banks being relatively minimal. In these areas minimal or no additional stabilization measures are recommended. Minimal measures may include seeding of the banks with an appropriate native seed mix based on erosion resistance qualities. Wheat or other similar erosion resistant, rapid growing plant may also be used as a temporary measure.

In the relatively few areas having high shear stresses along the banks additional control measures may be recommended. Such areas may include outside river bends, downstream of obstructions in the river (e.g. bridge abutments) or high boat traffic areas. In these areas installation of a custom native seed mix and a 100% biodegradable coconut fiber erosion control blanket, consisting of North American Green (NAG) C-125BN or equivalent is recommended. These materials will be installed from the river bank into all disturbed areas.

This same method will be implemented across the wetland restoration areas to stabilize the exposed soil while native perennial vegetation becomes established. Native seed will be installed and promptly covered with coconut fiber erosion control blankets or fabrics. The native seed mix will be developed based on species already present in adjacent un-impacted areas. Wheat or other similar erosion resistant, rapid growing plant may also be used as a temporary measure until the native plants have been reestablished. Erosion of soils from these restoration areas into adjacent communities is not anticipated, but will be controlled by the blankets, if required, and/or with other methods approved by the DNRE or other regulatory body with jurisdiction.

4.10 Mat Road Removal

The installation of mat roads may be necessary to access areas requiring response efforts. After completion of required response actions, the mat roads will be removed. The mat roads will be removed in a logical fashion working outward from the response area to the road access location. Mats will be loaded directly onto trucks that will adequately contain any residual soil or liquids during transport. Enbridge will coordinate with the EPA and MDNRE regarding the schedule for mat removal activities.

During the mat removal process, an environmental representative will be on site to observe the mat removal process and identify potential areas of visible oil or oil impacted soil which may be discovered beneath the mats. If discovered, the representative will direct the excavation of oil contaminated soil and will collect a sample once visual observation of the excavation indicates that no oil remains. Soil samples will be collected from the floor of the excavated areas in general accordance with the MDNRE guidance document entitled Sampling Strategies and Statistics Training Materials (S^3TM). To make the sample grid process simplified in the field, for excavations less than 60 lineal feet, one soil sample will be collected from each 25-feet of linear excavation and submitted for laboratory analysis. Excavations longer than 60 lineal feet may follow this 25-foot sampling frequency (which exceeds S^3TM requirements) or will have a sampling frequency calculated to follow the S^3TM guidance document. Samples will be analyzed for total petroleum hydrocarbons (TPH) parameters including Gasoline Range Organics (GRO), Diesel Range Organics (DRO), and Oil Range Organics (ORO). Soil samples will also be analyzed for volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PNAs), and select metals including barium, iron, nickel, vanadium, and molybdenum.

Once the soil sample has been collected from the excavation, the area will be immediately backfilled with a similar soil type and restored as per the methods described in Section 4.9. The limits of the excavation, field observations, and the location of the soil sample will be documented for future reference. The results of the soil sample analysis will be tabulated and used to direct possible future investigation and interim response activities pursuant to Michigan regulations.

Contaminated mats will be segregated and transported to the contaminated material staging area at a to-be-determined location based upon the areas under remedial actions where they will be chipped for subsequent disposal at a landfill. Uncontaminated mats will be transported to a staging area as indicated above. Uncontaminated mats that are not needed for potential future use may be demobilized.

4.11 Observations and Action Tracking

The goals and objectives of this O&M plan as well as response activities will be documented. An operation and maintenance tracking process has been developed to identify and prioritize areas requiring ongoing O&M which include area inspections and assessments, development of area-specific scopes of work, and verification of tasks completion which will include an Enbridge and EPA approval mechanism. This process will be tracked each work day and will provide documented feedback regarding assessment of areas and the timely implementation of appropriate response activities. Subsequent required follow up activities will be noted, implemented, and documented using the process.

The tracking process will begin with the comprehensive list of O&M areas identified on the O&M Monitoring Inspection Tracking form (referenced in Section 2.0 and included in Attachment A) which provides location (section, segment, and GPS coordinates), a unique identification number, a description of the area, standardized maintenance code(s), recommended inspection frequency, priority, comments and suggestions, and the date of last inspection. Crews will be mobilized to the area (based on the recommended inspection frequency) and record their observations and develop a proposed action/work plan for the area. This information will be documented on the Operations and Maintenance Daily Inspection Form. From this form, an area-specific work plan is developed and assigned to a work crew (and documented on the Operations and Maintenance Work Plan form) to implement. Once the work plan has been implemented, a follow up inspection is completed to document the work and make observations regarding possible additional required activities. Each O&M area will have a unique O&M record sheet (Unique ID Operation & Maintenance Record to Sign Off form) to document each successive response activity until such time that the problem has been adequately addressed and the area is removed from the O&M process. This form will have an Enbridge recommendation

and U.S. EPA concurrence signature documenting that the response metric has been attained. A sample O&M tracking form is included as Attachment A. An example of the O&M site closeout document is included as Attachment B.

The observations of reoccurring sheen and the corresponding location and arrangement of booms where sheen is observed will be tracked and documented using the O&M tracking process previously described. Upon completion of any upstream cleanup activities and when observations indicate that sheen is no longer present, the O&M record sheet will be used to document and verify that the sheen does not appear during the required 14 day period. Following successful completion of the 14 day period, the EPA will be notified and the form used to document approval of metric attainment and containment boom removal.

5.0 Excavated Soils

If an area is not responding to the specified O&M techniques (e.g., the continued presence of pooled oil, stressed vegetation, continuing sheen), excavation will be evaluated. At locations where site excavation is determined to be the best alternative for remediation, excavation work plans will be developed by Enbridge on a case by case basis and submitted for approved to the EPA and MDNRE (and other agencies as required) prior to starting work. An external contractor will be identified to perform the actual excavation work, under the direction of Enbridge. All excavation work, site restoration and waste disposal will follow the procedures referenced in the approved work plan.

5.1 Excavated Soil Management

Soil cells were constructed in Area A and Staging Area 4 of the Marshall spill response site to manage excavated soils from downstream locations. The cells in Area A are currently being used to manage debris collected from the field as well as soils. The soil cells will remain active as long as there is a flow of waste material into the cells. Use of all, but one of these cells, will cease when the last of the waste material has been managed and shipped offsite for disposal. One cell will remain as a centralized waste staging and management area until such time the EPA management of this project is complete. When cells are no longer required, a Soil Staging Area Closure Plan will be developed, and submitted to the U.S. EPA for review and approval, to document the planned decommissioning of these facilities. Soil Cells 2, 4, and 5 are expected to remain in use through 2011. All other soil cells will be discontinued by November 15, 2010.

6.0 Sampling of Current and Potential Drinking Water Sources

Plans and procedures for the sampling of existing and potential drinking water sources are addressed in the Sampling and Analysis Plan prepared by on August 2, 2010, amended as the *Drinking Water Well Supplement to the Sampling and Analysis Plan*, submitted on September 27, 2010.

7.0 Waste Management

All wastes generated during the O&M phase will be managed in accordance with the *Waste Treatment, Transportation and Disposal Plan* submitted on August 2, 2010 and revised on August 8, 2010.

8.0 Citizen Call Response Process

Calls from concerned citizens and/or area landowners will be managed according to the Landowner/Citizen Overbank Oil Call Response Process. This process provides a detailed structured approach for managing these calls. A flow diagram for the process is included in Attachment C.

9.0 Long-Term Support Areas for the Line 6B Spill Response

Ariel photographs of long-term operational areas are provided in this section. These areas include the Incident Command Post, decontamination stations, soil storage areas, material staging, and river access points.

9.1 Incident Command Post

The Incident Command Post will remain at 1601 Pratt Street, Marshall, MI 49068.

9.2 Decontamination Stations

9.2.1 Frac Tank City will remain as long term decontamination station.

9.2.2 C0.5 will continue to be used as a decontamination station. Based on further O&M assessment, C0.5 may be decommissioned in 2010 or 2011.

9.3 Soil Storage Areas

Division A will be maintained for oily mat storage. Soil Storage Cells 2, 4, 5 will remain in use.

9.4 Material Staging

1601 Pratt – will be used for consumable storage (inside) and some equipment in parking area

9.4.1 Frac Tank City

Frac Tank City will be used for material storage as space permits.

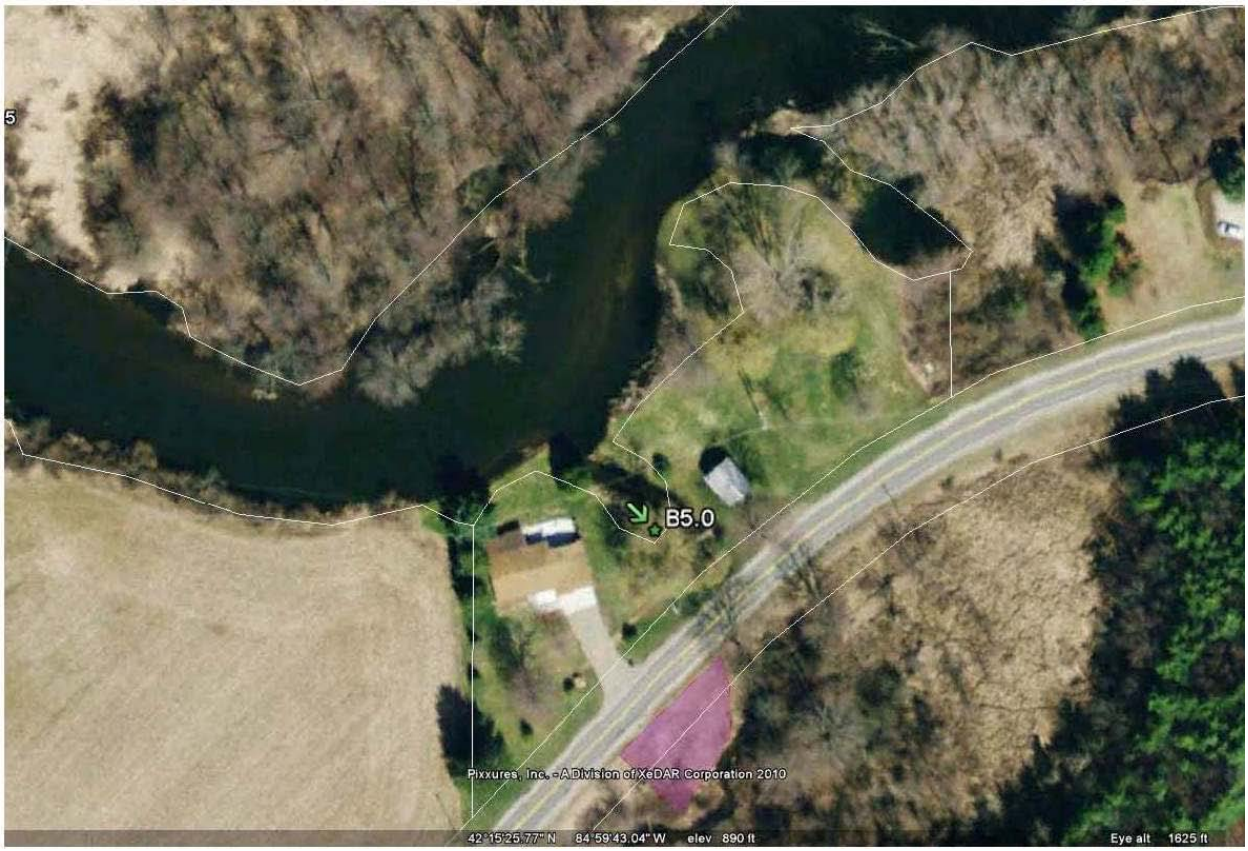
9.4.2 C3.2

C3.2 will be used as a seasonal material staging area depending on the level of river activity.

9.5 River Access

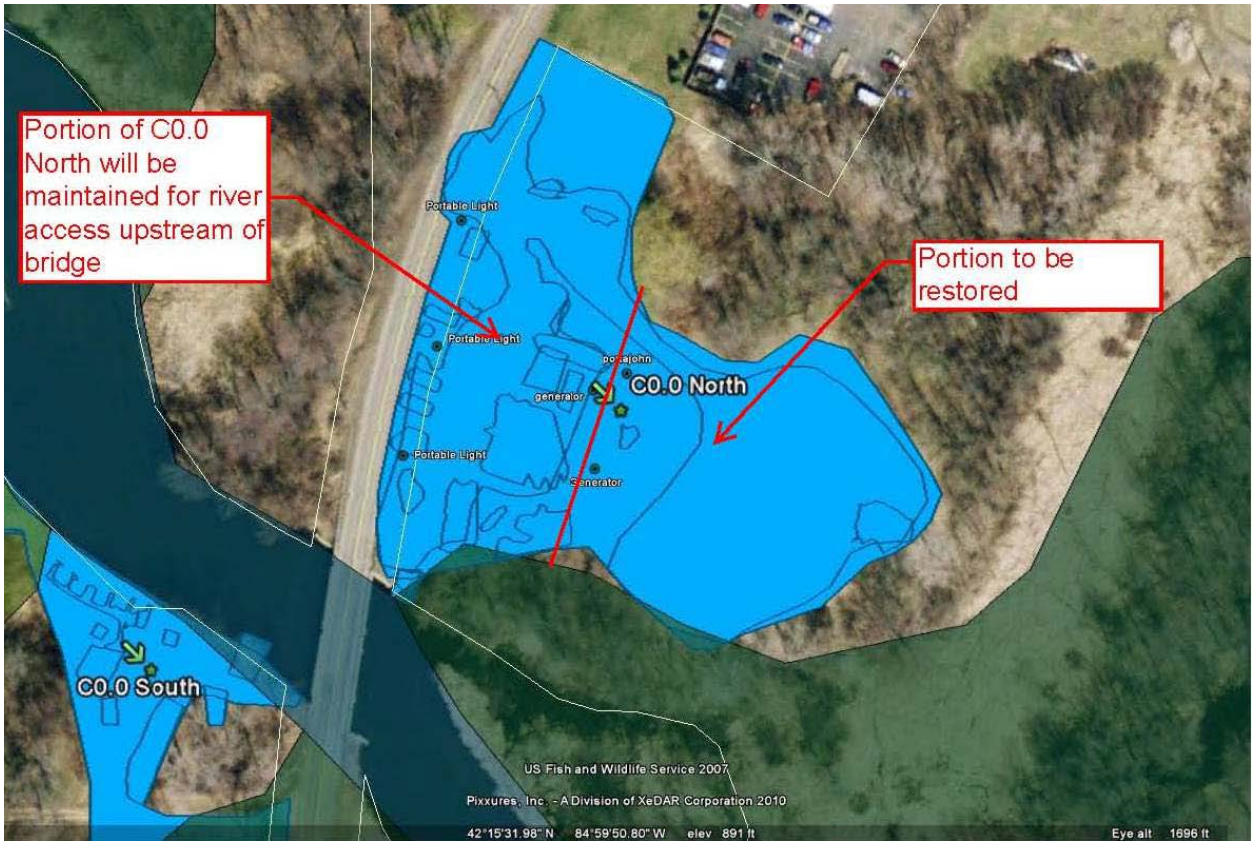
9.5.1 B5

B5 is the confluence of creek and river which will be accessed from south shore as necessary.



9.5.2 C0 North

A portion of C0 North will be maintained for river access upstream of bridge.



9.5.3 C0.5

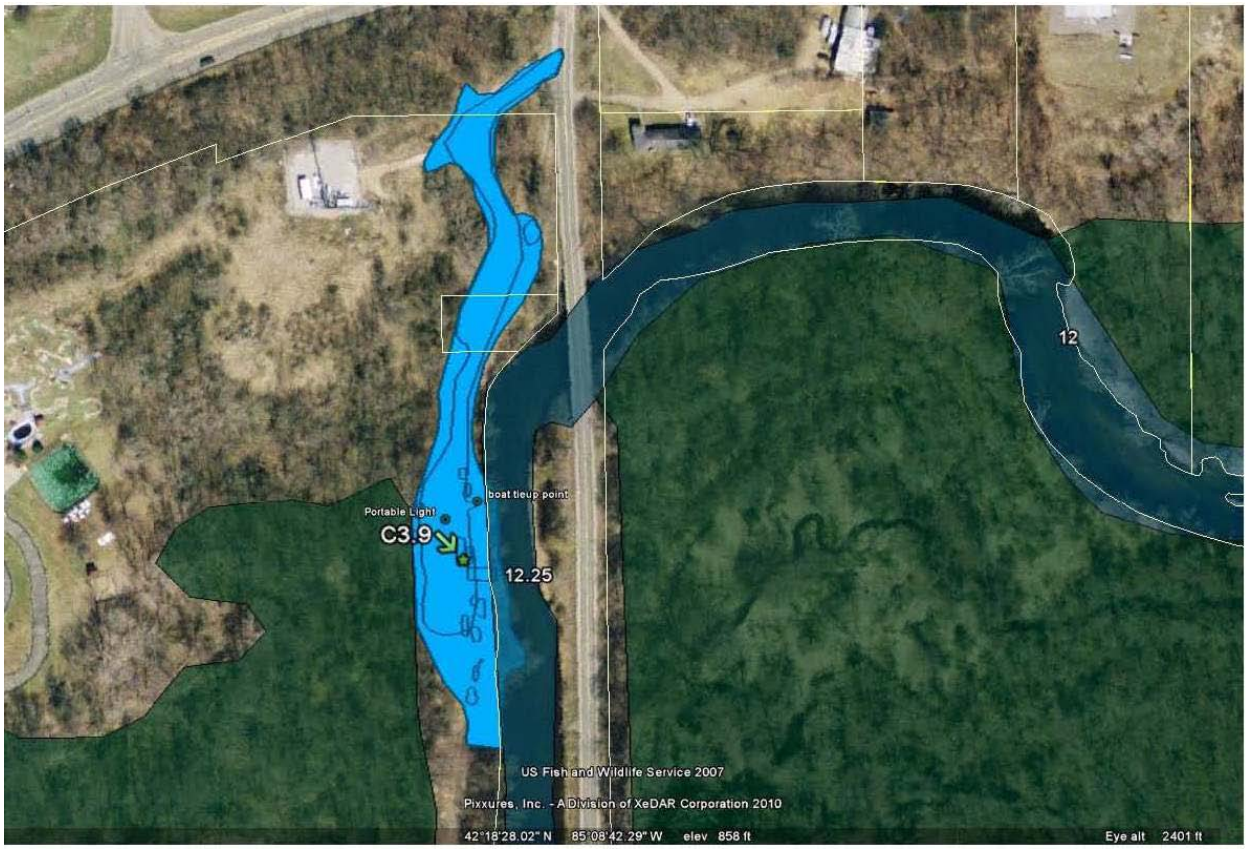
C0.5 will remain in operation for boom maintenance and O&M activities.

9.5.4 C3.2

C3.2 is an Enbridge owned property and will remain open for O&M activities.

9.5.5 C3.7 and 3.9

C3.7 is Enbridge owned property and may be reactivated if necessary for O&M activities. C3.9 will remain open for O&M activities.



9.5.6 C5

C5 will remain open for boom maintenance and O&M activities.

9.5.7 D1

D1 will remain open for gabion basket maintenance.

9.5.8 D2

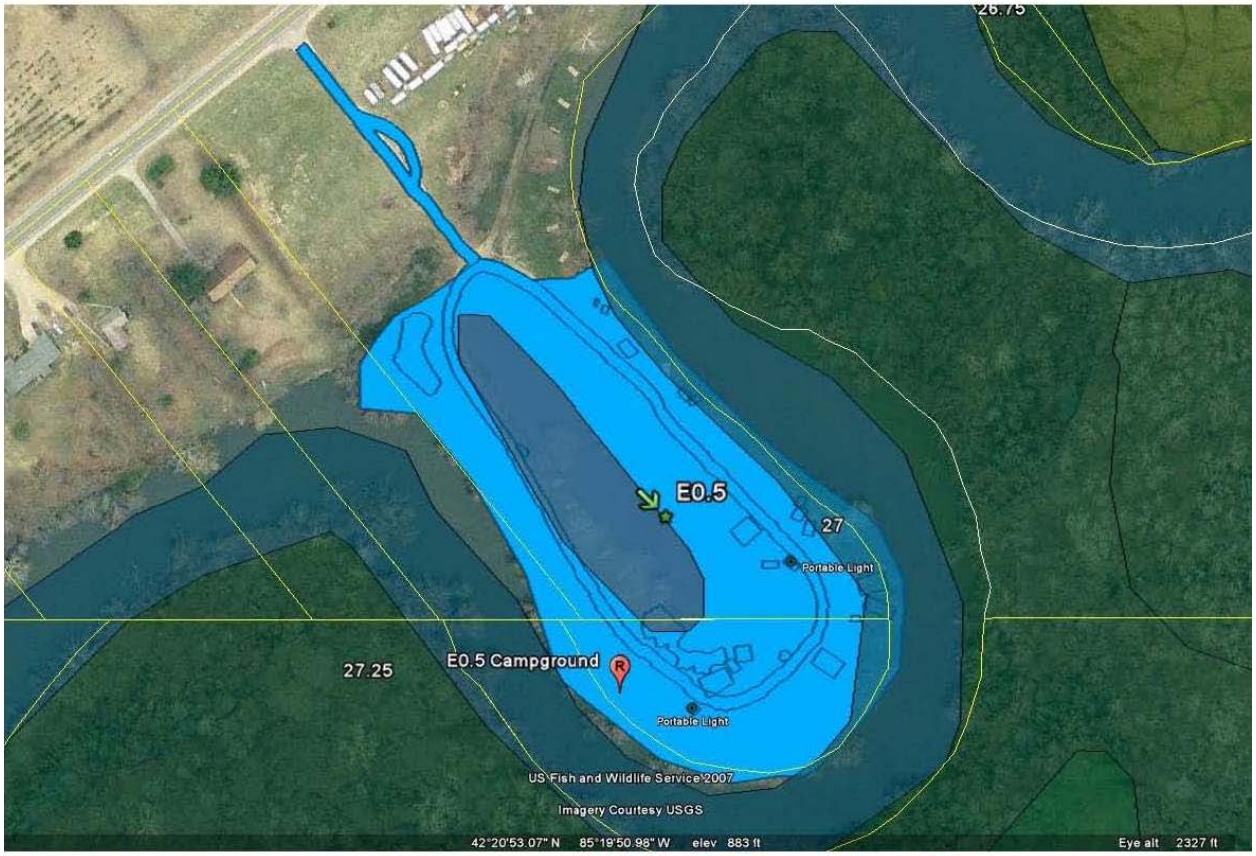
D2 will remain open for boat launch (day use only); no equipment is staged at site.

9.5.9 D3

D3 will remain open for gabion basket maintenance.

9.5.10 E0.5

E0.5 will remain open for river access until new site on Enbridge owned property is established.



9.5.11 E2

E2 will remain open for boat launch (day use only); no equipment staged at site.

9.5.12 E3

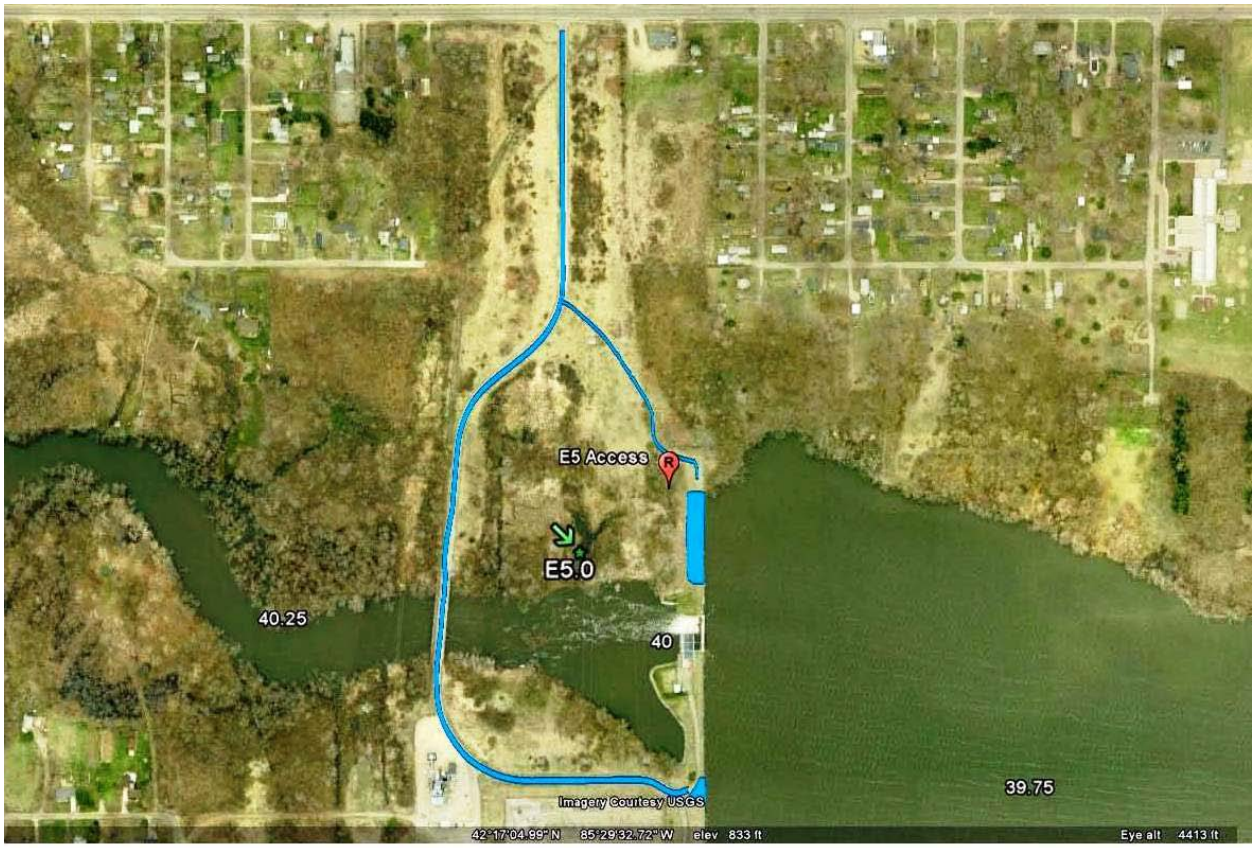
E3 may be reactivated, if necessary, for boom maintenance and O&M activities.

9.5.13 E4

E4 will remain open for boom maintenance and O&M activities.

9.5.14 E5

E5 will remain open for boom maintenance.



Approved

Enbridge Line 6B MP 608 Pipeline Release
Marshall, Michigan

Supplement to Operations and Maintenance Work Plan
Commonly Referred to as the
2011 Downstream Contingency Plan

Prepared for United States Environmental Protection Agency

Enbridge Energy, Limited Partnership

Originally Submitted: June 14, 2011

Resubmitted: August 6, 2011

Approved: August 11, 2011

Approved

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FIGURES

Figure 1 Overall Staging Areas and Boat Launch Location

Figure 2 Control Points

ATTACHMENTS

Attachment A Photo Plates

Attachment B Organizational Chart

Attachment C Contingency Plan Contact List

Approved

LIST OF ACRONYMS

Contingency Plan	2011 Downstream Contingency Plan
DRO	Diesel range organics
EMD	Michigan Emergency Management Division
Enbridge	Enbridge Energy, Limited Partnership
FOSC	Federal On-Scene Coordinator
GRO	Gasoline range organics
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MP	Mile Post
NRC	National Response Center
O&M	Operations and Maintenance
ORO	Oil range organics
PEAS	Pollution Emergency Alert System
PNAs	Polynuclear aromatic hydrocarbons
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
TPH	Total petroleum hydrocarbons
U.S. EPA	United States Environmental Protection Agency
U.S. EPA Order	U.S. EPA Removal Administrative Order Under Section 311(c) of the Clean Water Act, issued on July 27, 2010 to Enbridge Energy Partners, L.P., Docket Number: CWA 1321-5-10-001
VOCs	Volatile organic compounds
WTTD	Waste Treatment, Transportation and Disposal Plan

Approved

1.0 OBJECTIVES

This work plan commonly referred as the *2011 Down Stream Contingency Plan* (Contingency Plan) will document the actions to be implemented in the event of a product (defined as oil and/or oil sheen that affects navigable water ways and/or poses a threat of release of a visible oil or sheen discharge to navigable waterways) past the Morrow Lake Dam. The objectives of this Contingency Plan are:

- To ensure the safety of response personnel and the public,
- Eliminate impact to downstream receptors,
- Facilitate product recovery, and
- Protect critical areas from additional impact.

In order to meet the objectives, the implementation of the following control measures will be required:

- Control point booming,
- Site monitoring, and/or
- Product recovery, which includes:
    - Mechanical recovery, and/or
    - Manual recovery.

2.0 PLAN ACTIVATION CRITERIA

This work plan will be implemented in the event that any oil or oil sheen is detected downstream of the boom located at Morrow Lake Dam or upstream activities warrant additional downstream containment. The level of activation will depend on the situation and be based on product volume, weather conditions, and environmental concerns. Depending on the county (Kalamazoo or Allegan) within which oil/sheens are observed, the respective Emergency Management Department will be notified. Each county coordinates response and recovery activities to natural and human-made disasters within its jurisdiction. The Michigan Emergency Management Division (EMD) is the lead agency for responding to all hazard emergency and disaster incidents. The EMD is responsible for maintaining and implementing the Michigan Emergency Management Plan. The 24-hour Pollution Emergency Alert System (PEAS) can be

reached at (800) 292 – 4706 (within Michigan). The National Response Center (NRC) is the sole notification mechanism for oil spills and other incidents involving hazardous materials at the federal level. All spills of hazardous materials above reportable quantities must be reported to the NRC at (800) 424 - 8802.

If warranted by the level of activation, appropriate emergency response agencies may be contacted at the following numbers:

- Kalamazoo County Office of Emergency Management (269) 383 - 8743
- Allegan County Emergency Management (269) 673 - 0571
- Michigan Pollution Emergency Alert System (800) 292 - 4706
- National Response Center (800) 424 - 8802
- United States Coast Guard Great Lakes Search and Rescue (800) 321 - 4400
- Enbridge Call Center Hotline (800) 306 - 6837

A comprehensive organization chart that identifies specific points of contacts (including Enbridge personnel, Incident Command System personnel, and local cooperating agency personnel) has been included as attachment B. A verified and updated contact list for West of Morrow Lake has been included as attachment C.

3.0 IMPLEMENTATION

The following techniques and strategies will be implemented in the Contingency Plan. The location of staging areas will be selected based on proximity to observed impacts and subject to landowner approval. Immediate impacts will be addressed from areas such as parks and public access. Boat launches in public areas (MDNR, 1996) will be used to access the Kalamazoo River, located downstream of Morrow Dam.

3.1 Control Point Booming

Control point booming is the use of a containment boom to prevent the downstream migration of surface product. The control point booming will facilitate the recovery of migrating surface product. There are several booming strategies *(Attachment A*) that will be used as part of the control point booming activities, which include:

- Shore to Shore Booming (Photo Plate 1): In this strategy, a single span of boom is deployed to cover the entire width of the river. The upstream end of the boom is secured to an anchor point on the upstream bank. Hand lines or in stream anchors are used to maneuver the boom at the appropriate angle (dependent on current velocity) down to a recovery area. A small section of boom is then deployed along the downstream shoreline to prevent impact to the river bank (shoreline protection).
- Gate Booming (also referred to as "Open Chevron") (Photo Plate 2): In this strategy, two segments are deployed across the width of the river to allow for vessel traffic up and down the river. The upstream ends of both booms are secured in an overlapping position using in stream anchors. Hand lines or in stream anchors are used to hold the boom at the appropriate angle (dependent on current velocity) down to a recovery area. A small section of boom is then deployed along the downstream shoreline to prevent impact to the river bank (shoreline protection).
- Cascade Booming (Photo Plate 3): The cascade booming system is the deployment of multiple booms across the width of the river to allow for vessel traffic up and down the river or to reduce the strain that the current places on individual spans of boom. The upstream boom is secured to the shore at its upstream point. Using hand lines or in stream anchors the boom is deployed at an appropriate angle (dependent on current velocity) to a point in the river where it is secured with an in stream anchor. Each additional segment is then placed downstream in an overlapping position and secured with in stream anchors. The last span of boom is secured on its downstream end to the shore. A small section of boom is then deployed along the downstream shoreline to prevent impact to the river bank (shoreline protection).
- Chevron Booming (Photo Plate 4): The Chevron booming system consists of a single span of boom that is deployed to deflect product around a sensitive area or to recovery points on both banks. The center of the boom is secured in the middle of the channel using an in stream anchor. Hand lines or in stream anchors are used to secure both of the downstream booms at appropriate angles (dependent on current velocity) down to recovery areas. Small sections of boom are then deployed along the downstream shoreline to prevent impact to the river bank (shoreline protection).

Product collected by control point booming will be recovered using either hand skimming or by mechanical skimming devices if volumes warrant the use of mechanical equipment.

Control point booming location sites will be selected based on the following criteria:

- River characteristics (currents speed, depth, width, and bottom material),
- Site access (ease of product recovery and maintenance),
- Suitable anchor points,
- Distance to upstream control points,
- Distance to upstream sources of impact (identified impacted depositional areas and impacted overbank areas), and
- Access control to prevent impact to the public.

Currently five control points have been identified as likely locations for the installation of surface containment (*Figures 1 and 2*). This number is dependent on information gathered during inspection and monitoring activities and may vary. The identified control points are located at:

- MP 40.0 Consumers Power Drive (42º16'57.48" N by 85º29'45.85" W),
- MP 40.75 Vacant Lot East of 6228 Proctor Street (42º17'04.16" N by 85º30'21.18" W),
- MP 41.75 Lamplighter 5301 Comstock Avenue (42º17'08.33" N by 85º31'30.53" W),
- MP 44.00 Sutherland Park (42º17'29.24" N by 85º33'40.23" W), and
- MP 46.25 River View Road and River View Service Road (42º18'45.65" N by 85º34'18.90" W).

Subsurface containment may also be installed based on the monitoring and assessment activities. The locations of these sites will be based on the observations made by the monitoring team as well as the locations of any identified subsurface concerns. *Table 1* contains details of Control Point booming procedures.

Table 1. Containment Booming Procedures

Control Point	Mile Post	Containment Boom Length (ft)	Containment Boom Size	Containment Boom Upstream End	Containment Boom Downstream End
Consumers Power Drive*	40	1,250	6-inch by 6-inch	Anchored under the bridge at Consumers power Drive on the north bank	Anchored prior to the bend on the river on the south bank
Vacant Lot East of 6228 Proctor Street*	40.75	1,250	6-inch by 6-inch	Anchored on the south bank approximately 1,100 feet upstream of the vacant lot	Anchored to the north shoreline at the vacant lot
Lamplighter 5301 Comstock Avenue*	41.75	850	6-inch by 6-inch	Anchored on the north bank approximately 725 feet upstream of the mainland lawn	Anchored to the south shoreline at the downstream end of the maintained lawn
Sutherland Park*	44.00	1,100	6-inch by 6-inch	Anchored on the north bank approximately 1,050 feet upstream of the trail access.	Anchored to the south shoreline at the shoreline access
River View Road and River View Service Road*	46.25	1,000	6-inch by 6-inch	Anchored on the west bank approximately 950 feet upstream	Anchored to the east shoreline

* A 50-foot length of 6-inch by 6-inch containment boom will be run upstream along the shoreline from the downstream end of the control point to prevent impact to the shoreline.

Note: The site previously identified as Merrill Park (located at the corner of River Street and Comstock Avenue) was not selected as a control point due to the contour of the river in that area. This location was not selected because a majority of the river flow occurs along the south side of the channel, causing an ineffective and difficult collection point at the downstream end of the boom.

3.2 Monitoring

Site monitoring will be completed during the response activities, utilizing Air Operations, Vessels (Airboats and/or Jet Boats) as well as land based observation. During the monitoring, crews will observe river characteristics including water levels and temperatures, debris movement (including vegetation/debris dislodged during spring runoff and accumulated organic matter), visual checking for the presence of surface hydrocarbon (oil/sheen), and measurement of sediment temperature. The information collected during these activities will become a driver for

the implementation of this work plan determining the priority sequence and timing of containment deployment.

In addition to the monitoring activities identified above, oil and water quality samples will be collected from identified locations downstream of Morrow Lake for laboratory analysis. Field work will be conducted in accordance with the *Sampling and Analysis Plan (SAP)* and the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2010a and 2010b), as appropriate. The data will be used to evaluate potential environmental impacts and to identify the possible source of the oil/sheen. Depending on the size of the sheen, a representative number of oil and water quality samples will be collected and analyzed for the following crude oil-related parameters:

- Volatile organic compounds (VOCs),
- Polynuclear aromatic hydrocarbons (PNAs)
- Four metals (beryllium, vanadium, nickel, and molybdenum),
- Total petroleum hydrocarbons (TPH) measured as;
    - Gasoline range organics (GRO),
    - Diesel range organics (DRO), and
    - Oil range organics (ORO).

Sample handling procedures, holding times and sample preservation methods will follow the *SAP* and *QAPP* (Enbridge, 2010a and 2010b) that were prepared for the Michigan Department of Environmental Quality (MDEQ).

During the implementation of river monitoring activities, air monitoring and sampling activities will be performed in accordance with the current 2011 *Air Monitoring and Sampling Plan* (Enbridge, 2011a). The data will be evaluated to identify any adverse impacts to air quality so that appropriate response actions may be taken. Air monitoring will consist of real-time monitoring using a MultiRAE and UltraRAE or gastech pump to obtain readings for VOCs, benzene, sulfur dioxide (SO_2), and hydrogen sulfide (H_2S). Readings will be collected along the work site perimeter and in surrounding communities. Air sampling will consist of placing 12-hour duration sample canisters at several work perimeter locations. The number of samples at each location may vary, with at least one upwind and two downwind sample locations per work site. The canisters will be sent to an analytical laboratory for VOC analysis using method TO-15.

3.3 Product Recovery

Product recovery involves the removal of product from the water. Several recovery methods are listed below but not limited to:

- Hand Skimming: Hand skimming is the removal of product by physical labor. Personnel utilize hand tools such as dip nets, strainers, and pitchforks to lift the product and debris out of recovery areas and place it into a container for disposal.
- Rotary Skimming: Rotary skimming is the removal of product by a mechanical rotary skimmer. There are several types of rotary skimmers including drum, mop skimmers and brush skimmers. All rotary skimmers work by rotating a surface with oil adhering qualities through the product. The product is then mechanically removed from the surface and collected into a container for disposal.
- Vacuum Truck: This method employs a vacuum unit to recover free product or impacted sediment out of a containment area.

3.4 Debris

Debris collected at control points will be sampled and disposed of in accordance with the current approved *Waste Treatment, Transportation, and Disposal Plan* (WTTD) dated May 20, 2011 (Enbridge 2011b).

4.0 SPECIAL CONSIDERATIONS

Special safety considerations will be given to protection of personnel and the public.

- The safety of personnel working in, around, and on the water will involve:
    - Boat traffic will be kept to a minimum to reduce the risk to workers,
    - Marker buoys will be deployed upstream and downstream of all mid stream deployments,
    - Boats working in the vicinity of containment will do so under a no wake restriction with the exception of crossing the boom. Boom crossing will be done on step at the top end of the boom in the channel marked by marker buoys, and
    - Personnel will follow the applicable sections of the Site *Health and Safety Plan* (Enbridge, 2011c).

- The safety of the public will involve:
    - All sites that are accessible to the public will be clearly marked with signage warning of the dangers associated with the Site,
    - Public access will be limited during operations, and
    - Security personnel will be provided, as necessary or requested.

An adaptive management approach will be used in conjunction with the *2011 Downstream Contingency Plan*. This management strategy will allow for modifications to the approved plan to be made as warranted by field conditions. Changes made to the 2011 Downstream Contingency Plan will be communicated to the Federal On-Scene Coordinator (FOSC). Containment installation will be completed as required, therefore and approval may not be obtained prior to deployment. Verbal approval (with written follow up) will be obtained for any containment removal.

5.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; 2011 Air Monitoring and Sampling Addendum to the Sampling and Analysis Plan; June 21, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Waste Treatment, Transportation and Disposal (WTTD) Plan, May 20, 2011.

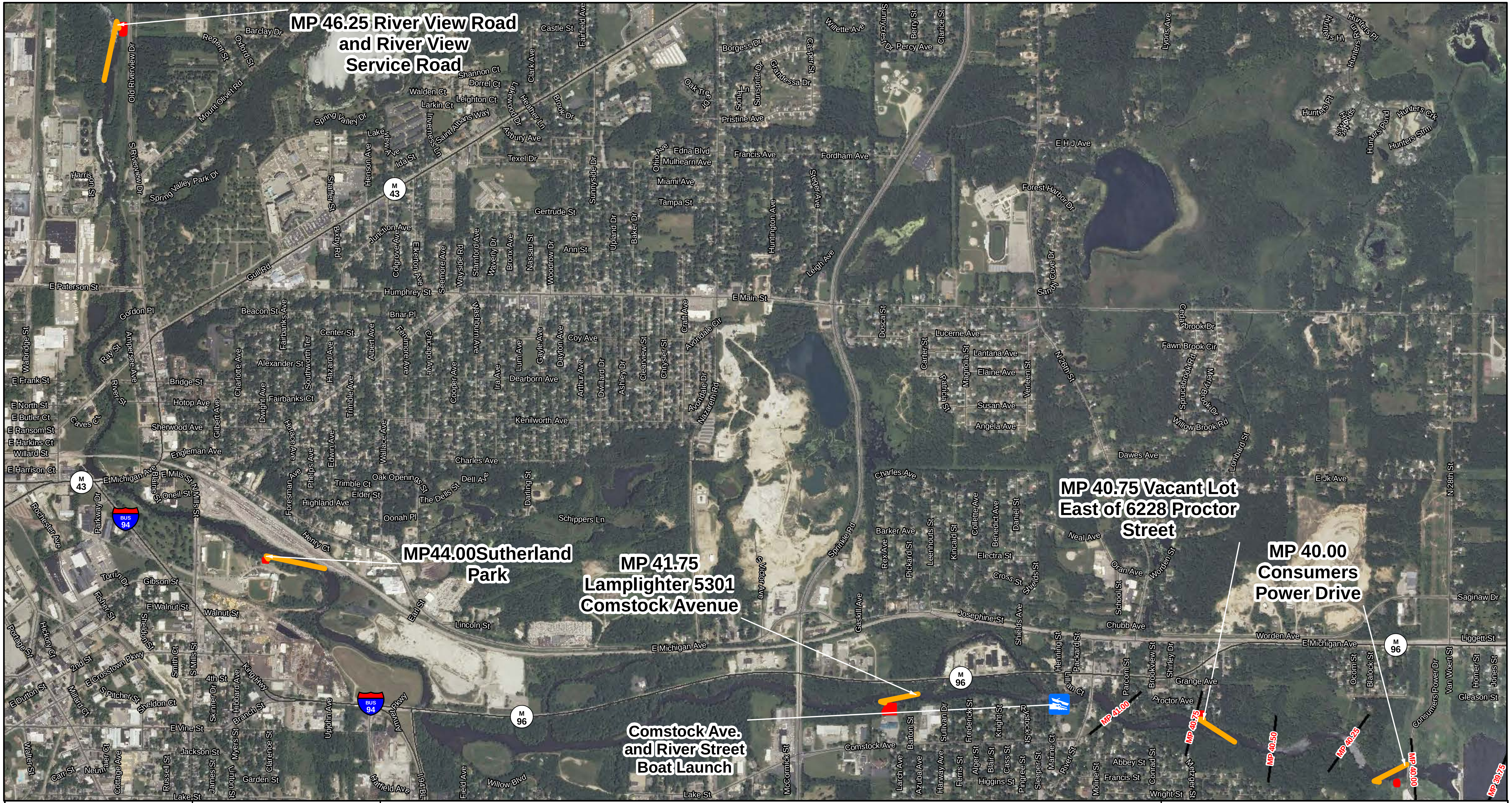
Enbridge, 2011c. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan; June, 2011.

Enbridge, 2010a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP), November 11, 2010.

Enbridge, 2010b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP), November 11, 2010.

MDNR, 1996. Michigan Public Boat Launch Directory, Michigan Department of Natural Resources, Parks and Recreation Division.

Figures



ENBRIDGE

Drawn:	DH	8/05/2011
Approved:	DP	8/05/2011
Project #:		60162778

Map Location

Quarter Mile Grid Segments
Proposed Boom
Staging Areas
Boat Launch

N

0 1,000 2,000
Feet

FIGURE 1
OVERALL STAGING AREAS AND
BOAT LAUNCH LOCATION

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Z:\Work\GIS\SWAT_Mapseries\MXDs\110805_SWAT_Overall_Staging_Areas.mxd

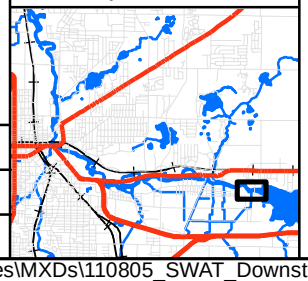
Aerial Photography Date: August 2010

Required Equipment: 1250' of 6" x 6" Containment Boom, 4000' of 1/2" or greater rope, 10 drive pins, 2 work boats, capstan winch.
Small Jon boats may be launched by hand at each site.

ENBRIDGE

Drawn:	JP	08/05/2011
Approved:	DP	08/05/2011
Project #:	60162778	

Map Location



Proposed Boom
Quarter Mile Grid Segment
Staging Area

N

0 150 300
Feet
1:3,600

FIGURE 2
CONTROL POINTS
MP 40.00 Consumers Power Drive

Sheet 1 of 5
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY,
LIMITED PARTNERSHIP

Z:\Work\GIS\SWAT_Mapseries\MXDs\110805_SWAT_Downstream_Contingency_Plan.mxd

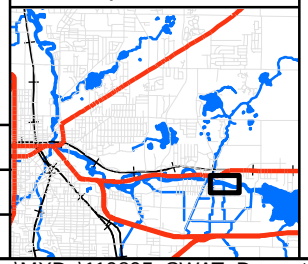
Aerial Photography Date: April 2011 over 2010 County Aerial

Required Equipment: 1250' of 6" x 6" Containment Boom, 4000' of 1/2" or greater rope, 10 drive pins, 2 work boats, capstan winch. Small Jon boats may be launched by hand at each site.

ENBRIDGE

Drawn:	JP	08/05/2011
Approved:	DP	08/05/2011
Project #:	60162778	

Map Location



Proposed Boom
Quarter Mile Grid Segment
Staging Area

N

0 150 300
Feet
1:3,600

FIGURE 2
CONTROL POINTS
MP 40.75 Vacant Lot East
of 6228 Proctor Street
Sheet 2 of 5
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY,
LIMITED PARTNERSHIP

Z:\Work\GIS\SWAT_Mapseries\MXDs\110805_SWAT_Downstream_Contingency_Plan.mxd

Aerial Photography Date: April 2011 over 2010 County Aerial

Required Equipment: 850' of 6" x 6" Containment Boom, 3000' of 1/2" or greater rope, 10 drive pins, 2 work boats, capstan winch.
Small Jon boats may be launched by hand at each site.

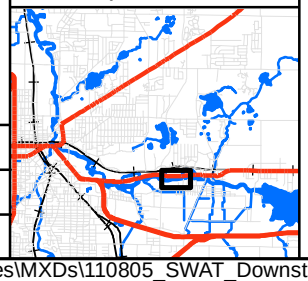
ENBRIDGE

Drawn: JP 08/05/2011

Approved: DP 08/05/2011

Project #: 60162778

Map Location



Proposed Boom

Quarter Mile Grid Segment

Staging Area

N

0 150 300

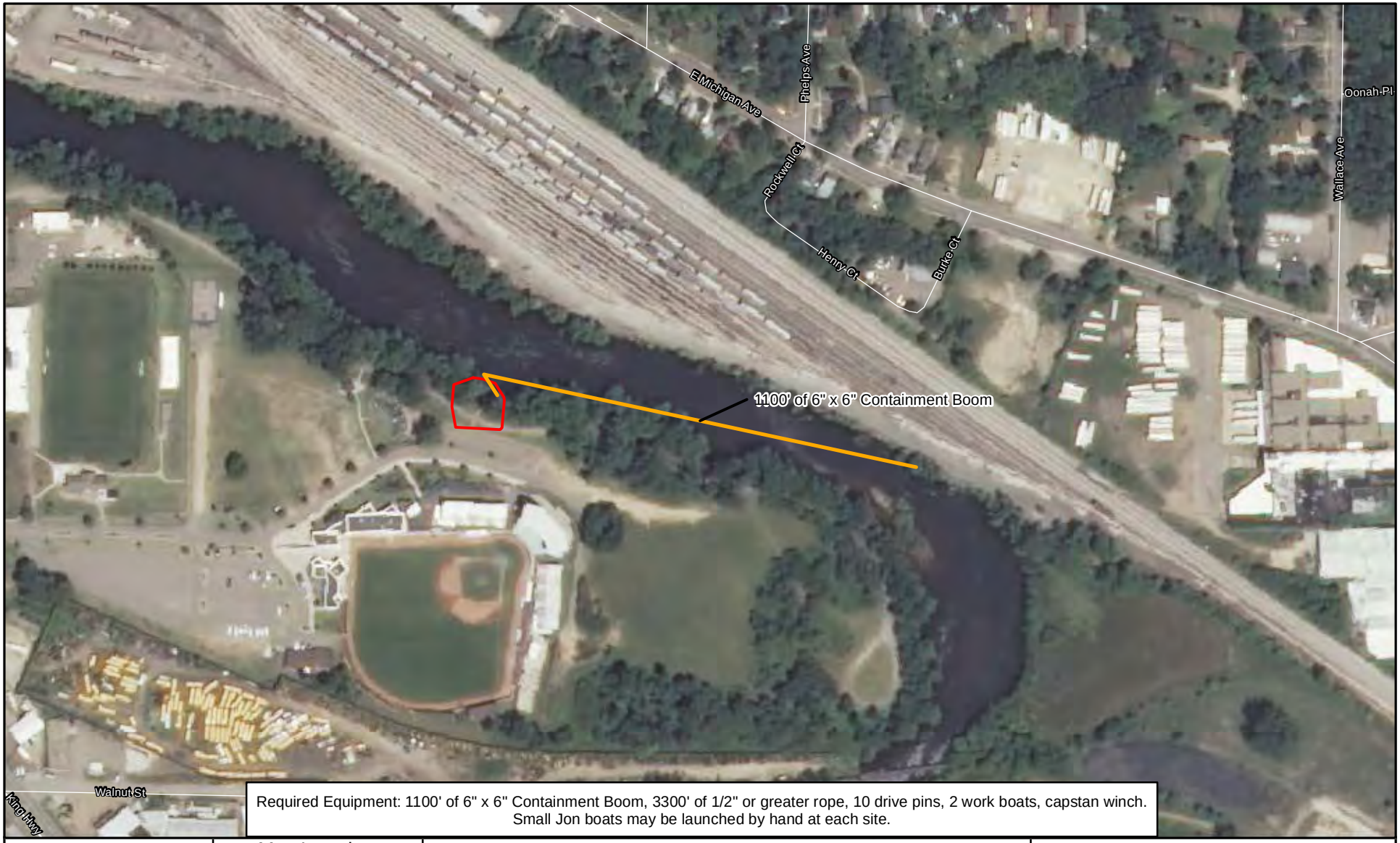
Feet

1:3,600

FIGURE 2
CONTROL POINTS
MP 41.75 Lamplighter 5301
Comstock Avenue
Sheet 3 of 5
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY,
LIMITED PARTNERSHIP

Z:\Work\GIS\SWAT_Mapseries\MXDs\110805_SWAT_Downstream_Contingency_Plan.mxd

Aerial Photography Date: April 2011 over 2010 County Aerial

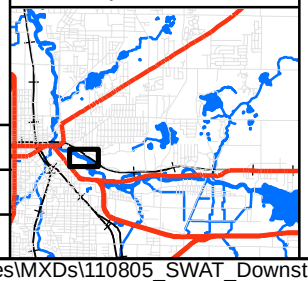


Required Equipment: 1100' of 6" x 6" Containment Boom, 3300' of 1/2" or greater rope, 10 drive pins, 2 work boats, capstan winch. Small Jon boats may be launched by hand at each site.

ENBRIDGE

Drawn:	JP	08/05/2011
Approved:	DP	08/05/2011
Project #:	60162778	

Map Location



Proposed Boom
Quarter Mile Grid Segment
Staging Area

N

0 150 300
Feet
1:3,600

FIGURE 2
CONTROL POINTS
MP 44.00 Sutherland Park

Sheet 4 of 5
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY,
LIMITED PARTNERSHIP

Z:\Work\GIS\SWAT_Mapseries\MXDs\110805_SWAT_Downstream_Contingency_Plan.mxd

Aerial Photography Date: April 2011 over 2010 County Aerial

Required Equipment: 1000' of 6" x 6" Containment Boom, 3000' of 1/2" or greater rope, 10 drive pins, 2 work boats, capstan winch. Small Jon boats may be launched by hand at each site.

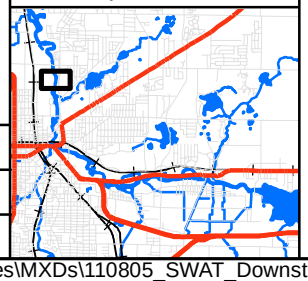
ENBRIDGE

Drawn: JP 08/05/2011

Approved: DP 08/05/2011

Project #: 60162778

Map Location



Proposed Boom

Quarter Mile Grid Segment

Staging Area

N

0 150 300

Feet

1:3,600

FIGURE 2
CONTROL POINTS
MP 46.25 River View Road and
River View Service Rd
Sheet 5 of 5
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY,
LIMITED PARTNERSHIP

Z:\Work\GIS\SWAT_Mapseries\MXDs\110805_SWAT_Downstream_Contingency_Plan.mxd

Aerial Photography Date: April 2011 over 2010 County Aerial

Attachment A

Photo Plates

2011 Downstream Contingency Plan – Photo Plates

Photo Plate 1: Shore to Shore Booming System

Photo Plate 2: Gate Booming System (also referred to “Open Chevron”)

2011 Downstream Contingency Plan – Photo Plates

Photo Plate 3: Cascade Booming System

Photo Plate 6: Protective Booming Around Entire Area

Attachment B

Organizational Chart

Enbridge Pipelines Response Unified Command

INCIDENT COMMANDERS
Ralph Dollhopf (US EPA)
Jeff Kimble (US EPA), Deputy
Mark DuCharme (DEQ)
Mike Alexander (DEQ)
National Response Center (800-424-8802)
Michigan Emergency Management Division (517-332-2521)
Michigan Pollution Emergency Alert Center (800-292-4706)
Lt. Paul Baker(Kalamazoo County)
Scott Corbin (Allegan County)
EJ Suardini (Arcadis)
Gary T. Griffith (Georgia Pacific)
John Sobojinski (Enbridge)
Christopher Haux (Enbridge), Deputy

ON-SITE SAFETY OFFICERS
Ted Blackburn (START/ US EPA)
TJ Waldo (START/ US EPA)
Rick Oleschuk (Enbridge)
Stewart Coates (McDaniel/Enbridge)

PUBLIC INFORMATION OFFICERS
Don DeBlasio (US EPA)
Jason Manshum(Enbridge)

OPERATIONS SECTION
Tricia Edwards (US EPA), Chief
Steve Wolfe (US EPA), Chief
Michelle DeLong (DEQ), Chief
Mark DuCharme (DEQ), Chief
Kim Churchill (Weston/DEQ), Deputy
Christopher Haux (Enbridge), Chief
John Gauderman (Enbridge), Deputy

PLANNING SECTION
Isaac Aboulafia (START/ US EPA), Chief
Mindy Luetke (START/ US EPA), Deputy
Farhan Ismail (BMcD/Enbridge), Chief
Dean Rawson (Enbridge), Deputy
Brad Nelson (Avery/Enbridge), Deputy
Amy Graham (Avery/Enbridge), Deputy

LOGISTICS SECTION
Lorie Hong (START/ US EPA), Chief
Charmaine Rosenbaum (Enbridge), Chief

FINANCE SECTION
Ron Motley
(Enbridge), Chief

Attachment C

Contingency Plan Contact List

Attachment C - Contingency Plan Contact List
Kalamazoo and Allegan County Contingency Plan
West of Morrow Dam

Name/Title:	**Ralph Dollhopf/ On-Scene Coordinator**
Company/Agency/Div	EPA Region 5 Superfund Division
Phone	Mobile:[redacted]
Email	dollhopf.ralph@epa.gov
Comment	Plan Coordinator

Name/Title:	**Paul R. Baker/Lieutenant Emergency Management**
Company/Agency/Div	Kalamazoo County Office of Emergency Management
Phone	Mobile: [redacted] Non-Emergency Dispatch Number: 269-383-882, 6
Email	TCSIVA@kalcounty.com
Comment	Planner for Kalamazoo County

Name/Title:	**Scott Corbin/ Director**
Company/Agency/Div	Allegan County Emergency Management
Phone	Mobile: [redacted] Office: 269-673-0566 Central Dispatch Number (Non-Emergency): 269-673-3899
Email	scorbin@allegancounty.org
Comment	Director for Allegan County

Name/Title:	**Bill Bomar, Director**
Company/Agency/Div	Plainwell City Department of Public Safety
Phone	[redacted]
Email	Bbomar@plainwell.org
Comment	Contact for Questions, assistance for Plainwell City, MI

Name/Title:	**EJ Suardini/ Project Manager**
Company/Agency/Div	Arcadis
Phone	[redacted]
Email	
Comment	Project Manager for Plainwell Dam Cleanup Project

Name/Title:	**Gary T. Griffith, PD/ Dir. Environmental Field Services**
Company/Agency/Div	Georgia Pacific
Phone	[redacted]
Email	gtgriffi@gapac.com
Comment	Contact for Georgia Pacific Sites along Kalamazoo River

Enbridge Energy, Limited Partnership
1601 Pratt Avenue
Marshall, Michigan 49068

December 21, 2011

Mr. Ralph Dollhopf
Federal On-Scene Coordinator and Incident Commander
U.S. Environmental Protection Agency
801 Garfield Avenue, #229
Traverse City, MI 49686

Re: In the Matter of Enbridge Energy Partners, L.P., *et al*,
Docket No. CWA 1321-5-10-001

Dear Mr. Dollhopf:

The United States Environmental Protection Agency (U.S. EPA) in a letter dated December 19, 2011, gave Enbridge Energy, Limited Partnership (Enbridge) notice of Approval with Modifications on the Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to Source Area Response Plan, and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan Commonly referred to as "Consolidated Work Plan for Activities through 2012" dated December 4, 2011.

Enclosed, please find the approved Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to Source Area Response Plan, and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan Commonly referred to as "Consolidated Work Plan from Fall 2011 through Fall 2012" dated December 21, 2011 along with a response to comments log for your convenience.

If you have any questions about these materials, please do not hesitate to contact me.

Sincerely,

ENBRIDGE ENERGY, LIMITED PARTNERSHIP
By Enbridge Pipelines (Lakehead) L.L.C.
Its General Partner

Richard Adams
Vice President, U.S.Operations

CC: Joel W. Kanvik, Enbridge
John Sobojinski, Enbridge
Bob Steede, Enbridge
Leon Zupan, Enbridge
Leslie Kirby-Miles, EPA Region 5 [kirby-miles.leslie@epa.gov]
Sonia Vega, EPA Region 5 [vega.sonia@epa.gov]
Enbridge@EPA.gov
Mark DuCharme, MDEQ
Mike Alexander, MDEQ

627250

RESPONSE TO COMMENTS LOG

Re: Approval with Modifications to Enbridge Energy, Limited Partnership's December 4, 2011 Submittal in response to the Administrative Order issued by U.S. EPA on July 27, 2010 and Supplement to the Administrative Order issued by U.S. EPA on September 23, 2010, pursuant to §311(c) of the Clean Water Act (Docket No. CWA 1321-5-10-001)

U.S. EPA is writing you regarding the following document resubmitted by Enbridge Energy, Limited Partnership, Enbridge Pipelines (Lakehead) L.L.C., Enbridge Pipelines (Wisconsin), and Enbridge Energy Partners, L.P. (herein collectively referred to as "Enbridge") on December 4, 2011:

> *Enbridge Line 6B MP 608, Marshall, MI Pipeline Release, Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to the Source Area Response Plan and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan. Commonly referred to as* ***"Consolidated Work Plan for Activities through 2012,"*** *Prepared for United States Environmental Protection Agency, Enbridge Energy, Limited Partnership, Submitted: October 20, 2011, Revised by the United States Environmental Protection Agency November 17. 2011, Revised by Enbridge Energy', Limited Partnership, Submitted: December 4, 2011*

The U.S. EPA approves Enbridge's above-referenced Consolidated Work Plan for Activities through 2012 ("Work Plan") with the modifications described herein. Please provide and incorporate the following elements into the modified Work Plan:

1. The schedule proposed by Enbridge in the Work Plan is not acceptable. Specifically, the dates proposed for completion of the hydrodynamic model are critical. Accordingly, the completion of the hydrodynamic model shall be accelerated. The schedule for tasks related to the hydrodynamic model (corresponding to line items 38 through 48 on the schedule submitted by Enbridge in the Work Plan) shall be as follows:

• Bathymetry and Terrain Submittal	December 16, 2011
• Grid Setup	December 16, 2011
• Configuration for Flow and Velocity	December 30, 2011
• Analysis of Sediment Samples and Cohesion Data	January 13, 2012
• Complete Configuration including Sediment Processes	January 27, 2012
• Model Calibration	February 10, 2012
• Preliminary and Baseline Model Scenarios	February 24, 2012
• Sensitivity Testing	February 24, 2012
• Develop Scenarios/Various Simulations	March 23, 2012
• Completion of Simulation	March 23, 2012
• Run Modified Scenarios	April 6, 2012

The U.S. EPA will continue to work with Enbridge in modifying and updating the project schedule as needed including, but not limited to, establishing interim milestones for U.S. EPA review.

Response: The schedule in Section 4.3.8 has been updated to reflect these changes.

2. Section 1.6: Figure 1.6.2 (Science Group Support of the OSCAR Process) is missing. Please add the referenced figure.

   Response: Figure 1.6.2 is included in the printed version and the pdf version.

3. Please ensure proper grammar with the use of "data" in its plural form throughout the text.

   Response: Text has been updated.

4. Please add a list of known Outstanding Sites Characterization and Reconciliation (OSCAR) sites to the revised Work Plan.

   Response: Figure 2.2 List of know OSCAR Sites has been added to Section 2.2.

5. Section 2.2:

   a. Page 6, Second Bullet: Please replace the existing text with "All former overbank excavation areas;".

      Response: Page 6, Second Bullet has been modified as requested.

   b. Page 6, Fourth Bullet: Please split the text into two bullets, one per sentence.

      Response: Page 6, Fourth Bullet has been modified as requested.

   c. Page 6, paragraph following bullets: Please convert the first sentence (which starts with "Submerged oil sites identified...") to a bullet and add it to the bulleted list immediately preceding the paragraph.

      Response: Page 6, paragraph following bullets has been modified as requested.

6. Section 4.3.2, the last paragraph on page 23: Reference is made to 4 stages of the adaptive management cycle, but the bullet list now has 5 items. Please correct and revise.

   Response: Section 4.3.2, the last paragraph has been modified as requested.

7. Section 4.3,4, second to last paragraph on page 29: the referenced "SCS" is defined as a "Scientific Certification System": however, previous drafts of the Work Plan defined "SCS" as a "Survey Control Station", Additionally, Table 4.3.2 refers to a "Survey. Control Station", Please ensure that the definition and usage of the referenced "SCS" are correct.

   Response: Text in Section 4.3.4 has been modified as follows: "Terrain data for areas outside the channel and for sub-aerially exposed parts of the channel may be collected on a different day than hydraulic and bathymetric data are collected for each reach; however, the same Quality Assurance ("QA") procedure for opening and closing observations at a Survey Control Station ("SCS") shall be followed for terrain surveys as for bathymetric surveys."

8. Section 4.3.8, Page 35: Please amend the list of hydrodynamic modeling phases to include sensitivity testing.

   Response: The schedule in Section 4.3.8 has been updated to reflect this change.

9. Attachment A, Figure 1: Include all of the inundated (pink) polygons recorded previously during the Spring 2011 reassessment. The Spring 2011 reassessment showed impacts to the two ponds at the Shady Bend Campground and these ponds should be added to the list of reassessment targets.

   Response: Attachment A, Figure 1 has been updated to include the two ponds at the Shady Bend Campground.

10. Attachment B, Figure 1: The Spring 2012 reassessment poling locations need to be expanded. A total of 439 moderate/heavy poling points fall outside the polygons identified in resubmittal of the Work Plan. In some cases, the distance from the point in question to the nearest polygon line is very small (1 to 5 ft); in many other cases there is no polygon line in the near vicinity (>100 ft). All points need to be accounted for in the maps in Attachment B, Figure 1.

    Response: Attachment B, Figure 1 has been updated as requested.

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to Source Area Response Plan, and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan

Commonly referred to as
"Consolidated Work Plan from Fall 2011 through Fall 2012"

Prepared for the United States Environmental Protection Agency by
Enbridge Energy, Limited Partnership
Submitted: October 20, 2011

Revised by the United States Environmental Protection Agency
November 17, 2011

Revised by Enbridge Energy, Limited Partnership
Submitted: December 4, 2011

Approved: December 21, 2011

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1.0 Introduction

The ***Consolidated Work Plan from Fall 2011 through Fall 2012*** (―Work Plan") attached herein is an addendum to the following United States Environmental Protection Agency (―U.S. EPA")-approved documents for the Enbridge Line 6B MP 608 oil spill (―Incident") which occurred near Marshall, Michigan on July 26, 2010:

- *Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter);*
- *Supplement to Source Area Response Plan; and*
- *Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan.*

1.1 Background

This Work Plan was prepared in response to the U.S. EPA's letter (October 6, 2011) to Enbridge Energy, Limited Partnership, Enbridge Pipelines (Lakehead) LLC, Enbridge Pipelines (Wisconsin), and Enbridge Energy Partners, L.P. (―Enbridge") requiring modifications to work plans for oil recovery activities to be conducted by Enbridge from Fall 2011 through Fall 2012. The October 6, 2011 U.S. EPA letter requires Enbridge to provide a work plan for continued activities to perform oil assessment, containment, and recovery activities pursuant to the Removal Administrative Order issued by the U.S. EPA on July 27, 2010 and a Supplement to Order issued by the U.S. EPA on September 23, 2010 (―U.S. EPA Order").

1.2 Regulatory Framework

As required by the U.S. EPA Order, all oil assessment, containment, and recovery activities shall be performed in accordance with Section 311(c) of the Clean Water Act, 33 U.S.C. § 1321(c), as amended by the Oi1 Pollution Act of 1990, and 33 U.S.C. § 2701 et seq. Paragraph 18 of the Removal Administrative Order and Paragraph 6 of the Supplement require, among other things, that Enbridge perform the following actions in response to the Enbridge Line 6B Incident:

1. Assess all oil-impacted areas and media;
2. Contain all oil;
3. Remediate/recover all submerged oil;
4. Recover all oil sheen;
5. Remediate all oil-containing soils;
6. Remediate all oil-containing sediments; and
7. Perform operations and maintenance activities directed by the U.S. EPA.

In addition to the regulations cited above, oil assessment, containment, and recovery activities shall be performed in accordance with all federal, state, and local regulations. Undertaking activities directed by the U.S. EPA does not obviate the need for Enbridge to acquire all necessary permits and comply with other applicable regulatory requirements.

1.3 Purpose and Objective

This Work Plan requires activities designed to improve the understanding of submerged oil transport, containment of oil, and recovery of oil-containing soil/sediment related to the Enbridge Line 6B Incident. Activities and tasks described herein shall be performed from Fall 2011 through Fall 2012.

This Work Plan applies to all affected oil-impacted overbank areas (the areas along the banks and floodplains of the Kalamazoo River) and submerged oil located within the Kalamazoo River (including the Morrow Lake Delta and Morrow Lake). Although the U.S. EPA has transitioned primary oversight authority of oil containment and recovery activities in and adjacent to Talmadge Creek to the Michigan Department of Environmental Quality (–MDEQ"), all activities performed by Enbridge in and adjacent to the Talmadge Creek shall also be compliant with the U.S. EPA Order, and is subject to further review by the U.S. EPA.

In order to address the remaining oil, Enbridge shall evaluate and design a broader range of options to address remaining oil than were employed in 2010 and 2011. Once Spring 2012 reassessments of the Kalamazoo River and overbank have been completed, Enbridge, as directed by the U.S. EPA, shall implement site-specific options for each area to address residual oil and sheen. Options include, but are not limited to, the following:

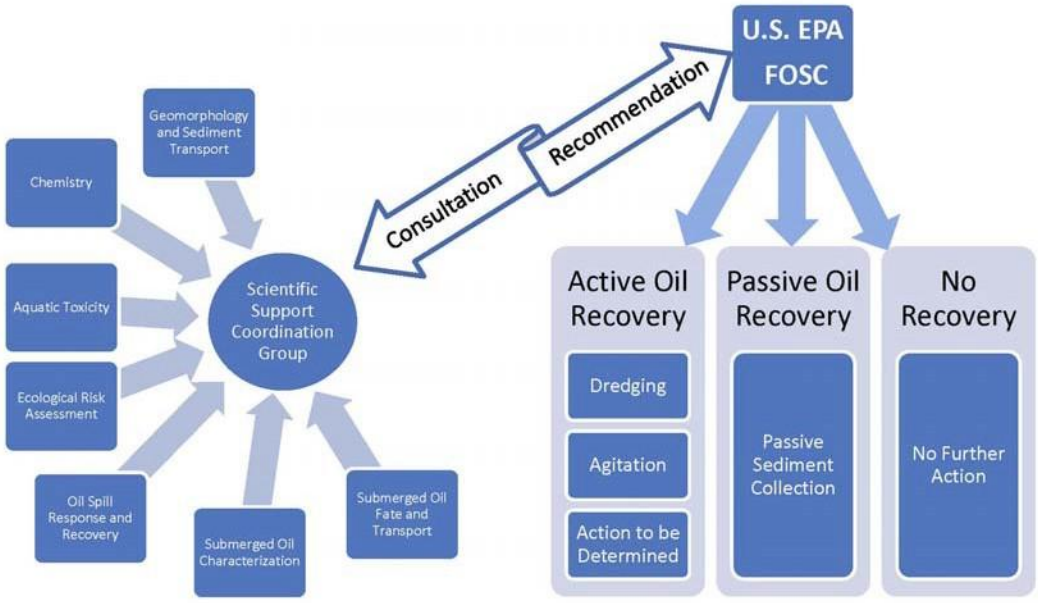
- Dredging of oil-containing sediments;
- Excavation of overbank areas;
- Agitation of sediments coupled with oil/sheen collection;
- Installation of passive sediment collection devices/structures; and/or
- No further action.

1.4 Environmental Protection

As stated above, all response activities shall be governed by applicable regulations, and as directed by the U.S. EPA in the role of Federal On-Scene Coordinator ("FOSC"). Response actions chosen by the U.S. EPA will continue to consider ecological benefits and consequences of recovery activities, engineering feasibility factors, and other scientific factors. Many ecological or scientific consideration incorporated by the U.S. EPA in its directives will be guided by advice from entities commissioned by the U.S. EPA FOSC. These entities are established as the U.S. EPA Scientific Support Coordination Group ("SSC Group") for the Enbridge Line 6B incident.

All active oil recovery shall include an evaluation of ecological considerations, as well as an evaluation of the potential benefits and consequences of oil recovery, or the lack thereof. Although Enbridge may recommend actions, the decision of adverse ecological risk will be made solely by the U.S. EPA FOSC who will consult with the SSC Group. The supporting role of the SSC Group is demonstrated in Figure 1.4.

Figure 1.4 Scientific Support Coordination Group



1.5 Adaptive Management

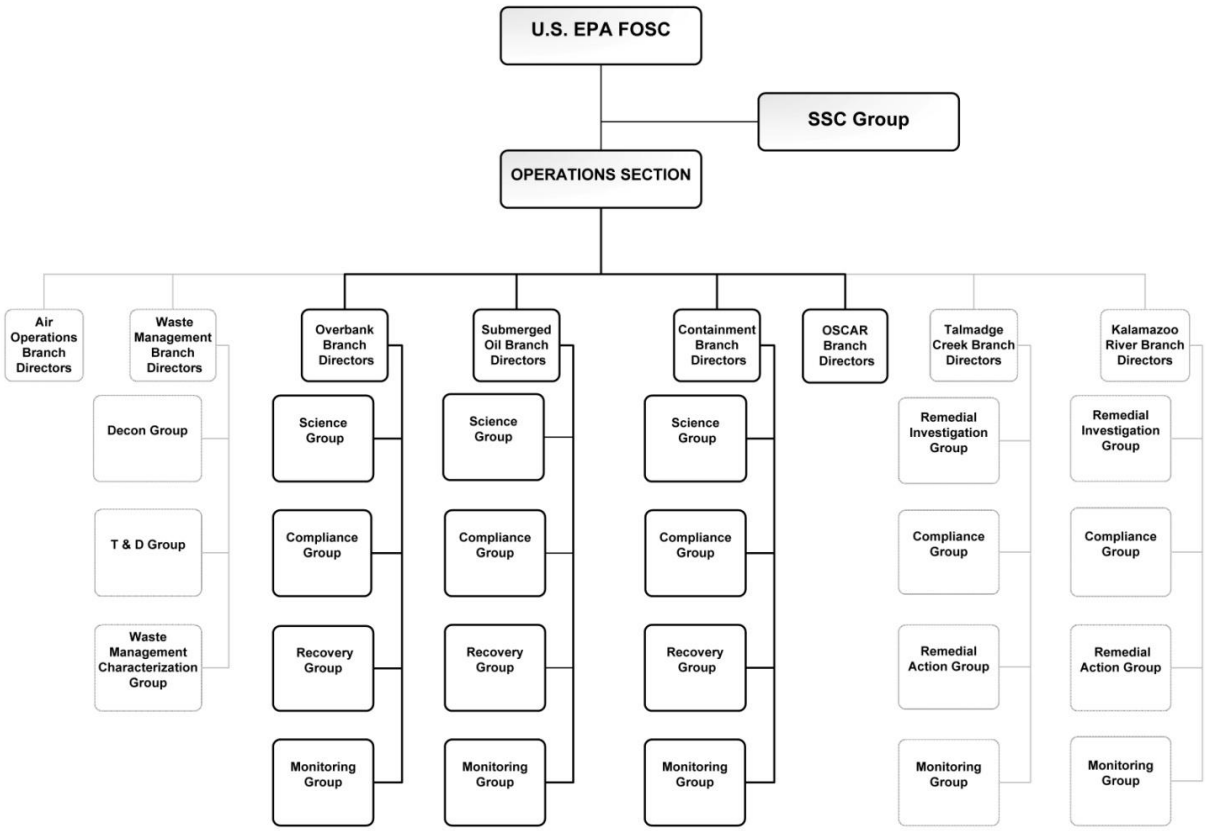
Many of the activities described in this Work Plan are investigative in nature and are designed to provide scientific information that can be used to further refine assessment, containment, and/or oil recovery activities. Therefore, future findings of assessment and investigative activities may affect the viability and/or effectiveness of activities described herein. Findings of investigative activities shall be evaluated and considered in an iterative fashion when determining tactics and strategies to accomplish the overall objectives of the work. However, any changes to the activities

described must be approved by the U.S. EPA prior to changing this Work Plan and/or implementation of activities.

1.6 Organizational Structure

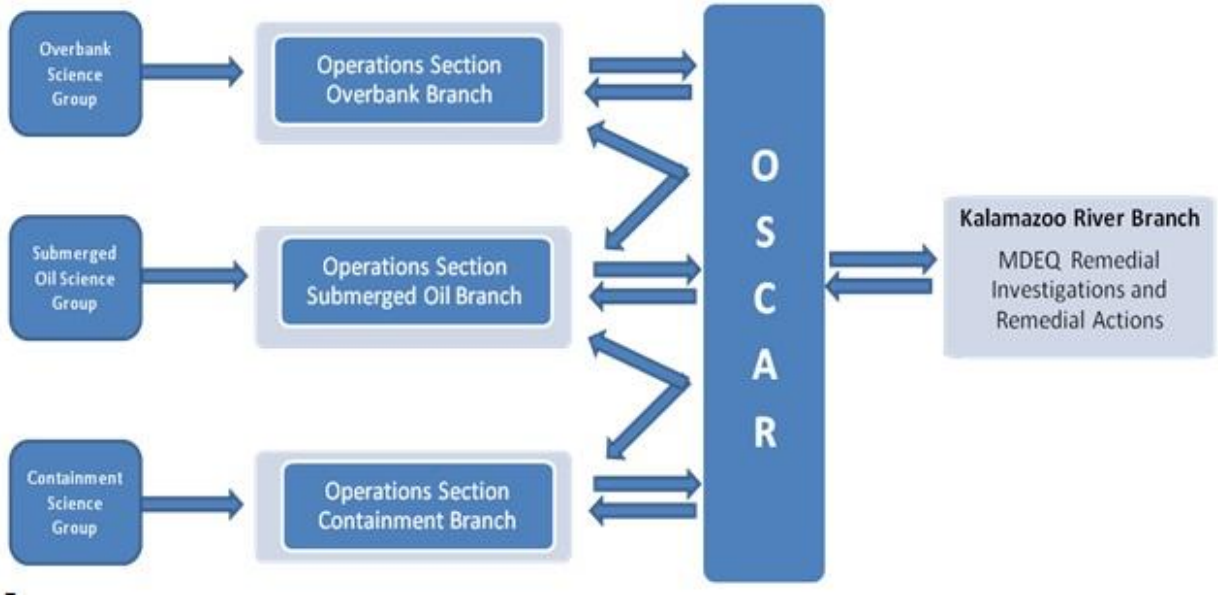
An organizational structure has been established in conjunction with the U.S. EPA to optimize implementation of this Work Plan. The organizational structure has been adopted into the Incident Action Plan and has been used to coordinate, guide, and evaluate reassessment, scientific studies and oil recovery activities while providing a critical communication tool. The organizational structure is dynamically designed to be refined and modified to adapt to changing project conditions, clean up progress, and shifting command emphasis.

Figure 1.6.1 Organizational Structure



Critical components of the organizational structure are the science groups, branch directors, the Outstanding Sites Characterization and Reconciliation (~~O~~SCAR") Branch and FOSC. As depicted in the figure below, the science groups contained within the branches advise the branch directors based on an evaluation of information that is compiled and evaluated. The branch directors present their evaluation and recommendations to the OSCAR Branch. The OSCAR Branch evaluates the data and determines if further action is necessary for each site under the U.S. EPA Order or if site transition to the MDEQ is appropriate. Further detail about the OSCAR Branch is provided in Section 2.0.

Figure 1.6.2 Science Group Support of the OSCAR Process



2.0 OUTSTANDING SITES CHARACTERIZATION AND RECONCILIATION

The U.S. EPA established the OSCAR process during 2011 reassessment and recovery activities. The OSCAR process shall continue during 2012 with the objective to compile a single list of impacted and unresolved sites along the Kalamazoo River, and Morrow Lake. The OSCAR Branch shall be comprised of Enbridge, the U.S. EPA, and MDEQ.

2.1 Objectives

The OSCAR Branch will determine a course of action for each site until no further action is required under the U.S. EPA Order.

2.2 Methods and Procedures

To reach this goal, qualitative assessments will be conducted by the respective operations branch at each unresolved site to characterize the nature and extent of remaining oil impact. A vegetative assessment at each site will be conducted concurrently with the qualitative assessment to determine if the location meets the MDEQ criteria for wetland areas of potential high value criteria. Once the assessment is complete for a given site, the respective operations branch shall evaluate the current and historical data, and present the information to the OSCAR Branch. Based on the information presented, the OSCAR Branch will determine if recovery or assessment actions should be implemented next at that site.

The OSCAR Branch evaluates information associated with the following general reassessment sites:

- Overbank pond and back-water areas identified as ―Strike" sites during 2011 SORT reassessment and recovery activities;
- All former overbank excavation areas;
- Un-reconciled O&M sites that have not been determined to have had response action completed consistent with the U.S. EPA Order;
- 2011 Late Summer Reassessment (―LSR") poling delineated areas, LSR data gaps, and other sites identified by the Shoreline Overbank Science Group (―SOSG");
- New sites including shoreline and overbank areas and other locations identified via monitoring, aerial over-flights, or other means;
- Impacted overbank areas identified during 2012 SORT reassessments; and
- Submerged oil sites identified during the 2012 submerged oil reassessment.

The OSCAR Branch shall evaluate all available information for each site, and make a determination as to whether or not response actions have been completed at each site consistent with the U.S. EPA Order and ready for future management under Part 201 of Michigan Act 451 of 1994 as amended (―Part 201"). If the OSCAR Branch determination is that the site no longer needs response under the Order, then the OSCAR Branch will recommend that the site be transitioned to the MDEQ. If the site is determined to need further response work pursuant to the Order, the OSCAR Branch will make a recommendation to the appropriate operations branch to

complete all work necessary at the site. These recommendations may include, but are not limited to, one of the following:

- Additional qualitative assessment activities;
- Additional recovery operations using approved methods;
- Transfer of the site to the appropriate branch;
- Initiation of an expedited Remedial Investigation (RI) pursuant to MDEQ Part 201;
- Permitted recovery operations under the U.S. EPA Order; and/or
- No further action.

If response work is required, a site specific work plan shall be submitted to the U.S. EPA that outlines the specific actions that shall be taken to ensure that the site no longer needs response pursuant to the Order. Upon completion of any response work, the OSCAR Branch will re-evaluate each site consistent with the OSCAR process. The OSCAR process will be continued as needed until all sites are transitioned to the MDEQ. A list of known OSCAR sites, current to the printing of this Work Plan, is demonstrated in Figure 2.2.

Figure 2.2 List of known OSCAR Sites

Outstanding Site Characterization and Reconciliation (O.S.C.A.R.)

MP	Site ID	Status
0.75	Talmadge Creek Culverts	
2.25	CB 2.00	
2.25	CB 2.07	
4.25	SO 4.15 South AA	
4.25	SO 4.15 South AC	
4.25	SO 4.25 Center	
4.50	SO 4.3 South B	
4.50	SO 4.40T AA	
4.50	SO 4.40T AB	
4.50	SO 4.40T B	
4.75	SO 4.6 Center	
4.75	SO 4.6 South	
4.75	SO 4.7 South	
5.00	SO 4.8 South	
5.00	SO 4.8 North A	
5.00	SO 4.8 North B	
5.00	SO 4.8 Center	
5.00	SO 4.9 South A	
5.00	SO 4.9 South B	
5.00	SO 4.9 South C	
5.00	SO 4.9 South D	
5.25	SO 5.25 North A	
5.25	SO 5.25 North C	
5.75	SO 5.55 North/5.35 North A	
5.75	SO 5.55 North/5.35 North B	
5.75	SO 5.55 North/5.35 North C	
5.75	SO 5.55 North/5.35 North D	
5.75	SO 5.55 North/5.35 North E	
5.75	SO 5.55 North	
5.75	SO 5.63 South	
5.75	SO 5.75 Northwest	
5.75	SO 5.75 South A	
5.75	SO 5.75 South B	
5.75	SO 5.75 Center	
6.00	SO 5.9 North	
6.00	SO Main St. Bridge SW	
6.00	SO 5.9 South A	
6.00	OB 5.92 RDB	
6.25	SO 6.25 R1	
6.50	SO 6.41T	
6.50	SO 6.45 North A	
6.75	SO 6.68T	
7.00	SO 7.0R1 B	
7.00	SO 7.0 South	
8.00	SO 7.75	
8.25	OB 8.22 I	
8.25	SO 8.25 I1 A	
8.25	SO 8.25 I1 B	
8.25	SO 8.25 I2 A	
8.25	SO 8.25 I2 B	

MP	Site ID	Status
8.50	SO 8.43T	
8.50	OB 8.48 LDB	
8.50	SO 8.50	
8.50	SO 8.5 L1	
8.50	SO 8.5 L3	
8.75	SO 8.75 North B	
8.75	SO 8.59	
9.00	OB 8.97 I	
9.00	SO 9.0 I2 A	
9.00	SO 9.0 I2 B	
9.00	SO 9.0 I3	
9.00	SO 9.00	
9.00	OB 9.10 LDB	
9.25	SO 9.25 L1	
9.50	SO 9.45T	
9.50	SO 9.5 I1 A	
9.50	SO 9.5 I1 B	
9.50	SO 9.5 I1 C	
9.75	SO 9.75 South A	
9.75	SO 9.75 South B	
10.00	SO 10.0 Center	
10.25	SO 10.17T	
10.25	SO 10.2 South	
10.25	SO 10.21T	
10.25	SO 10.25 North	
10.50	OB 10.37 RDB	
10.50	SO 10.4 North	
10.50	SO 10.5 North	
10.75	SO 10.65T A	
10.75	SO 10.65T B	
10.75	SO 10.65 North	
10.75	SO 10.75 L2	
11.00	SO 10.8 South	
11.00	SO 10.89T A	
11.00	SO 10.89T B	
11.00	SO 10.89T C	
11.25	SO 11.16T	
11.25	SO 11.21	
11.25	SO 11.25 R1	
11.25	SO 11.25R2 A	
11.25	SO 11.25R2 B	
11.25	SO 11.25R2 C	
11.75	OB 11.79 LDB	
12.50	SO 12.45T	
12.50	SO 12.50	
12.50	OB 12.56 LDB	
12.75	SO 12.75 I1	
13.00	SO 12.91T	
13.00	OB 13.04 RDB	
13.25	SO 13.25 North	

MP	Site ID	Status
13.25	SO 13.25 L1	
13.50	OB 13.40 LDB	
13.50	SO 13.5 L1	
13.75	SO 13.6 South	
14.00	SO 13.85 North	
14.00	SO 13.85 South A	
14.00	SO 13.85 South B	
14.00	SO 13.95 North	
14.00	SO 14.0 I1	
14.25	SO 14.2 South	
14.50	SO 14.35 North A	
14.50	SO 14.35 North B	
14.50	SO 14.35 North C	
14.50	SO 14.40T B	
14.75	SO 14.6 South	
14.75	SO 14.75 A	
14.75	SO 14.75 B	
14.75	SO 14.75 C	
14.75	SO 14.75 L1 A	
14.75	SO 14.75 L1 B	
15.00	SO 14.8 South	
15.00	SO 14.9 South A	
15.00	OB 14.97 I	
15.00	OB 14.98 I	
15.25	SO 15.05 South B	
15.25	SO South Mill Pond AA	
15.25	SO South Mill Pond AB	
15.25	SO South Mill Pond AC	
15.50	SO 15.25	
15.50	SO 15.4 A	
15.50	SO 15.4 B	
15.50	SO 15.4 C	
15.75	SO North Mill Pond A	
15.75	SO North Mill Pond B	
17.00	SO Rock-Tenn	
18.25	SO 18.15 South	
18.50	SO 18.5 South	
18.75	SO 18.65 South	
19.00	SO 18.8 Center A	
19.00	SO 18.8 Center B	
19.00	SO 18.85 North	
19.00	SO 18.95 North	
19.25	SO 19.15 South	
19.25	SO 19.25 L1	
19.25	SO 19.25 L1 AA	
19.50	SO 19.45 North	
19.50	SO 19.47T	
19.75	SO 19.56T	
20.25	SO 20.1 South	
20.75	SO 20.63T	

MP	Site ID	Status
21.25	SO 21.11T	
21.50	SO Custer Dr Bridge SW	
21.50	SO 21.4	
21.50	SO 21.50	
21.75	SO 21.54T	
21.75	SO 21.55 South	
22.25	SO 22.25T	
22.75	SO 22.75 North	
23.75	SO 23.54T	
24.00	SO 23.83T	
24.75	SO 24.65 South	
25.00	SO 24.82T	
25.00	SO 24.92T	
25.75	SO 25.7 North	
26.25	SO 26.0	
26.25	SO 26.13T	
25.50	OB 26.23 LDB	
26.25	OB 26.25 RDB	
26.25	SO 26.25	
26.75	SO 26.65 A	
26.75	SO 26.65 B	
27.00	SO 26.8 Southeast	
27.25	SO 27.02T	
27.25	SO 27.1 North	
27.25	SO 27.15 South	
27.75	SO 27.7 North	
28.00	SO 27.9	
28.25	SO 28.15 South	
28.25	SO 28.25	
28.50	SO 28.28T	
28.50	SO 28.34T	
28.50	SO 28.39T	
28.50	SO 28.45 South A	
28.50	SO 28.45 South B	
28.50	SO 28.47T	
28.50	SO 28.5 North	
28.75	SO 28.65T	
28.75	SO 28.75 North	
29.00	SO 28.9 South	
30.75	SO 30.7 North	
31.00	SO 30.8 South B	
32.25	SO 32.15	
31.25	SO 31.25 North	
32.75	SO 32.65 Southeast	
33.00	SO 32.89	
33.00	SO 33.00 L1	
34.50	SO 34.48T	
36.00	SO 35.84T A	
36.25	SO 36.23 RDB	
36.50	SO 36.45 North	

MP	Site ID	Status
36.75	SO 36.6 South B	
36.75	SO 36.75 North	
36.75	SO Delta A	
37.00	SO Delta BA	
37.00	SO Delta BB	
37.00	SO Delta G	
37.00	SO Delta I	
37.25	SO 37.1 North	
37.25	SO Delta M	
37.25	SO Delta N	
37.25	SO Delta P	
37.25	SO Delta Q	
37.50	SO Delta FF	
37.50	SO Delta GG	
37.50	SO Delta HH	
38.50	SO Lake J	

LEGEND

3	Overbank Branch
198	Submerged Oil Branch
5	Containment Branch
1	Talmadge Creek Branch
7	Kalamazoo River Branch
2	CONSISTENT W/ EPA ORDER and up for MDEQ Part 201 Program Consideration

216 Total

3.0 REASSESSMENT OF OIL LOCATION AND EXTENT

3.1 Shoreline and Overbank Reassessment

3.1.1 Objectives

The shoreline and overbank along the Kalamazoo River downstream impacted areas will be reassessed in Spring 2012. Supplemental qualitative reassessments may be conducted as discussed in Section 3.1.4. The objective of the Spring 2012 reassessment is to determine the presence or absence of oil and/or oil sheen along targeted overbank areas along the affected river system from MP 2.25 of the Kalamazoo River to the Morrow Lake Dam. The information collected during the Spring 2012 Reassessment will be compared with previous overbank assessment results to determine what additional overbank recovery activities are required.

An Overbank Science Group (–OSG") shall be established to review data associated with overbank assessments and recovery activities. The OSG shall be comprised of Enbridge, the U.S. EPA, and MDEQ. The overall goal for the OSG will be to ensure reassessment data quality and completeness, evaluate overbank oil recovery tools and effectiveness, and to make recommendations to OSCAR for each reassessment site.

To reach this goal, the OSG shall review and evaluate the following data on an ongoing basis throughout Fall 2011 and continuing through Fall 2012:

- Historic and ongoing assessment data; and
- 2012 reassessment results.

The OSG shall consult and coordinate with the OSCAR Branch to discuss findings and to provide recommendations for overbank oil reassessment and recovery operations.

3.1.2 Spring 2012 Reassessment Methods and Procedures

Targeted locations shall be qualitatively reassessed during Spring 2012 according to the Shoreline Overbank Reassessment Technique (–SORT") procedures developed and utilized during Spring 2011. SORT teams shall be comprised of one U.S. EPA Superfund Technical Assessment and Response Team (–START") or U.S. EPA representative, one MDEQ representative, and Enbridge representative(s). SORT teams shall complete the following tasks for each targeted reassessment location:

- Characterize oiling conditions and substrate types using a standardized terminology (SORT Metric Quick Guide);
- Characterize shoreline and overbank habitat types and the degree and characteristics of any oiling conditions;
- Record percent cover of a specific oiling condition within a point/zone on field maps and data collection forms;
- Collect a waypoint and/or polygon dimensions for each of the oiled points/zones identified as potentially needing additional response activities using a Global Positioning System (–GPS") unit with sub-meter accuracy;

- Identify and estimate the area of impact of specific oiling and substrate conditions observed during current conditions;
- Determine whether the impacted area is characterized as a sensitive habitat according to the MDEQ Water Resources Division (–WRD"); and
- Assign site identification nomenclature prescribed by the OSCAR Branch to avoid conflict with historic naming conventions (2010 Shoreline Cleanup Assessment Techniques (–SCAT"), 2011 SORT, O&M, etc.).

3.1.3 Spring 2012 Reassessment Sites

Spring 2012 SORT activities shall focus on, but not be limited, to the following sites:

- Former excavation areas;
- Impacted areas identified during the 2011 SORT reassessment that were inundated during the 2011 SORT reassessment activities (including Strike sites); and
- Impacted areas identified as having –Film", –Sheen", and/or –Pooled Oil" during the 2011 SORT reassessment.

Shoreline and overbank sites currently targeted for reassessment are presented in Attachment A. Data obtained for each site shall be uploaded to the GIS database using the appropriate naming and symbol conventions. SORT data for each site shall also be added to the OSCAR list and presented to the OSCAR Branch for review and evaluation. The OSCAR Branch shall review all current and historic information for each reassessment site to determine whether sites have been or shall continue to be addressed under the U.S. EPA Order or transitioned to the MDEQ.

3.1.4 Supplemental Qualitative Assessments

Supplemental qualitative assessment activities shall be conducted on an ongoing basis to characterize any remaining oil and/or oil sheen from areas identified from the OSCAR process.

3.1.4.1 Supplemental Qualitative Assessment Methods and Procedures

Supplemental qualitative assessment activities will be conducted by the OSG to assess if further actions are needed under the U.S. EPA Order. The qualitative assessments shall include screening techniques to determine the presence or absence of oil and/or oil sheen including the following:

- Visual examination of exposed surface soils and vegetation to determine the presence and extent of any pooled oil, residual oil accumulations, oil film, or oil sheen;
- Poling assessment of any overbank areas that remain submerged at the time the inspections are performed, using approved poling techniques;
- Visual and ultraviolet (–UV") screening of soil cores collected using hand-augers or other means according to applicable Standard Operating Procedure (–SOPs");
- Visual assessment of soils/mud flats/dried overbank ponds and backwater areas according to the Bucket Sheen Test SOP, approved by the U.S. EPA in correspondence dated October 11, 2011;

- Visual assessment of soils/mud flats/dried overbank ponds and backwater areas according to the Poling Ring Test SOP approved by the U.S. EPA in correspondence dated October 11, 2011; and
- Aerial over-flight photo log review.

Core sample collection shall be performed in accordance with procedures described in the existing approved Sampling and Analysis Plan (SAP, Enbridge, 2011). Procedures for performing and evaluating UV screening of soil cores shall be described in a separate SOP to be submitted and approved by the U.S. EPA prior to undertaking the work.

3.2 Submerged Oil Reassessment

3.2.1 Objectives

The 2012 submerged oil reassessment scope of work shall include site-wide poling of river sediments. Supplemental poling reassessments may be conducted as discussed in Section 3.2.5. Data obtained from submerged oil reassessment activities shall be used for comparison to 2010 and 2011 submerged oil data sets, and to make determinations as to the distribution and relative quantity of submerged oil remaining in the river. Submerged oil reassessment information shall be used in conjunction with other considerations to direct all future submerged oil recovery actions. Additional focused poling within specific sub-areas of the river shall be performed, as determined by the SOSG.

The SOSG shall be established to review data associated with submerged oil assessment and recovery activities. The SOSG shall be comprised of Enbridge, the U.S. EPA, United States Geological Survey (–USGS"), and MDEQ. The overall goal for the SOSG will be to ensure reassessment data quality and completeness, evaluate submerged oil recovery tools and effectiveness, as well as to provide recommendations for the placement of sediment traps and to make recommendations to OSCAR for each reassessment site.

To reach this goal, the SOSG shall review and evaluate the following data on an ongoing basis throughout Fall 2011 and continuing through Fall 2012:

- Historic poling data;
- Sediment core data;
- Hydrodynamic assessment data;
- Hydrodynamic modeling data;
- Temperature effects studies data;
- Submerged oil quantification data;
- 2012 Reassessment results;
- Containment placement, monitoring, and removal; and
- Placement, monitoring, and maintenance of oil-containing sediment traps.

The SOSG shall consult and coordinate with the OSCAR Branch to discuss findings and to provide recommendations for submerged oil reassessment and recovery.

3.2.2 Spring 2012 Reassessment Methods and Procedures

Targeted locations shall be qualitatively reassessed during Spring 2012 according to the procedures developed and utilized during Spring 2011. Submerged oil reassessment activities shall include poling of soft sediments in targeted depositional areas. Data associated with poling including water depth, pole advancement depth, soft sediment thickness, bed characteristics, the presence/absence of oil, GPS coordinates, and the relative amount of oil/sheen shall be collected at each location.

Water depth data shall be collected using a 6-inch diameter disk attached to the end of an aluminum pole approximately 2 inches in diameter marked at 0.1-foot intervals. At each poling location, the disc shall gradually be lowered to the top of the sediment bed, and the depth from the water surface to the top of soft sediment (water depth) shall be recorded to the nearest 0.1-foot.

Soft sediment thickness data shall be collected using a pole without a disk and marked at intervals of 0.1-foot. The pole shall be pushed vertically through the sediment until advancement is restricted. The depth to sediment surface (water depth) and maximum poling depth into the soft sediment shall determine the soft sediment thickness at each location. A description of the sediment type shall be documented based on the poling results (e.g., soft sediment – silt over sand).

An approximate determination of the relative amount of submerged oil at each poling location shall be made by using the pole with a 6-inch diameter disk to agitate the soft sediment. After agitation, the amount of oil/sheen observed at the water surface shall be described using the same categories as the 2011 field season (heavy, moderate, light, or none). These categories are outlined in the attached Submerged Oil Field Observation Flow Chart (Figure 1). If ~~"m~~oderate" or ~~"h~~eavy" indications of submerged oil sheen/globules are observed, the area shall be delineated with additional poling. The poling teams shall work away from the ~~"m~~oderate" or ~~"h~~eavy" location until they have poled either a ~~"l~~ight" submerged oil classification, or no indication of submerged oil.

A GPS unit shall be used to document the coordinates for each poling location. All poling locations shall be surveyed during the project to the extent practicable using a differential GPS unit with sub-meter accuracy. The horizontal coordinate system shall be the Michigan State Plane Coordinate System, South zone, referenced to the North American Datum (~~"N~~AD") 83, in international feet.

All poling activities shall be conducted during optimal temperature conditions as determined via an evaluation of the results from temperature effects on submerged oil studies as described herein. As such, sediment and water temperature data shall be collected during poling activities as thresholds for data reliability are approached.

3.2.3 Spring 2012 Reassessment Poling Locations and Frequency

Site-wide poling shall be conducted in targeted areas along the Kalamazoo River from the confluence of Talmadge Creek and the Kalamazoo River to the Morrow Lake Delta, within Morrow Lake and at additional areas downstream of the Morrow Lake Dam. Poling activities shall be focused in depositional areas with soft bed sediment types since submerged oil is most often associated with depositional geomorphic environments. Poling locations shall be minimal in erosional or bed-material transporting areas with sand/gravel bed types, because submerged oil is not typically associated with this these higher river velocity geomorphic settings.

Poling shall be conducted at the following locations:

- All locations where moderate or heavy submerged oil was identified during the 2010 and 2011 field seasons, including areas identified during 2011 LSR locations;
- Within all 2011 focus areas;
- Additional poling boundaries;
- At select transect locations; and
- As directed by the U.S. EPA.

Additional poling targets extending from approximately MP4.0 to Ceresco Dam, from approximately MP14.0 to Battle Creek Dam, and within the engineered channel portion of the river from approximately MP18.0 to 20.0 may be added if determined by the SOSG. Additionally, any areas identified from the hydrodynamic assessment or hydrodynamic modeling results as potential depositional areas, and not previously poled, will be added to the list of targets for the 2012 site-wide poling. For all these areas, crews shall visually assess the area and select representative poling locations. The crews may add poling locations to an area based on field observations. Proposed site-wide poling locations for the Spring 2012 Reassessment are presented in Attachment B, Figure 1.

Poling locations on the Morrow Lake fan shall be determined by the SOSG. Poling locations within Morrow Lake shall be comparable to the areas presented in the Addendum to the Spring 2011 Overbank and Poling Reassessment Work Plan. Additional required poling data collection downstream of the Morrow Lake Dam is described in Section 4.2.1 of this work plan, and the targeted locations are summarized therein.

3.2.4 2012 Late Summer Reassessment

The purpose of the 2012 LSR is to determine the status of submerged oil after any 2012 recovery operations have been completed. The existing U.S. EPA approved poling SOP will be used to perform poling at a level-of-effort recommended by the SOSG. The poling will be conducted using a top-to-bottom approach after oil recovery work has been completed. The poling locations shall be biased to depositional areas to determine the effectiveness of the recovery activities.

3.2.5 Supplemental Poling

Supplemental poling activities will be conducted where recommended by the SOSG, if necessary, to assess if further actions are needed under the U.S. EPA Order. Supplemental poling methods and procedures will be the same as those described in Section 3.2.2 above.

3.3 Data Collection and Documentation

Electronic field data forms shall serve as a daily record of events, observations, and measurements during all shoreline, overbank, and submerged oil field assessment activities. All information shall be recorded electronically on these forms and shall include:

- Names of field crew;
- Date and time of site entry and exit;
- Location of activity;
- Site description;

- Field measurements;
- Field observations; and
- Photographs.

Paper copies of the field forms shall be printed and filed for hard copy backup of all data collected. In addition, all electronic data shall be downloaded to a server at the end of each work day and stored in a GIS database. GIS is used to organize data and to display the data in map form. Location information, field observations, media characteristics, utility information, and results are stored in the GIS database.

3.4 Data Analysis

All reassessment results shall be uploaded to the GIS database on an ongoing basis, and shall be reviewed by the OSG and/or SOSG, as appropriate. Data generated during shoreline, overbank, and submerged oil reassessment activities shall be used along with other data sets to determine additional reassessment data collection needs, and to make informed decisions regarding recovery targets as well as appropriate active and/or passive recovery strategies and tactics.

4.0 SUBMERGED OIL CHARACTERIZATION

Submerged oil characterization includes the hydrodynamic assessment, hydrodynamic model, temperature effects on submerged oil study, and submerged oil quantification. The hydrodynamic assessment includes poling in Morrow Lake, poling downstream of the Morrow Lake Dam, cohesion and erodibility tests, water velocity profiling, sediment core collection, and understanding of sediment transport. The hydrodynamic model consists of setup, data analysis, data inputs, and evaluation of the results. The temperature effects on submerged oil is a bench scale study to better understand the effects that water and sediment temperatures have on submerged oil liberation and the subsequent effectiveness of recovery methods. Submerged oil quantification is a model used to calculate the volume of submerged oil from representative sediment cores and poling data collected throughout the affected area.

4.1 Objectives

The overall objective of submerged oil characterization is to understand its fate and transport related to recovery and containment. Four areas, hydrodynamic assessment, hydrodynamic modeling, temperature effects study, and submerged oil quantification have been identified as critical to this understanding and are further described herein.

4.2 Hydrodynamic Assessment

Data shall be collected to evaluate the fate and transport of fine-grained sediment, submerged oil, and oil-containing sediment in the affected river system (Talmadge Creek, Kalamazoo River, Morrow Lake Delta, Morrow Lake fan, and Morrow Lake). Data shall be collected in cooperation with the SOSG. The primary objectives of the hydrodynamic assessment are to:

- Develop an understanding of the physical and chemical behavior associated with the migration, mobilization and recovery of submerged oil and oil remaining in riverine sediment, including, but not limited to, the effects of temperature and river velocity on the migration of submerged oil.
- Identify physical patterns and migration rates of submerged oil along channel bars, impoundments, and delta/fan environments caused by including high flow, low flow, seasonal/diurnal variation, and oil recovery/assessment activities;
- Optimize and focus submerged oil recovery strategies;
- Evaluate effectiveness of submerged oil recovery operations; and
- Provide support for quantification of submerged oil in riverine sediment.

4.2.1 Poling in Morrow Lake Downstream of Fan

Qualitative assessments using poling techniques shall be performed at locations and frequencies similar to 2010 pre-recovery, Spring 2011 reassessment activities, and routine monitoring points established during the 2011 recovery activities. Additional information collected with the descriptions of oil/sheen shall include geo-referenced locations, qualitative velocity, water depth, soft sediment depth, and qualitative substrate descriptions. Enbridge shall perform poling as specified below:

- Poling locations upstream of Morrow Lake Dam:
  - Poling locations shall have their horizontal coordinates recorded with sub-meter accuracy using differential GPS receivers. For subsequent surveys, the initial poling locations shall be resurveyed to detect change.
  - Poling locations shall be well distributed across the Morrow Lake fan upstream of the control point E4.5 double chevron, and well distributed within and along the downstream side of the double chevron, extending westward until no further indications of submerged oil are detected.
  - If the area where submerged oil indications are detected expands, then the monitored area and number of poling locations also shall increase accordingly.
  - Locations shall be reviewed and updated in consultation with the SOSG.
- Poling frequency upstream of Morrow Lake Dam:
  - Poling will be conducted daily in the Morrow Lake fan during submerged oil recovery operations but each monitoring point will not be completed daily. In 2011, the 40 monitoring point cycle was completed every second day:
  - Post-recovery at least 24 hours but not more than 60 hours after completion of submerged oil recovery operations at a site and downstream of the given site;
  - At least once each season when (Fall 2011, Spring 2012, Summer 2012, and Fall 2012) water temperature is greater than 45°F or the temperature threshold determined in the temperature study described in herein; and/or
  - After large flood events (two year or higher) in 2012. Poling after multiple floods within a three month period, shall occur more than once if the difference in recurrence interval between floods is 5 years or higher.
- Focus area poling locations downstream of Morrow Lake Dam (e.g., next likely depositional areas):
  - Immediately downstream of the Morrow Lake Dam, in left backwater area at MP 39.9 South;
  - Margin of a bend on the left descending bank at MP 40.3 South;
  - Downstream side of a mid-channel island at MP 40.9 North;
  - North side channel margin at MP 41.1 North and upstream of River St. Bridge; and
  - Upstream end of an oxbow at MP 41.25 North (downstream of River St. and upstream of King Hwy).

Focus area poling locations downstream of Morrow Lake Dam are shown in Attachment C, Figure 1. A minimum of five poling locations shall be collected at each focus area. During the initial poling survey conducted in Fall 2011, the poling locations were selected in the field to be representative of the focus area based on sediment thickness, water depth, and water velocity. Poling locations shall have their horizontal coordinates recorded with sub-meter accuracy using differential GPS receivers. For subsequent surveys, the initial poling locations shall be resurveyed to detect change.

- Poling frequency downstream of Morrow Lake Dam:
    - At least once each season when (Fall 2011, Spring 2012, Summer 2012, and Fall 2012) water temperature is greater than the temperature threshold determined in the temperature study described herein; and/or
    - After large flood events (two year or higher) in 2012. Poling after multiple floods within a three month period, shall occur when the difference in recurrence interval between flood events is 5 years or greater.

If submerged oil is found downstream of the Morrow Lake Dam, the poling locations shall be re-evaluated with the SOSG.

4.2.2 Cohesion and Erodibility Tests

The purpose of these tests is to provide information on specific sediment characteristics and their effect on submerged oil migration and transport under typical Kalamazoo River temperature and velocity conditions.

A literature search has been initiated to identify other project work that may have produced similar data based on the particle size and the river type. This literature search data and the site specific data shall inform selection of appropriate values for hydrodynamic parameters, including cohesion, critical shear stress, and erodibility, which shall be used in the hydrodynamic model (described herein). The specific field techniques have been selected in consultation with the U.S. EPA and USGS and shall commence in Fall 2011. The locations of the 15 in-situ jet tests selected in consultation with the USGS are shown in Attachment C, Figure 2. The test locations include the following:

Table 4.2.2 In-situ Jet Testing Locations.

Location	Geomorphic Setting	Surface particle size (top six inches)
5.25 South	Upstream of dam; increased channel width	Silt loam to 4.5’
5.75 South A	Upstream of dam	Silt loam to 2.3’
10.75 L2	Backwater; high flow cutoff channel	Silt loam over sand – adjust toward shoreline
12.5 C	Oxbow	Sandy loam with visible oil – adjust toward shoreline
14.35 North	Upstream of dam; increased channel width	Silt loam over sand – visible oil – adjust toward shoreline
14.75 A	Cutoff channel	Sand over coarse sand – move location further into cutoff channel and near shoreline
South Mill Pond	Upstream of dam; pond	Silt to 3.3’
19.25 L1	Cutoff channel	Silt loam to 0.7’
21.5	Oxbow	Silt loam to 0.8’

Location	Geomorphic Setting	Surface particle size (top six inches)
26.0	Increased channel width; man-made area	Loamy fine sand – visible oil – adjust location near shoreline
30.8 South	Increased channel width; tributary input	Silt loam to 1.5’
36.25 A	Outside meander bend; upstream of island	Loamy sand – no visible oil – move to 36.25 C; SEKR3650C0a; Downstream of island
Morrow Lake Delta H	Sandy bed in consistent depositional area	Sand over loamy sand – no visible oil – adjust location near shoreline or downstream of island (South)
Morrow Lake Delta Z	Soft bed in deposition area	Silt loam to 0.7’
Morrow Lake fan	Near mouth of neck	Silt loam to 0.5”

At three locations - 5.75 South A, 21.5 Oxbow, and Morrow Lake Fan - water depths were greater than 6 inches which required collection of a representative sample of the bottom material with a box corer or other device. In this situation, jet tests shall be conducted on the core samples at a nearby location in the field, with minimal disturbance to the surficial layer of the core.

Results shall be reviewed by the SOSG to determine if adequate coverage exists or if additional testing is necessary. When complete, a test completion report shall be prepared, describing actual field methods and materials, site and sample characteristics, test results, evaluations, and conclusions concerning cohesion and erodibility.

4.2.3 Water Velocity Profiling

Existing hydrodynamic data consist of estimated velocity ranges and current-meter point measurements at discrete poling locations throughout the river system during a narrow range of streamflow conditions. Multi-dimensional understanding of velocity distributions and profiles is needed for adequately describing bed shear stresses under a much wider range of streamflow conditions.

An Acoustic Doppler Velocimeter (–ADV”) or Acoustic Doppler Current Profiler (–ADCP”) shall be used to measure velocities in the x, y, and z directions. Both types of velocity meters collect 3-dimensional data, but the ADCP can collect data continuously along transects as a full vertical profile, whereas the ADV measures velocities at a single point. Both sets of data are needed to more accurately estimate shear stress on the bed and banks of the river. The preference shall be to use the ADCP in the Morrow Lake Delta and fan if the water depths are sufficient for its use. Shallow water depths on the Kalamazoo River may require the use of a hand-held or pole-mounted ADV.

The ADCP shall be properly calibrated prior to any data collection for this study in accordance with manufacturer's specifications and instructions; this shall include site-specific calibration in relation to speed of sound through the river water, and to account for geo-magnetic field variation that can affect the measured flow-direction results.

Daily quality-assurance tests of the ADCP instrument's operational performance (360-degree rotational closure, loop closure, etc.) shall be conducted and results recorded.

Data shall be used to determine migration/transport rates for sediment which may include submerged oil, and also for calibration/validation of the hydrodynamic model. Velocity data shall be collected at the following locations and times:

- Horizontal and vertical velocities at cross-sections (at varying river stages) in specific geomorphic areas including:
  - Morrow Lake fan (at least three latitudinal profiles and four longitudinal profiles);
  - Each side of existing containment location E4.5 (if present);
  - Morrow Lake Delta channels;
  - 35th Street Bridge;
  - Neck of delta and downstream of the neck on the Morrow Lake fan to determine velocity changes longitudinally; and
  - Kalamazoo River: Representative river reaches to evaluate the flow patterns associated with depositional areas, the thalweg, dam impoundments, meanders, oxbows, cutoff channels, and changes in channel width. Selection of representative reaches coordinated with and approved by the U.S. EPA and USGS.

- Horizontal and vertical velocities to evaluate stream-wise changes in velocity along longitudinal transects located at selected, key reaches, including:
  - 35th Street to the Morrow Lake fan;
  - MP 3.0 to Ceresco Dam; and
  - Other reaches of concern in depositional areas where the number of available velocity readings does not adequately explain the river flow pattern. Selection of these reaches coordinated with and approved by the U.S. EPA and USGS.
- At least once each season (Fall 2011, Spring 2012, Summer 2012, and Fall 2012); and/or
- During mean flow conditions;
- During low flow conditions; and
- During high flow conditions (e.g., various flows above median values, including a minimum of two high-flow conditions; high flows are defined as those in the 3rd quartile and 4th quartile of the flow-duration table). High-flow data collection is conditioned upon the actual occurrence of those flow conditions within the study period and task schedule. During high flow events, the ADCP may be used from bridges for compliance with safety policies.

Provisional locations of cross-sectional and longitudinal transects where velocity profiles shall be measured are shown in Attachment C, Figure 3. The USGS shall provide data for velocity profiles and cross-sections from discharge measurements made at the existing gauging stations (at bridge

locations), if available. Final selection of velocity profile locations were made in consultation with and approved by the U.S. EPA and USGS.

4.2.4 Surficial Streambed Sediment Characteristics

Existing data consist of pre- and post-recovery cores linked with poling data from various locations along the Kalamazoo River, including the Morrow Lake Delta/fan area. Additional cores shall be collected to aid in the determination of submerged oil transport rates, depositional patterns, and submerged oil quantification. Target depth for cores shall be 4.5 feet below the water-sediment interface or less if refusal.

Additional sediment cores shall be collected and evaluated as follows, consistent with previously used techniques associated with 2011 submerged oil quantification:

- Hand pushed or driven check-valve sampler (given the shallow depths) shall be used.
- Cores shall be advanced to target depth or refusal. (If target depth is achieved and the recovery is less than 80%, a discrete interval sampler shall be used to obtain recovery greater than 80%. If refusal occurs prior to reaching the target depth and recovery is less than 80%, a second core attempt shall be made, except that at the discretion of the sampler, with concurrence by START/U.S. EPA observer, or by USGS oversight, a second attempt at collection may be omitted in such a case).
- For in-situ bulk density cores, a second check-valve sample shall be collected as a core to a target depth of 5 inches or more, but less than 1 foot. This core shall remain intact and shipped for bulk density and particle size analysis.
- Penetration depth and recovery ratios shall be recorded.
- High water-content sediment-water interface (that may contain submerged oil) shall be recovered.
- In the Morrow Lake Delta, the cores shall penetrate into pre-dam floodplain/channel deposits or to refusal.
- Sediment cores shall be collected from the following locations:
    - Sample locations shall be co-located with poling and velocity transects/profiles wherever possible. Sample locations that are not co-located with these data points shall be noted in the sample log.
    - Morrow Lake fan: transects shall be aligned along a contour from North/South and East/West and in the former river channel (adequate number of locations to allow construction of at least three latitudinal profiles and four longitudinal profiles).
    - 35th Street Bridge to Morrow Lake fan and within the Morrow Lake Delta channels.
    - Other locations in key reaches to be determined in consultation with the SOSG, such as Mill Ponds/Ceresco Dam.

Sediment core sample provisional locations are shown in Attachment C, Figure 4. Final selection of sample locations were coordinated with and approved by the U.S. EPA and USGS.

Sediment cores shall be collected at the following times:

- Fall 2011 (post-recovery and pre-ice formation) – including chemical analysis;
- Spring 2012 (post-flood; pre-recovery) – including chemical analysis for post-spring flood;
- Summer 2012 – visual analyses only;
- Fall 2012 (post-recovery) – including chemical analysis; and/or
- After large flood events (2-year or longer recurrence interval) in 2012. Coring after multiple floods within a 3-month period shall occur only if the difference in recurrence interval between flood events is 5 years or greater. If post-flood cores are supplemental to the scheduled coring events, the type(s) of sample analyses to be performed for collected cores shall be determined in consultation with the SOSG.

On-site core logging shall include the following:

- Stratigraphic logging using the Sediment Logging Standard SOP which includes the Unified Soil Classification System (“USCS”) and United States Department of Agriculture (“USDA”) classification system;
- Color assessment using Munsell Color Charts;
- Visual observation of submerged oil with natural light during characterization and documentation of submerged oil depth and sediment profile layers;
- Depth of oil sheen or globules;
- Use of an UV illuminator for visual observation of submerged oil indicators;
- Standardized sheen test;
- Photographic documentation; and
- Identification of pre-dam (i.e., before Morrow Lake Dam was constructed) and post dam sediment layers in the Morrow Lake fan to calculate sedimentation rates. The sediment cores collected in 2011 and cores to be collected in 2012 will be logged and used to determine if a change in the sedimentation rate has occurred due to submerged oil recovery activities. The flood events that have occurred since July 2010 will also be evaluated in relation to frequency and recurrence interval of past flood events.

During the Fall 2011, Spring 2012, and Fall 2012 coring events, analytical chemistry data shall be obtained from samples secured from the sediment cores. Samples shall be collected from intervals affected by the Enbridge Line 6B Incident based on lithology throughout the entire length of core. Duplicate and matrix- spike/matrix-spike-duplicate pair samples shall be collected at a frequency of 1 each per 20 samples (i.e., 3 QC samples per 20 primary samples). An equipment blank sample shall be collected prior to each coring event, by coring reference material certified to be free of Total Petroleum Hydrocarbons (“TPH”) compounds. Samples shall be analyzed for crude oil related constituents, including TPH (DRO and ORO) and PNAs, using the new revised sample preparation process (10 gram aliquot, new drying method – see (Quality Assurance Project Plan (“QAPP”) for “background” core samples). Samples collected from lithologic intervals potentially affected by the Enbridge Line 6B Incident shall be analyzed for the following:

- TPH consisting of Diesel Range Organics ("DRO") and Oil Range Organics ("ORO");
- Polynuclear aromatics ("PNA's");
- Trace metals of beryllium, molybdenum, nickel, and vanadium;
- Percent moisture and total organic carbon ("TOC");
- Bulk density;
- Particle size distribution; and
- Organic matter content (loss on ignition method).

Enbridge shall evaluate the coring results after each sampling event and may modify, with the U.S. EPA's approval, the number of samples and locations, as appropriate. Modifications to the Work Plan shall be presented to the U.S. EPA for approval.

4.2.5 Sediment Transport

To determine how submerged oil and oil-containing sediment may be transported in various geomorphic settings, additional information shall be collected and evaluated. The existing data sets consist of turbidity measurements, sediment bed-material types (poling data, cores), and velocity measurements collected over the course of the project to date. Anecdotal evidence suggests that submerged oil migrates in association with fine-grained bedload and/or suspended sediment.

This evidence also suggests that the migration is dependent on flow conditions, affected by temperature, and agitation from oil recovery operations. Increased sediment transport also takes place during runoff events (e.g., rain events), but a substantial part of annual load presumably occurs during low-flow conditions (cf. 36-43 percent for Paw Paw River near Paw Paw (USGS 04102320), 1980-82, draining 195 mi^2).

To evaluate how submerged oil is transported in various geomorphic settings and the mass of submerged oil transported in suspended and/or bed-load components, Enbridge shall collect the following data to allow for a better understanding of the issues:

- Time-integrated suspended sediment sampling, which shall occur downstream of agitation/recovery areas and silt curtains. Enbridge shall use Walling suspended sediment traps (Phillips et al., 2000) at the following locations and in accordance with the following parameters:
    - Two traps placed upstream of the confluence of Talmadge Creek and the Kalamazoo River to obtain background suspended sediment samples.
    - Morrow Lake: downstream and in the vicinity of E4.5 control point. Three traps shall be placed in 2011 depositional areas.
    - Seven traps shall be located on an approximate North-South transect across the Morrow Lake fan in 2011 depositional areas. The traps shall be placed and co-located at poling locations.
    - Downstream of Dickman Road culverts and upstream of the Kalamazoo River Dam: A sampler will be placed mid-channel upstream of the 20th Street Bridge. Locations were field checked to verify that it is an appropriate location for sampling suspended sediment. Following the sampling event in Fall 2011, the SOSG will review the data

and determine if locations are appropriate/representative or if other locations shall be selected.

- Ceresco impoundment: Transects shall be located immediately upstream of the dam, in the thalweg and adjacent to the thalweg on each side, and downstream of the former rail road trestle (two to three locations, equally spaced along a transverse transect).
- Traps have been placed using 2 rebar per location. The length of rebar is selected based on the water depth and soft sediment thickness. The rebar is driven into the sediment bed and the samplers are placed over the rebar using polyvinyl chloride (–PVC") sleeves. Two ropes are used to set the sampler at the appropriate depth and the ropes are tied off to the rebar. Fluorescent painted PVC rope hangers and a buoy mark the location. Locations set in deeper water (>2.5 feet) shall be installed with two Walling traps to obtain a near streambed sample and a near water surface sample.
- During submerged oil recovery, Enbridge shall check the traps monthly, after storm events, immediately following oil recovery operations, and at other times as directed by the U.S. EPA. Sampling shall be conducted once per month or when there is adequate volume in a single trap or for a composite sample from a suspended sediment location (each location consists of one or two traps). The UV test will be used on each trap or composite sample to determine the presence or absence of submerged oil.
- After oil recovery operations are complete for the field season, Enbridge shall check and the traps once a month and at other times as directed by the U.S. EPA. The Walling samplers shall be removed before freeze up or remain in place over the winter, if conditions allow. This decision shall be made in consultation with the SOSG.
- In Spring 2012, the Walling samplers shall be installed as soon as safe work conditions allow. For 2012, the Walling samplers shall be installed, monitored and sampled in the same manner as 2011, except that during periods of high flow, sediment samples may need to be retrieved more frequently than monthly.
- Assuming adequate volume is collected, sediment chemistry data shall be obtained from samples secured from the Walling suspended sediment traps and shall be analyzed for following parameters:
    - TPH (DRO, ORO);
    - PNA's;
    - Trace metals of beryllium, molybdenum, nickel, and vanadium;
    - Percent moisture and TOC;
    - Particle size distribution; and
    - Organic matter content (loss on ignition method).

If insufficient sample is obtained from a trap, the following guidelines to prioritize sample analysis will be utilized. Alternatively, in consultation with the SOSG, traps from a single location could be composited to increase the amount of material for a sample, or re-install the trap to obtain additional sample for sampling at a later date. Sample prioritization will be as follows when insufficient sample quantity precludes all analyses:

1. TPH (DRO, ORO)
2. PNAs
3. TOC
4. Percent moisture
5. Particle size distribution
6. Trace metals of beryllium, molybdenum, nickel, and vanadium
7. Organic matter content

The proposed suspended sediment sample locations are shown in Attachment C, Figure 5.

4.2.6 Data Results

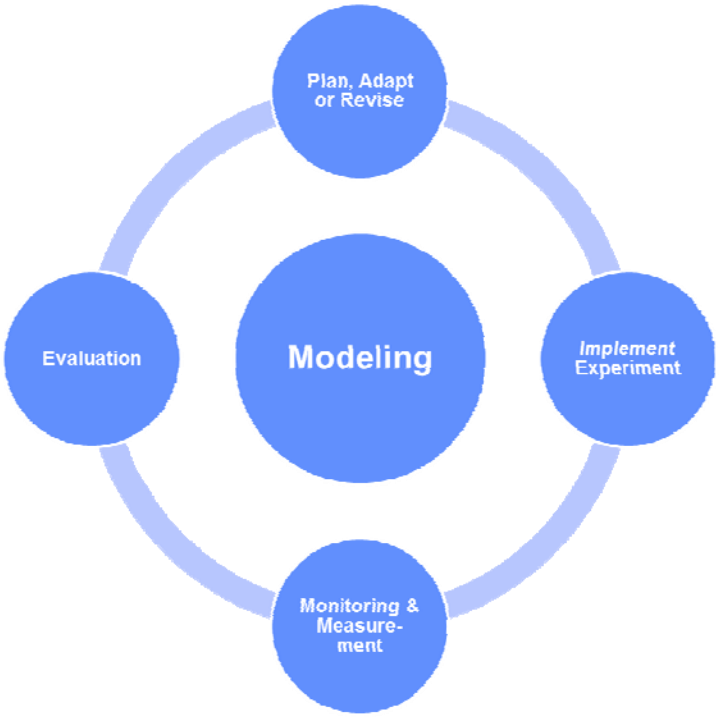
Enbridge shall provide the U.S. EPA, MDEQ, and USGS with the results of all data from the hydrodynamic assessment in spreadsheets, maps, model runs, and/or word processing formats. Also included shall be other related data for the following parameters/items: water temperature, turbidity, sediment temperature, water velocity, surface water elevation, depth to soft sediment, soft sediment thickness, depth to hardpan, core logging information, all other surface water field parameter data collected to date, analytical data, river discharge rates, river stage, and sediment curtain configurations from project inception (Geographical Information System format). Enbridge shall also provide location information (e.g., global positioning system data, latitude/longitude). The evaluation and presentation of the data shall be provided to the U.S. EPA within 30 days after field work is complete.

4.3 Hydrodynamic Modeling Strategy and Operational Plans

4.3.1 Introduction

A physical-process model of an environmental system can be a valuable resource for testing the present understanding of a complex system, revealing gaps in knowledge and areas where better detail is needed to provide useful predictions of future scenario outcomes or the effects of system alterations. Such applications of modeling are particularly valued to support several stages of the adaptive management cycle (Figure 4.3.1). A process model can suggest strategies for attaining environmental management goals that planners then formulate as management experiments to be implemented for real-world testing. The model can explore where and when to monitor the system to most sensitively gather metrics on how well the experiment is working. Monitoring data shall allow updates to the model to continue to advance our understanding of the river and make informed management decisions pertaining to the location and recovery of submerged oil.

Figure 4.3.1 The Adaptive Management Cycle of Experimentation and Iterative Learning



For an inland riverine ecosystem where sediment-associated contaminant transport is of principal concern, critical data for understanding submerged-oil entrainment, transport, deposition, and recovery include predicted water-surface elevations, velocity magnitudes, flow directions, and bed-shear stresses for a broad range of hydrologic conditions up to the 50-year flood discharge.

4.3.2 Purpose and Scope

This Work Plan describes tasks and procedures that shall achieve the following objectives of the hydrodynamic modeling study of the fate and transport of submerged oil from the Enbridge Line 6B Incident:

1. Successfully calibrate a 3-dimensional hydrodynamic model for unsteady, open-channel flow, capable of simulating with useful accuracy the spatial and temporal variations in river velocities, bed-shear stresses, and consequent sediment entrainment, transport, and deposition of sediment-oil mixtures;
2. Gain improved understanding of the transport of submerged oil; specifically, by simulation of the variables in objective 1 resulting from various regimes of streamflow conditions that include flows ranging from low flows of frequent occurrence to flood flows having
    a. an annual exceedance probability (–AEP") of 0.02 (50-year recurrence interval);
3. Simulate a variety of scenarios for containment, collection, and recovery of submerged oil-laden sediment, and for proposed sediment collection structures and future boom arrangements; and

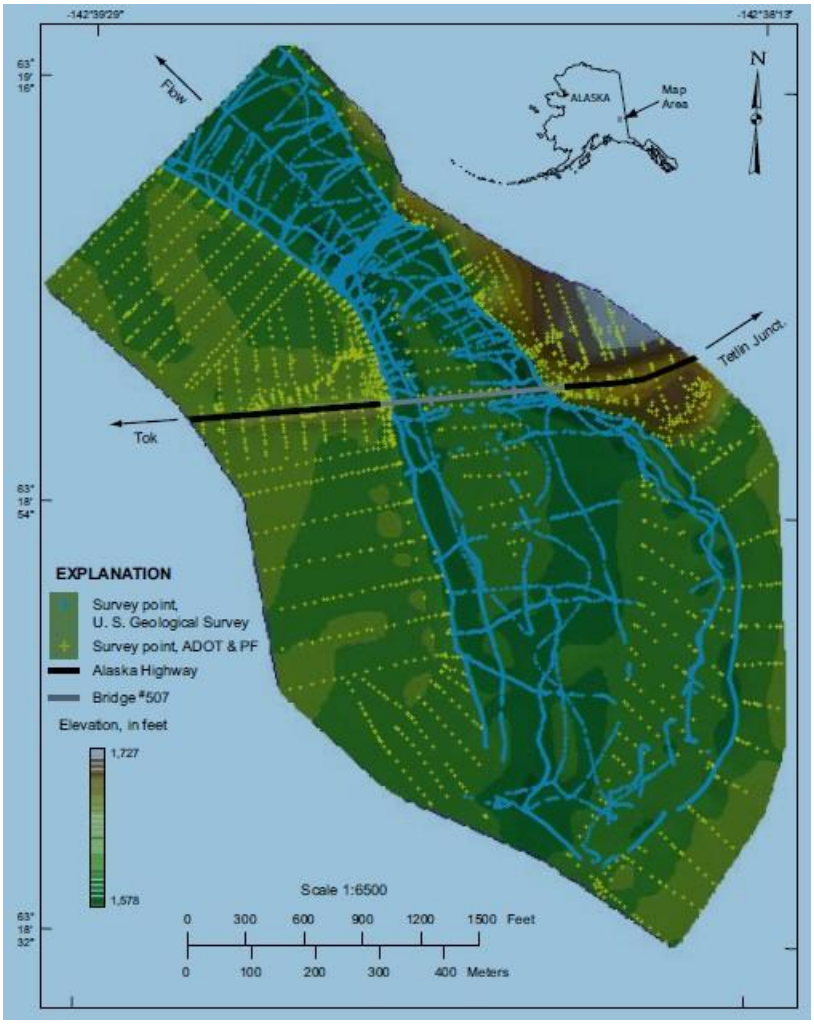
4. Document the post submerged oil recovery findings of this hydrodynamic model to assist in the long term planning, design, implementation, monitoring, and evaluation of future river management methods.

The model design will be a collaborative process with SOSG involvement at all stages of model development.

The model domain shall extend from the USGS stream flow gauging station on the Kalamazoo River at Marshall (station ID 04103500) at the upstream end, to Morrow Lake Dam on the downstream end. Laterally, the model domain shall include all areas inundated by the peak flow having a 50-year recurrence interval (0.02 AEP). The model shall be calibrated to river stage and velocity measurements, and sediment transport measurements. The data used for streamflow and sediment discharge rates will represent the present hydroclimatic period, recognized to have begun in North America during the early 1970s (cf. Wolock and McCabe, 1999; Milly et al., 2005; McCabe and Wolock, 2010). Oil-containing sediment collection areas and techniques to be simulated shall be identified in consultation with the SOSG, shall be approved by the U.S. EPA prior to simulation, and shall include such techniques as in-stream silt curtains, booms of various types, and other barriers constructed of natural or artificial materials with a variety of permeability and pore sizes. Submerged oil recovery scenarios to be simulated shall be planned in consultation with the SOSG, shall be approved by the U.S. EPA prior to simulation, and shall include such techniques as shallow agitation (~0.5 ft), deep agitation (> 1.5 ft), and low-disturbance alternatives. Early products of the modeling study shall include metadata and maps of the digital elevation model comprising bathymetric and terrain models of the respective sectors of the model domain (e.g., see Figure 4.3.2); graphs showing the goodness-of-fit between measured and simulated values of the calibration targets; and graphs illustrating the sensitivity of simulation results to incremental changes in the calibration parameters. The model shall be verified with additional data collected in 2012 as part of this Work Plan and/or at such time when the obligations under the U.S. EPA Order have been met. The modeling strategy is an iterative process incorporating the four main stages of the adaptive management cycle:

- Plan, adapt or revise;
- Implement experiment;
- Monitoring and measurement; and
- Evaluation.

Figure 4.3.2 -- Example map of digital elevation model showing points where bathymetric and terrain data were collected (from Conaway and Moran, 2004).



4.3.3 Study Area Description

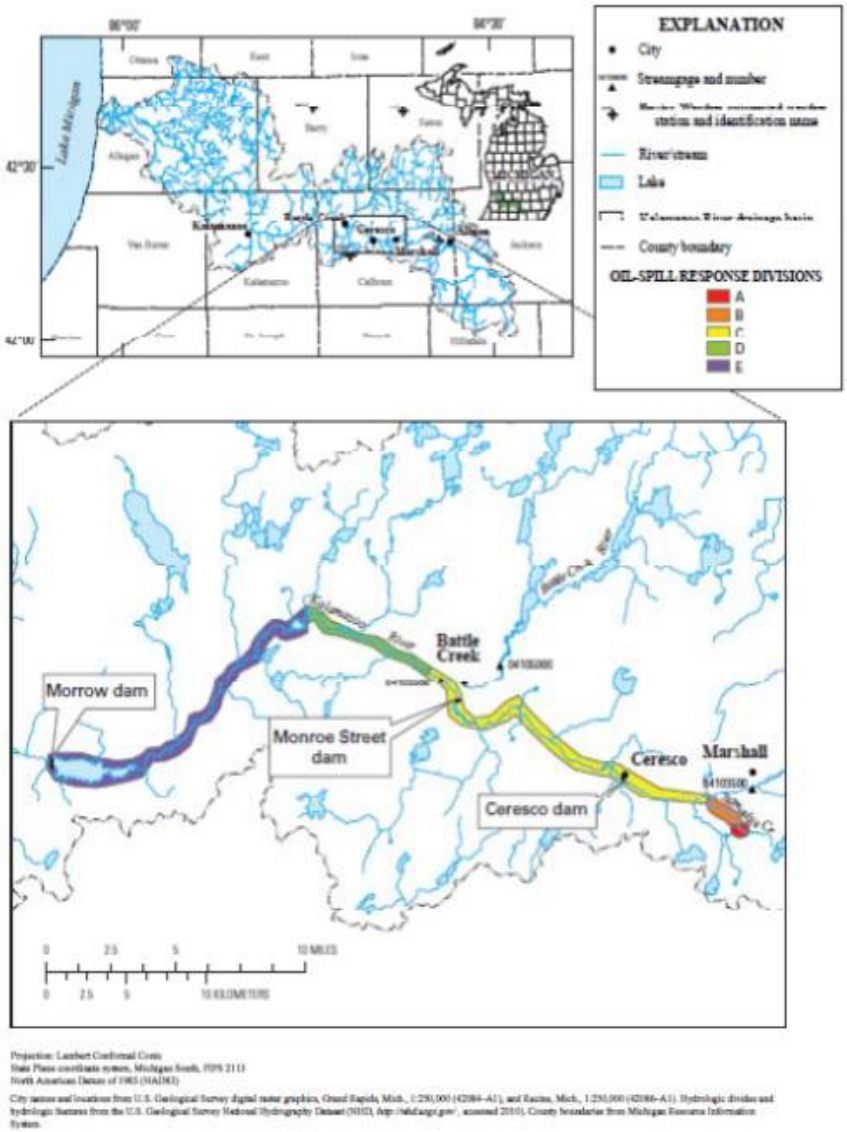
Because of the need to estimate streamflow from ungauged tributaries, including Talmadge Creek, a description of the study area's salient characteristics is critical to the hydrodynamic modeling study. The streamflow of Talmadge Creek and other ungauged tributary streams shall be estimated at each model time increment. Among the longer tributaries (> 4 mile long) downstream from Talmadge are Bear, Minges-Harper, Battle, Wabascon, Sevenmile, Augusta, and Gull Creeks. The modeling study area includes all of the 38 mile of the Kalamazoo River affected by the 2010 oil spill, ending at Morrow Lake Dam, which is about 80 mile upstream from Lake Michigan (Figure 4.3.3). Morrow Lake Dam also is designated as the upstream boundary of the binationally recognized Kalamazoo River Area of Concern (1987 amendment to the 1978 Great Lakes Water Quality Agreement; Kalamazoo River Public Advisory Council, 2000). By previous convention, the point where released crude oil entered Talmadge Creek has been designated to have a river-wise downstream mile-post coordinate (–MP") of 0 mile and Morrow Lake Dam is located near MP 40.

Warm to hot summers and severe winters characterize the temperature regime of the humid continental climate in the study area. At a representative climate station (Battle Creek 5 NW) normal monthly mean temperatures range from 23.1° F in January to 71.0° F in July (National Climatic Data Center, 2002). Normal precipitation near Battle Creek is 35.15 inch. and monthly means range between 2.4 and 3.6 inch. for all months except January (1.7 inch), February (1.5 inch), and September (3.9 inch). Thus there is no pronounced dry season.

The study area lies wholly within the drift plains ecological region of Southern Michigan and Northern Indiana (Omernik, 1987; U.S. Environmental Protection Agency, 2007). The Kalamazoo River near the study area flows through an alluvial valley eroded into glacial deposits and, locally, bedrock units including the Marshall Sandstone and Coldwater Shale (Dorr and Eschman, 1970; WMU, 1981). The river drains a basin characterized by well-drained soils developed on relatively permeable glacial deposits having developable yields of groundwater (Bent, 1971). Consequently, streamflow of the Kalamazoo River largely is groundwater fed. Additional description of the geology and hydrogeologic framework of the study area is provided in Enbridge (2010, p. 11-12).

Within the study area, the Kalamazoo River reaches are mostly sinuous and single-threaded, but numerous islands, bars, and chutes also occur. As a result of historical dam building projects, three impoundments have resulted in upstream deposition of sediment, channel aggradation, and braided delta formation where width is not constrained. In addition to the impounded slackwater, the Kalamazoo River includes a variety of other sluggish backwater and side channels, flood chutes, abandoned or intermittently abandoned oxbows, and floodplain wetlands that are hydraulically connected to the main channel and that have had repeated submerged oil recovery efforts. Many depositional areas are located along channel margins and banks, where the river channel naturally widens. Some are the result of large wood debris and overhanging trees and branches. Lastly, during 2011 low flow, submerged oil accumulated in areas that were scoured during flooding associated with the initial oil spill. Some of these have been sites of recurring submerged-oil deposition (e.g., ~~"~~the oxbow" at MP 21.5). Existing observations of depth, velocity, and sheen intensity generally are associated with point data collection (poling method) during safe-boating conditions (not flood flows) and have been inadequate to develop complete, detailed, and accurate predictive capabilities with regard to objectives 2 through 4 as enumerated for this study. Hydraulic flow fields observed during low-flow conditions can be either dampened or intensified when flow rates are higher; consequently, existing data for low-flow hydraulics are an insufficient basis for reliable development of either river-structure design or sediment transport studies (cf. Conaway and Moran, 2004). The modeling work described in this Work Plan provides an expanded scope and methods to obtain information about the riverine system during low- and high-flow conditions to allow the study objectives to be fully addressed.

Figure 4.3.3 -- Location of Kalamazoo River study area.



4.3.4 Existing Hydraulic Models of the Kalamazoo River in the Study Area

USGS model: Marshall-to-Battle Creek. Heavy rainfall in the study area during the 3 days preceding the Enbridge Line 6B Incident produced flood conditions that heightened environmental effects of the spill by transporting fresh, buoyant crude into many low-lying areas. The flood peak had an approximate annual exceedance probability of 4 percent on the Kalamazoo River (Hoard et al. 2010). When post-flood attention focused on characterizing the extent of the spill, the USGS was tasked with constructing a hydraulic model using the U.S. Army Corps of Engineers' Hydrologic Engineering Center River Analysis System (–HEC-RAS") (U.S. Army Corps of Engineers, 2002).

USGS crews surveyed stream-channel and bridge geometry, providing data for a 15-mile stretch of the Kalamazoo River from Marshall to Battle Creek to assist with remediation of flood-plain sediment and vegetation affected by the spill. Enbridge shall consider the published flood elevations

from Hoard et al. (2010) as an independent source of water-level validation targets for the present study. Also Enbridge shall consider the channel bathymetric data for cross-sections surveyed in August 2010 by USGS crews, using hydroacoustic instruments for depths and differential GPS receivers to record horizontal position. Water-surface elevations were surveyed at 19 locations along the modeled reach and used to calibrate the HEC-RAS model (Hoard et al. 2010).

AECOM model: Battle Creek-to-Morrow Lake Dam. Subsequently, Enbridge (AECOM, written communication, June 2011) in response to a U.S. EPA letter (dated April 14, 2011) commissioned the expansion of the USGS model from Battle Creek to Morrow Lake Dam; the simulation of flood peaks with recurrence intervals of 10, 25, 50, and 100 years; and the July 25, 2010, flood event. The purpose of the expanded modeling study was to help identify the inundated area at the time of the spill.

New LiDAR data were collected during April 2011 to provide a topographic model in support of this study. Also, channel transects were surveyed at spacing of 2,000 feet or less throughout the area of expanded study and at all bridge crossings of the Kalamazoo River from Battle Creek to Morrow Lake Dam. In addition to transects, a sonar-derived bathymetric map of the bottom of Morrow Lake was constructed. All 8 bridge crossings in the expanded reach were surveyed and measured to describe the location and thickness of each pier, total opening size, and bridge deck elevation.

Additionally, high water marks (~~"~~HWMs") were identified and their elevation measured using hand-held GPS receivers. Many of these HWMs were oil stain rings on tree trunks, left by the July 2010 flood ongoing at the time of the Enbridge Line 6B Incident.

4.3.5 Data Collection

Multi-dimensional hydrodynamic models require considerably more hydrologic, topographic, bathymetric, and hydraulic data collection than do one-dimensional models. For this study, advanced hydraulic, bathymetric, and topographic surveying instrumentation shall be used for collection of needed data efficiently and with reliable accuracy. Discharge measurements and/or water-level data shall be obtained from hydrologic data systems of the USGS and Enbridge for all stream gauges actively operating during the study period (Table 4.3.1). Miscellaneous discharge measurements on ungauged tributaries have been made by the USGS and MDEQ and Michigan Department of Natural Resources; these shall be compiled for potential use in calibrating or estimating contributions of tributaries to the main stem's discharge. The specific method selected for estimation of streamflow of each ungauged tributary shall be described in detail by Enbridge, and is expected to comprise use of available streamflow and weather data with either a numerical rainfall-runoff modeling approach to estimate the streamflow at the mouth of each ungauged tributary, and/or a statistical modeling approach based on basin characteristics and streamflow records of gauged streams paired with each ungauged tributary; possibly with varying approaches among the various tributaries; and will include methods for evaluating accuracy of the estimates and their contribution to the overall uncertainty of the hydrodynamic model.

All USGS gauging stations have hourly time-series data for water level and discharge. Enbridge's 10 stage-only gauges have only once daily observations of water level, and were operated seasonally, lacking observations for the winter period. All water levels shall be compiled as altitudes referenced

to the National Geodetic Vertical Datum (–NGVD") of 1988, and shall provide either boundary conditions for model runs, or calibration targets.

Table 4.3.1 Stream flow-gauging stations within or adjacent to the study area, with daily streamflow data inventory through October 2011.

Agency	Station identifier	Station name	Start date	End date	Count of daily values
USGS	04103500	Kalamazoo River at Marshall	Oct. 1948	Oct. 2011	15,914
USGS	04105000	Battle Creek at Battle Creek	Oct. 1930	Oct. 2011	28,988
USGS	04105500	Kalamazoo River near Battle Creek	July 1937	Oct. 2011	27,124
USGS	04105700	Augusta Creek near Augusta	Oct. 1964	Oct. 2011	17,196
USGS	04105800	Gull Creek at 37th ST near	Oct.	Feb.	3,065
		Galesburg	1964	1973	
USGS	04106000	Kalamazoo River at Comstock	Apr. 1931	Oct. 2011	27,219
Enbridge	MP 2.25	Kalamazoo River at 15 Mile Rd	Apr. 2011	Oct. 2011	155
Enbridge	MP 5.25	Impounded Kalamazoo River near Ceresco	Apr. 2011	Oct. 2011	161
Enbridge	MP 10.0	Kalamazoo River near boat launch C-3.2	Apr. 2011	Oct. 2011	163
Enbridge	MP 15.0	Kalamazoo River at South Mill Pond, Battle Creek	Apr. 2011	Oct. 2011	151
Enbridge	MP 18.75	Kalamazoo River at S Bedford Rd, Springfield	Apr. 2011	Oct. 2011	162
Enbridge	MP 21.5	Kalamazoo River at Custer Drive	Apr. 2011	Oct. 2011	152
Enbridge	MP 27.0	Kalamazoo River at Shady Bend near Augusta	Apr. 2011	Oct. 2011	157
Enbridge	MP 30.0	Kalamazoo River at Fort Custer RA near Augusta	Apr. 2011	Oct. 2011	158
Enbridge	MP 35.0	Kalamazoo River at Galesburg	Apr. 2011	Oct. 2011	143
Enbridge	MP 38.0	Morrow Lake near Galesburg	Apr. 2011	Oct. 2011	158

The existing data used to inform the hydrodynamic model includes the HEC-RAS cross-sections, longitudinal profile, water depths at specific stream gauge datum, Real Time Kinematic –Global Positioning System(–RTK-GPS") x, y, and z coordinates at poling locations, stream bed particle size and bulk density data. This data is used in the model setup to establish the characteristics of the river.

One of the parameters of the hydrodynamic model is the bathymetry of the river channel. In 2010, single and multi-beam sonar were evaluated to map the bathymetry of the Kalamazoo River. The shallow water depth across most of the river prohibited using these tools. Single beam bathymetry was completed for Morrow Lake and the western half of the Morrow Lake Delta. Multi-beam sonar was used on a portion of the area upstream of Ceresco Dam. Poling is used to determine the water depth and the RTK GPS reading provides x, y, and z coordinates which include top of water and sediment bed elevations. This altitude elevation data can be used in conjunction with the water depth to determine the top of sediment elevation. The top of sediment elevation collected at thousands of poling points is the basis for a bathymetric map.

The SOSG shall review the existing bathymetry data developed from the poling and sonar activities and the corresponding inputs to the hydrodynamic model. The SOSG shall identify and evaluate data gaps to determine their effect on the accuracy of the model. Additional poling may be conducted or bathymetric mapping (echo sounder, single beam or multi-beam sonar) may be used to fill the data gaps. The SOSG will ensure that all data collected is adequate to achieve the goals and objectives of the model and will identify data quality objectives.

Data collected in 2011 to setup and inform the model includes detailed poling cross-sections at specific HEC-RAS cross-sections, particle size and bulk density data from sediment cores, velocity monitoring, suspended sediment samples, and cohesion/erodibility data. The detailed poling cross-sections were completed at 23 cross-sections and water depth data was collected every 10 feet on a transect perpendicular to stream flow. Particle size and bulk density data was collected at 110 sediment core locations from the Kalamazoo River, Morrow Lake Delta, and Morrow Lake fan. Velocity data was collected with an ADCP at single point and transect locations. The velocity data is collected in 3D to capture the detail of the water velocity. The velocity profile horizontally and vertically has a direct relationship to amount and type of sediment transport. The suspended sediment data will be used to determine if and/or how much submerged oil is moving in suspension at different depths in the water column. The cohesion/erodibility data provides the model with specific values for the river sediment cohesiveness, critical shear stress, and erodibility.

The SOSG shall review existing data sets to identify data gaps. The methods needed to fill the data gaps shall be determined by the SOSG. The purpose of the data and the methods used to collect the data will be clearly communicated to the field personnel.

Terrain data for areas outside the channel and for sub-aerially exposed parts of the channel may be collected on a different day than hydraulic and bathymetric data are collected for each reach; however, the same Quality Assurance (–QA") procedure for opening and closing observations at a Survey Control Station (–SCS") shall be followed for terrain surveys as for bathymetric surveys. Any instrument substitutions shall be approved by the U.S. EPA in advance of data collection.

All bathymetric and terrain data shall be compiled as altitudes referenced to the current NGVD (NGVD 1988). Horizontal coordinates shall be referenced to Michigan's State Plane Coordinate

System, as specified elsewhere herein. All coordinates shall be expressed in international foot (1 international foot = 0.3048 meters).

Table 4.3.2 [Example of] Location of survey control stations and daily water-surface elevations during bathymetric survey, Tanana River near Tok, Alaska (from Conaway and Moran, 2004).

[WSELEV, water-surface elevation]

Location (Alaska State Plane zone 2, NAD 83, NAVD 88 survey feet)			
Description	**Easting**	**Northing**	**Elevation**
ADOT&PF Control point 1	1533071.81	3404825.83	1,627.08
ADOT&PF Control point 2	1533711.52	3404928.48	1,625.14
ADOT&PF Control point 3	1534655.68	3405031.25	1,643.88
ADOT&PF Control point 4	1534942.47	3404923.68	1,672.00
08-07-02 Starting WSELEV	1533724.71	3405027.71	1,609.87
08-08-02 Starting WSELEV			1,610.09
08-08-02 closing WSELEV			1,610.24
08-09-02 Starting WSELEV			1,610.41
08-09-02 closing WSELEV			1,610.48

Results from the bathymetric and terrain surveys shall be merged to produce a digital elevation model with sufficient data density and adequate spatial distribution that allows development of an accurate and stable, high-resolution hydrodynamic model. The acceptable standard error of the digital elevation model (–DEM") shall be determined by the SOSG.

4.3.6 Hydrodynamic Model Geometry, Parameterization, and Calibration

Software selection shall support the modeling of as many of the physical river-process mechanics as is practical given present state-of-the-science and practical considerations of needs for data quality, timeliness, and cost-effectiveness. The initial geometry of the model shall be defined using the DEM that merges results of the bathymetric and terrain surveys. Areas of ineffective flow (near shoreline where obstructed or where channel curvature creates secondary flow patterns) shall be identified where possible using velocity data obtained from ADCP or ADVM measurement sections. The model domain shall extend from sufficiently near the USGS streamflow-gauging station on the Kalamazoo River at Marshall (station ID 04103500) to assume its streamflow record as the inflow at the upstream end, to Morrow Lake Dam on the downstream end. Laterally, the model domain shall include all areas inundated by the peak flow having a 50-year recurrence interval (0.02 AEP).

Mesh configuration shall be summarized in tabular form (e.g., see Table 4.3.3) and shown for selected parts of the model domain in Figure 4.3.3. Results from surveyed or as-built engineering data provided for bridges and dams shall be incorporated into the final mesh prior to any model runs.

4.3.6.1 Model parameterization

Some model parameters account for energy losses associated with channel roughness and those associated with expansions and contractions of the hydraulic cross-sectional area. Overbank areas of channel cross-sections shall be assigned time-invariant roughness values, but main channel areas shall have bed form roughness values that vary as the dynamic interaction between hydraulics and sediment produces varying bed form states during the course of a simulation run. Expansion and contraction coefficients initially shall be set to 0.1 and 0.3, respectively, for all cross-sections in the model domain.

Other model parameters relate to sediment entrainment, transport, and deposition. Among these shall be characteristic metrics of the particle-size distribution (—PSD"), density and cohesion of the oil-sediment mixture, critical shear stress for entrainment, metrics of bank erodibility, and characteristic settling velocity. Settings for fixed-value parameters and boundary conditions shall be listed in tabular format (e.g., see Table 4.3.3). Water temperature and viscosity also are important considerations for sediment transport and settling, but time-series data from water- temperature monitoring shall be the basis for these.

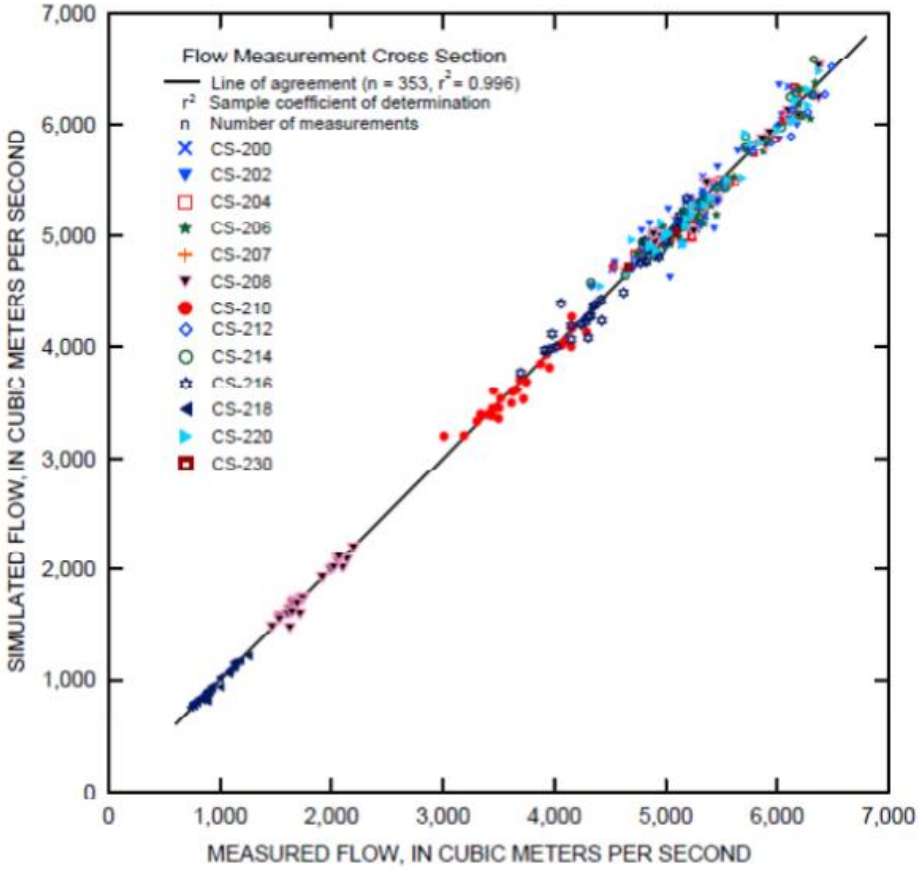
Hourly water-level data from the Kalamazoo River at Marshall gauging station shall serve as the upstream boundary condition for model runs. Water level data for Morrow Lake from a stage-only gauge (operated by Enbridge) shall provide the downstream boundary condition for model runs, whenever applicable. If data are available from the operator of Morrow Lake Dam, the discharged outflow from Morrow Lake would provide an additional check and downstream condition. Flow augmentations and lateral fluxes for tributary mouths and streambed seepage, respectively, shall be either estimated from tributary streamflow gauging stations (Table 4.3.1) or hydrologic models, as described herein.

4.3.6.2 Model calibration

Boundary conditions and model parameters shall be calibrated to data collected during the hydraulic surveys and available or published data from the USGS, State agencies, Enbridge, or other institutions. The drag coefficient for the channel plan form shall be calibrated through an iterative process where predicted water-surface elevations and current velocity magnitudes are compared to measured values. The lateral eddy viscosity also shall be calibrated though an iterative process and predicted velocity vectors shall be compared to those measured by the ADCP or ADVM. Available data for selected high-water marks (—HWMs") of known peak flows shall be compared to predicted water levels for similar, simulated upper-quartile and larger discharges. Other HWMs and published data for flood-inundation simulations of known peak flows may be used either as calibration or validation targets for this hydrodynamic model. If published data from previous simulations are used, differences in model construction and assumptions shall be noted and their effects on comparisons shall be discussed. Graphs shall be prepared showing the relation between measured and simulated values for the calibration targets. Summary statistical metrics shall be calculated to quantify the goodness-of-fit for the calibrated model.

Recorded or measured streamflow at intermediate and downstream sites shall be compared with simulated streamflows to estimate additional metrics for the calibration goodness-of-fit. An example graph showing results of this type for a model of the St. Clair River, Michigan-Ontario, is shown in Figure 4.3.4 (from Holtschlag and Hoard, 2009).

Figure 4.3.4 -- Relation between simulated flow and flow measured on the St. Clair River from 1996 to 2007 (from Holtschlag and Hoard, 2009)



4.3.6.3 Sensitivity Testing

Once a final calibrated model is obtained, Enbridge shall conduct sensitivity testing to evaluate the uncertainty of simulation results related to uncertainty in model-calibration parameters and other input parameters. Adjusted parameter settings shall be increased and decreased from their final settings in the following relative increments: 2, 5, 10, 15, 20, and 25 percent of the final setting used for the calibrated model. For each incrementally adjusted setting, a simulation run shall be used to determine the resultant effect on model sensitivity targets: water levels, velocities, discharge, suspended-sediment concentrations and loads, scour volume, and depositional volume. Effect on each target shall be expressed as a percentage departure from its value in the final, calibrated model.

Table 4.3.3 [Example of] Model parameters and boundary conditions used for simulations of the calibration discharge and the discharge having a 50-year recurrence interval at station Kalamazoo River at xx (after Conaway and Moran, 2004).

Model parameter or boundary condition	**Calibration discharge**	**50-year flood discharge**
Number of grid cells	100,000	200,000
Mesh spacing in stream-wise and transverse directions, in feet	5	5
Channel form drag coefficient	.004	.004
Bed form drag coefficient	.008	.006
Grain roughness coefficient	.020	.020
Overbank drag coefficient	.12	.12
Expansion coefficient	0.1	0.1
Contraction coefficient	0.3	0.3
Lateral eddy	4.3	4.3
viscosity, in ft2/s		
Discharge, in ft3/s	3,500	6,000
Initial water-surface elevation at downstream end, in feet	xx.xx	yy.yy
Stream gradient, in ft/ft	.00011	.00013
Sediment median size, in mm	.35	.35
Sediment d84 size, in mm	xx.x	yy.y
Density of oil-sediment mixture	x.xxxx	y.yyyy
Cohesion of oil-sediment mixture	x.xx	y.yy
Critical bed-shear stress for sediment entrainment	x.xx	y.yy
Bank shear strength	x.xx	y.yy
Bank tensile strength from roots	x.xx	y.yy
Characteristic settling velocity	x.xx	y.yy

4.3.7 Hydrodynamic Simulations Using Calibrated Model

Progress on model development shall proceed from the planning stages forward in a collaborative mode, with frequent, regular consultation with the SOSG, very similar to what was begun with the weekly calls for the hydrodynamic assessment work group. The final, calibrated model shall be used for testing scenarios of various management strategies. All scenarios shall be compared with a baseline simulation that contains no changes from existing conditions (Fall 2011 [specific date to be determined in consultation with the U.S. EPA and USGS]) in terms of geometry, sediment size distribution, sediment loading from upstream, or river management; this baseline simulation shall be referred to as the Fall 2011 baseline, and shall provide the capabilities indicated in Objective 1, thus demonstrating attainment of that purpose of the study. The Fall 2011 baseline results shall themselves be valuable for identifying velocity patterns and indicated sediment-depositional areas that correspond to a range of possible stream flow events. However, in the context of adaptive management many other benefits can be provided by simulating contemplated changes or additions to the suite of river management practices implemented in the study area.

Enbridge shall achieve study Objective 2 by simulation of a variety of streamflow conditions that represent the present flow regime, including flows in both below-median quartile of a flow- duration table for the Kalamazoo River, each above-median decile of a flow-duration table for the Kalamazoo River in the study area, and high-flow events that contain peak streamflows with return intervals of 1.5, 2, 5, 10, 25, and 50 years. Objective 3 shall be achieved through simulation of specific system scenarios, with the set of scenarios corresponding to varying combinations of streamflow, sediment inputs, oil-sediment temperature, and river-management practices and installations. The following Table 4.3.4 lists some of the scenarios envisioned for testing by use of the calibrated model with, as examples, hypothetical additions of dikes or chevrons to the channel structures, changes in channel roughness caused by introduction of large woody debris (~~L~~WD”), or construction of sediment collection areas. Selection of actual scenarios shall be made in consultation with the SOSG.

Enbridge shall achieve Objective 4 by transferring the model to a regulatory agency at the federal, state, or local level when submerged oil recovery is complete. Findings from the post recovery modeling study shall be communicated to officials working at all phases of river management.

Those planning or designing long term river-management strategies and experiments need to suggest scenarios to be modeled, and modelers shall provide results and interpretations to the planners/designers that inform adjustments to the implementation plans for each experiment. Predictive simulations using the final implementation plan for a river-management experiment shall indicate where deposition and other changes in channel geometry are expected to be the largest, and where sediment transport rates are likely to be at maximum. Those locations become the priority monitoring targets for that experiment. During an extended experiment and after its completion, the collected monitoring data shall be used by modelers to construct an updated version of the hydrodynamic model that represents conditions at the respective time. The updated version shall be re-calibrated using the monitoring data, and used to evaluate the ~~h~~ow?” and ~~w~~hy?” behind the experimental outcomes.

Clearly, achieving the goal of science impact on the river management process shall be an iterative and sometimes lengthy, demanding process. But finding the optimal long-term solutions for river management requires prudent application of the modeling results to achieve Objective 4 of the study.

4.3.8 Timeline for Hydrodynamic Simulations [Example]

Existing data and hydrodynamic assessment data collected during the Fall 2011 field work for import into the hydrodynamic model included HEC-RAS model cross-sections, longitudinal profile, water depths, stream bed particle size, poling downstream of Morrow Lake Dam, LSR poling, sediment core collection, velocity monitoring, suspended sediment samples, detailed poling cross-sections, and the cohesion/erodibility test. The schedule provided includes the existing and assessment data availability to upload to the model. The dates shown are when the data were available for upload. The Summer 2011 reference means the data were available before the hydrodynamic model scope was defined.

- Single Beam Bathymetry of Morrow Lake — Summer 2011
- Multi-Beam Bathymetry upstream of Ceresco Dam — Summer 2011
- HEC-RAS cross-sections — Summer 2011
- Longitudinal profile — Summer 2011
- Water depths at specific stream gauge datum — Summer 2011
- Stream bed particle size — Summer 2011
- Bulk Density data — Summer 2011
- Poling downstream of Morrow Lake Dam — October 2011
- Late Summer Reassessment poling — November 2011
- Detailed poling cross-sections — November 2011
- Sediment core collection — December 2011
- Velocity monitoring — December 2011
- Suspended sediment samples — December 2011
- Cohesion/erodibility data — December 2011

The phases of the hydrodynamic model are grid setup, configuration for flow and velocity, analysis of sediment and cohesion data, complete model configuration including sediment processes, model calibration, preliminary and baseline model scenarios, and modeling of various flow events and changes in river conditions. The model milestones are provided below.

- Provide bathymetry and terrain data to the SOSG — December 9, 2011.
- Model Grid setup and QC — December 16, 2011
- Configuration for flow and velocity — December 30, 2011
- Analysis of sediment samples and cohesion data — January 13, 2012
- Complete configuration including sediment processes — January 27, 2012
- Model calibration — February 10, 2012

- Preliminary and baseline model scenarios — February 24, 2012
- Sensitivity Testing — February 24, 2012
- Develop Scenarios/Various Simulations — March 23, 2012
- Completion of Simulations — March 23, 2012
- Run Modified Scenarios — April 6, 2012

A schedule will be developed with the SOSG to evaluate the draft component pieces of the model prior to the model milestone dates listed above.

Scenarios representing different flow events and structural control features shall be selected through consultations among Enbridge, the U.S. EPA, MDEQ, and with other stakeholder input. The results of the iterative scenarios will be reviewed by the SOSG and will allow review and adaptive management discussions, and runs of modified scenarios. It is expected that adherence to this timeline shall allow final planning, coordination, logistics, and staging for experiments to be completed by the end of March 2012. A report summarizing the simulations of target stream flow conditions and management scenarios shall be prepared and submitted by April 13, 2012.

Table 4.3.4 Partial listing of management scenarios to be simulated and compared with the Fall 2011 Baseline simulation.

Question addressed	**Stream flow conditions**	**Sediment conditions**	**Temperature conditions**	**River-management practices**	**Range of dates (if using a recorded flow scenario)**
Risk of having sediment transport over Morrow Lake Dam by a frequent winter high-flow pulse	Recorded high-flow event with peak discharge = 3,260 cfs at upstream gauge	Steady input concentration of 100 mg/L at 35th Street Bridge	Cold – 2 to 4 deg. C. for water; 4 to 7 deg. C. for sediment-oil mixture	No booms, curtains, dikes, chevrons, or sediment traps except existing Morrow Lake Dam	Jan. 2008 [specific range of days to be included to be determined in consultation with U.S. EPA and USGS]
Risk of sediment remobilization by E4.5 double-chevron removal	Uniform flow at above-median rate for Fall season; i.e., discharge = 870 cfs at upstream gauge [	Initial, instantaneous concentration of 100 mg/L spread over 40,000 ft^2 area immediately upstream of E4.5 control point	Cool – 4 to 6 deg. C. for water; 6 to 9 deg. C for sediment-oil mixture	No booms, curtains, dikes, chevrons, or sediment traps except existing Morrow Lake Dam	--

Question addressed	Stream flow conditions	Sediment conditions	Temperature conditions	River-management practices	Range of dates (if using a recorded flow scenario)
Effective location of sediment containment areas	Annual regime of streamflows for 3 different years: one in lower quartile of annual mean Q, one near median, and one in upper quartile.	Use sediment rating curves to estimate input concentrations at upstream gauges, and estimate sediment inputs from tributaries	Use interpolated estimates from NWS observation network	Include scenarios with only SCA traps, others with SCA traps plus booms/curtains	TBD
Effects of different agitation/recovery methods, e.g., aggressive agitation within Ceresco Dam impoundment	Annual regime of streamflows for 3 different years: one in lower quartile of annual mean Q, one near median, and one in upper quartile.	Use sediment rating curves to estimate input concentrations at upstream , and estimate sediment inputs from tributaries	Use interpolated estimates from NWS observation network	Compare currently used methods with: deeper, more aggressive agitation; and perhaps with sonic/ultrasonic	TBD
Other scenarios, TBD through SOSG discussions	TBD	TBD	TBD	TBD	TBD

[Notes: cfs, cubic feet per second; mg/L, milligrams per liter; R.I., recurrence interval; FD%, flow-duration non-exceedance percentage; ft^2, square feet; --, not applicable; all scenarios shall be simulated using full model domain and constructed as extensions of the fully calibrated Fall 2011 baseline; TBD, to be determined]

Data from quarterly monitoring activities through the Spring 2012 ice-out and snowmelt runoff periods shall be compiled and used to update the model for further simulations during the April-June 2012 quarter. Those simulations would focus on two goals: (1) understanding the river observations collected during December 2011through March 2012; and (2) predicting likely outcomes of a second series of management experiments (or modifications to pre-existing experiments) that would be planned for implementation during the mid-Summer to early-Fall 2012 period. Unforeseen developments in hydrologic, sediment, or oil conditions could motivate more frequent cycles of incremental scenario formulation, simulation, interpretation, decision making, and management

implementation. Nevertheless, a long-term timeline could be constructed on a backbone of semi-annual circuits of the adaptive-management cycle.

4.4 Temperature Effects on Submerged Oil

This Work Plan is to evaluate the effect of temperature on the relative occurrence of oil/sheen on the water surface upon agitation of sediment at various temperature ranges. The objectives of this study of temperature effects on submerged oil is to enhance the understanding of the effects that water and sediment temperatures have on submerged oil liberation and the subsequent effectiveness of recovery methods.

4.4.1 Overview

During recovery operations the fraction of oil that is recoverable by toolbox techniques released from the sediment underlying the water column by agitation. The agitation causes submerged oil to rise to the water surface where the oil is collected and appropriately disposed. The oil properties (e.g., density and viscosity) that facilitate its movement to the water surface are sensitive to temperature (Kong, 2004; Fingas et al., 2006). As water and sediment temperatures decrease, oil density and viscosity are both expected to increase. The study described in this Work Plan attempts to evaluate the temperature effects on the relative quantity of oil/sheen that rises to the water surface upon agitation of sediment at various temperature ranges.

4.4.2 Objective

The objective of the bench-scale study is to identify the lower threshold temperature at which the fraction of oil that is recoverable by toolbox techniques does not readily reach the water surface and sheen upon being mechanically agitated. The oil contaminated sediment behavior shall be observed in ranges of temperatures discussed later in the Work Plan. The threshold temperature shall be the temperature at which oil is absent at the surface or has only a light presence. The evaluation of the temperature effect shall be semi-quantitative because the threshold shall be determined relative to observations at other temperatures.

4.4.3 Study Procedures

Sediment and water samples shall be collected from the Kalamazoo River and transported to the field laboratory where the tests shall be conducted. The study design and data collection parameters are presented in Attachment D. The laboratory shall be housed in a field trailer or a house garage that is ventilated and contains adequate space for the study. Appropriate health and safety procedures shall be followed in accordance with the Site Health and Safety Plan (“HASP”) (Enbridge, 2010a) and any other approved applicable guidance. The U.S. EPA and/or MDEQ observers shall provide oversight for the entire testing process.

4.4.3.1 Sediment Collection

River sediment shall be obtained from a depositional area that is likely to contain heavy oil based upon screening using poling and selected in collaboration with the SOSG. A petite Ponar® sampler or similar device shall be used to collect and place the grab sample of sediment (approximately 6 liters each) into each of five 7½-liter plastic containers. The petite Ponar® or alternative sampling

method shall be deployed to sample shallow sediments where oil is believed to be present, not greater than 5-inches in depth. Sediment samples in all five containers shall be observed and photographed under natural and UV light and the appearance of the sediment, texture, color, debris, and other notable features, shall be described. The general presence of sheen/oil on the sediment shall be noted under visible light and confirmed using a portable UV light viewed under a light blocking hood. The presence, size, and percent abundance of globules under both visible and UV light shall be recorded.

Two of the five sample containers shall be covered with river water in the field by tilting the container at an angle and very gently pouring river water into it before slowly returning it upright being careful not to disturb the sediment. These samples shall be agitated in the field to confirm that the sediment releases sheen upon agitation to ensure that the location selected for sampling contains sheen-generating oil. If the samples do not produce sheen, consideration of river water and sediment temperatures shall guide operational decision to warm these two samples and repeat the agitation and evaluation as described: if the warmed samples still produce no sheen, an alternative area of submerged oil shall be sampled. The three sample containers that are not agitated in the field shall be covered with a lid for transport to the field laboratory for the study and the two agitated samples shall be disposed following proper waste disposal procedures. Samples of sediment and river water retained for the bench study shall be chilled to between 32° F and 40° F, but not frozen, and retained cold until the sample is used in the bench study. Sample disturbance and movement shall be minimized, and every sample shall be handled in the same way. In addition to the sediment grab samples, approximately 23 liters of river water shall be collected for the study. Sediment in the three containers brought in from the field shall be sampled and analyzed for particle size distribution.

4.4.3.1.1 Sampling Location

The sediment samples for testing shall be collected at a depositional location where sheening and globules released by poling have indicated the presence of ―heavy" sheening from submerged oil, which has been presumed to indicate substantial concentration of oil in sediment. The initial location and representative depositional setting shall be selected in consultation with the SOSG to be representative of an agreed upon depositional setting (e.g., backchannel, oxbow, cutoff, dam, island, or delta) and sediment type (very fine sand, silt or organic muck). The study design may be applied to different depositional environments and sediment types after completion of the initial study depending on review of study design effectiveness by the SOSG. One sampling crew comprised of three persons with the U.S. EPA and/or MDEQ oversight shall collect the samples during the course of one day.

4.4.3.1.2 Sampling Methods

Sediment samples shall be collected following the applicable sediment sampling SOP presented in the approved SAP as amended (Enbridge, 2011b) particularly Section 6.3.2 (entitled ―Ponar® or Ekman dredge Sampling") found in SOP EN-202.

4.4.3.2 Controlled Temperature

The sample design includes testing three replicate samples at five different target temperatures for a total of 15 trial tests as summarized in Attachment D. Each replicate sample shall consist of equal volume aliquots from each of the three remaining undisturbed grab sample containers, for a total

replicate sample volume of 400 milliliters (~~m~~l"). In order to maintain as undisturbed sample as possible, the splits for the lab analysis shall be taken directly from the grab sample. For example, replicate sample #1 at temperature #1 shall consist of approximately 133 ml of sediment taken from each of the three grab samples for a total sediment sample volume of approximately 400 ml. The aliquots shall be placed into a 2-liter beaker (7.5-inches tall and 6.25-inches in diameter). A split sample shall then be collected from each of the three grab samples using the same sampling methods, and prepared for laboratory analysis of a single composite sample. The split sample shall be homogenized, and the sample shall be analyzed for TPH measured as DRO and ORO, and TOC. The sediment remaining in the replicate sample beakers shall then be covered by river water, filling the beaker to 1½ liters. Three beakers shall be placed into a temperature controlled, bench top circulating water bath that is set at the desired target temperature. Target water bath temperatures are 35° F, 45° F, 55° F, 65° F and 75° F. Samples shall initially be in storage at temperatures between 32° F and 40° F and shall be placed into the water bath and allowed to equilibrate for one hour, then water and sediment sample temperatures shall be monitored using a digital thermometer (e.g., Omega HH11B) and recorded at 15 minute intervals until both water and sediment temperatures are stable and within 4° F of the target temperature. The water and sediment may equilibrate at different temperatures and at different times given the different heat capacities of the two matrices. Equilibration and monitoring times may be adjusted in response to the time required to achieve stabilization, if warranted. Other changes to sample design or procedures that result from lessons learned during the study shall be documented.

Once the sediment and water temperatures are stabilized within the target temperature range, the initial appearance and percent coverage of sheen and the number of globules on the water surface shall be recorded. The percent of sheen coverage shall be estimated by counting the number of squares on a clear rigid acetate grid (e.g., 5 by 5 equals 1 inch) that is placed on top of the beaker, which has a surface area of approximately 0.213 square feet.

4.4.3.3 Sediment Agitation

Samples shall be agitated in the temperature controlled environment and the parameters presented in Attachment D shall be recorded. Samples will be examined under visible and UV light and documented via photographs as well as with field notes to confirm the presence of oil. Prior to each agitation, sheen on the surface of the water in the sample container shall be removed with sheen net, wipe or other absorbent device. As the sheen is removed, care shall be taken to reduce motion so that the sediment in the container is not agitated, and also so that the sheen is not further smeared onto the edges of the sample container.

The general appearance of sheen (gray, silver, metallic/transitional) and percent coverage and the presence, size, and abundance of globules on the water surface shall be noted prior to the initial agitation. Using a Nalgene® rod (selected to be representative of poling), the sediment shall be stirred, initially with one complete circle, and a description of the appearance of sheen and globules on the water surface shall be recorded.

Photographs under visible and UV light shall be taken; the angle of incident light shall be adjusted to best reveal the sheen in the image. Following the initial stir and observations, the sheen shall be removed from the surface of the water. The sediment shall then be stirred three more times; this second agitation shall occur within 15 minutes of the initial agitation (otherwise, temperatures of

water and sediment would need to be re-measured prior to the second agitation). The three stirs shall start in the middle of the sample and work outwards with each turn. The appearance and percent coverage of sheen and globules shall be noted after completing agitation and photographed under visible and UV light.

For consistency, the same person shall agitate each replicate sample at nearly the same temperatures within the targeted temperature range, while making every effort to follow the exact same procedures. Similarly, a single observer shall be estimating the percentage surface area coverage for all samples. Photographs of the sheen on the surface of the water shall be taken for each agitation as stated above. For at least 25% of the visual observations of the amount of sheen present, the photographs shall be quantitatively analyzed to confirm the accuracy of visual estimation of percentage cover by sheen.

Water and sediment temperatures shall be re-measured immediately following the recording of all observations and photographs to verify that conditions remained within the target temperature range.

4.4.3.4 Final Warm Agitation

All replicate sample sets shall be warmed by heating the bath to 75° F and the sediment shall be agitated again with three stirs of the sediment as described above. The sheen shall be removed from the surface of the water prior to heating so that any oil liberated during heating is documented. Agitation at a warm temperature following the bench test shall be used to confirm that a lack of or a reduced amount of sheen was due to the effects of the lower temperature and not a lack of oil in a sediment aliquot. After the final warm agitation, sheen will be removed. The water will then be decanted and the presence or absence of sheen/oil in the remaining sediment will be documented via photographs using visual and UV observations.

4.4.4 Data Evaluation and Reporting

The data on presence or absence of oil/sheen at tested temperatures shall be analyzed to evaluate the effects that temperature has on submerged oil liberation. Consistency between replicate samples within a temperature range shall be assessed to evaluate reliability and uncertainty of the results. This information can be used in the design of any subsequent studies to clarify the results or investigate oil bearing sediment from other depositional environments.

A completion report shall present the experimental results and explain the effects of temperature on the liberation of oil/sheen from sediments. The report shall address the application of the results of this or possible additional studies (as evaluated by the SOSG) to different depositional environments, and shall discuss the study design effectiveness. Results and conclusions may be used to help guide future submerged oil recovery efforts. As appropriate, the report shall provide applicable conclusions based on geomorphic settings and depositional environments that can be classified as similar.

4.4.5 Insitu Temperature Study

Submerged oil assessment and recovery work performed during October 2011 was completed in accordance with the *Submerged Oil Recovery Standard Operating Procedure* (Enbridge, 2011). In support of the submerged oil recovery operations a river study was conducted between October 14 and 29, 2011 to assess the relationship between liberation of submerged oil from sediment as a

function of water temperature. Water temperature potentially affects the liberation of submerged oil since physical characteristics including viscosity, solubility, and volatility are typically influenced by temperature. Recovery work by some methods may be less effective as water temperature decreases during the late fall and winter seasons. Poling methods at selected locations, not subjected to recovery activities on the Kalamazoo River, were used to agitate sediment and document oil release as a function of water temperature. A Report of Findings will be developed as part of the above temperature effects bench-study. This Report will outline the methods and procedures followed and the results of the river study.

4.4.6 Additional Temperature Effectiveness Studies

The need for additional field or laboratory temperature effectiveness studies shall be evaluated by the SOSG. The SOSG shall evaluate additional information from this study as well as other studies and multiple lines of evidence as necessary to understand the effectiveness of overall oil recovery. In addition, water and sediment temperature data shall be collected from established USGS and site-specific staff gauges on an ongoing basis for use in validating current and future temperature effects studies and in other applications, as appropriate.

4.5 Submerged Oil Quantification

A scientifically-based model shall be used to calculate the volume of submerged oil for the entire affected water way. This includes Talmadge Creek and the Kalamazoo River (from the confluence with Talmadge Creek through a location immediately downstream of the Morrow Lake Dam), corresponding to MP 0.0 through MP 40.00.

The model shall be populated with chemical, physical, and geotechnical (i.e. sediment thickness) data obtained from sediment cores collected after submerged oil recovery activities as well as post-recovery poling activities that were completed in 2011. This process shall be similar to that used to perform the submerged oil quantification calculated based on pre-Summer 2011 oil recovery activities. The Spring 2011 Quantification Model and Report will be finalized in consultation with the SOSG. Only data collected under the U.S. EPA and/or MDEQ approved work plans shall be used in the proposed evaluation.

4.5.1 Objectives

The objective is to quantify the volume of submerged oil from the Enbridge Line 6B Incident that is present in the sediments in Talmadge Creek and the Kalamazoo River from the confluence with Talmadge Creek down to Morrow Lake at the time of each quantification event. This information will be used by the SOSG in consideration of future activities.

Quantification of submerged oil shall be performed at the following times, and at other time directed by the U.S. EPA:

- Fall 2011– after Summer/Fall 2011 oil recovery activities are complete;
- Spring 2012 – prior to performing 2012 oil recovery activities; and
- Fall 2012 – after Summer/Fall 2012 oil recovery activities are complete.

4.5.2 Quantification Model

This section describes the numeric model that shall be used to estimate the amount of submerged oil remaining in the Kalamazoo River (including the Morrow Lake Delta and Morrow Lake).

A model was previously developed to quantify the amount of submerged oil in sediment identified during the Spring 2011 reassessment of Talmadge Creek and the Kalamazoo River (including the Morrow Lake Delta and Morrow Lake). This same conceptual model shall be the basis for Fall 2011 (post-2011 oil recovery activities), Spring 2012 (pre-2012 oil recovery activities), and Fall 2012 (post-2012 oil recovery activities) models for submerged oil quantification.

These subsequent models shall use:

- Variable 1 – Measured TPH concentration in sediment. An alternative to using TPH results may be considered by the U.S. EPA in consultation with the SSC Group.
- Variable 2 – Sediment bulk density.
- Variable 3 – Lateral extent of oil-impacted sediment.
- Variable 4 – Vertical extent of oil-impacted sediment.
- Variable 5 – Density of released oil, adjusted for weathering.

The models shall utilize a spreadsheet to calculate the volume of impacted sediment. Once calculated, the mass of oil impacted sediment shall be determined from the impacted volume and sediment bulk density. These volume calculations shall be performed separately for different sub-regions of the total oil-impacted river system, where individual sub-regions will be reviewed with the SOSG and may correspond to: 1) subareas of the river designated by similar submerged oil category: heavy, moderate, or light, as determined by poling (i.e., poling-delineated areas): and 2) separate vertical layers or strata within those subareas (e.g., defined by similar sediment type). Subsequently, the mass of oil present in each stratum shall be calculated based on a representative concentration value (either a simple summary statistic or the estimated value from a linear statistical model) of laboratory- reported TPH concentrations and total impacted sediment mass. Finally, the volume of submerged oil shall be calculated from an approximation of the density of the weathered crude. The algorithm used in the model shall be as follows:

Gallons of Oil (gal) in stratum $\boldsymbol{j}$ =

$$\{[D_{\boldsymbol{j}}\ (\text{inches}) * A_{\boldsymbol{j}}\ (\text{acres}) * P_{\boldsymbol{j}} * 4{,}046.86\ (\text{m}^2/\text{acre}) * 0.0254\ (\text{m/inch})$$

$$*P_{Sed\boldsymbol{j}}\ (\text{g/cm}^3) * 10^6(\text{cm}^3/\text{m}^3) * TPH_{\boldsymbol{j}}\ (\text{mg/kg}) * 10^{-6}(\text{kg/mg})\ ]$$

$$/P_{Oil}(\text{g/cm}^3)\} * 10^{-3}(\text{L/cm}^3) * (0.2642\ \text{gal/L})$$

Where:

A_j = Total Area of Interest (acres)

P_j = % of Area of Interest with TPH Concentration (decimal equivalent)

D_j = Thickness of oil impacted sediment layer (inches)

$P_{Sed\,j}$ = Dry density – sediment (g/cm^3)

P_{Oil}= Density – oil (g/cm^3)

TPH_j = Representative concentration (e.g., linear model estimate, arithmetic mean, median, and/or geometric mean) of submerged oil concentration in stratum ***j*** (mg/kg) –. Coverage provided for light, moderate, and heavy poling designations with the mean TPH value used to calculate the concentration of each tenth foot interval of the array for sample cores.

Data sources include:

P_j (% of area of interest with TPH concentration) from poling-delineated areas for ~~"h~~eavy" and ~~"m~~oderate" categories, and either mixing-model or frequency based analysis for ~~"l~~ight" and ~~"n~~one" categories.

D_j (Depth of oil layer) = from thickness of oil-containing sediments as indicated by analytical chemistry data and/or statistical analysis, and/or supplemental data collected from field sampling.

$P_{Sed\,j}$ (Dry density – sediment) = from stratum mean of estimated bulk density measured in sediment containing submerged oil.

$P_{Oil\,j}$ (Density – oil) = from weathering adjustment applied to estimated density of released crude oil, which was assumed to be 0.9285 (g/cm^3) *http://www.crudemonitor.ca/* – 5-year average as defined below.

An example of the model is presented below:

Morrow Lake Delta

Total Area of Interest (acres) =	37	1 acre = 4,046.86	m^2
% of Area of Interest with TPH Concentration =	100.0%	1 " = 0.0254	m
Cold Lake Crude Density =	0.9285 ± 0.0005	g/cm3	
Thickness of oil layer (inches) =	6 "	1 L = 0.264172052	gallons
Mean TPH Concentration ± S.D. (mg/kg) =	101 ± 111		
Density of sediment (g/cm^3)=	1		
(From bulk density of 1.125 and 48.5% moisture)			
n = 44			
Volume of impacted sediment with TPH concentration =		22,819.41	m^3
Mass of sediment impacted based on impacted volume and bulk density =		22,819.41	kg
Mass of oil based on concentration =		2,297.0	kg
Volume of oil based on Cold Lake Crude density =		2473.86	L
Gallons of oil =		**654**	**gallons**

4.5.2.1 Model Architecture

The model shall have an open architecture, whereby it is adaptable and flexible to approximate the amount of oil present in the sediment within specific geomorphic strata, river reaches/lake areas, or broader reaches/lake areas with minimal modifications. It shall be automated and based on the six specific parameters/variables listed above, or more as directed by the U.S. EPA. Output shall be standardized and list key parameters/assumptions used in the model along with summary statistics and evaluations of uncertainty.

4.5.3 Input Data

4.5.3.1 Variable 1 – Measured TPH Concentration in Bed Sediment

The concentration of submerged oil in the bed sediments as of Fall 2011shall be estimated using an estimated 100 sediment cores (or other quantity as directed by the U.S. EPA) collected from apparently oil-containing areas of streambed, plus at least 10 additional cores from areas that demonstrated light qualitative indications of oil. Subsequent sediment core collection shall follow the adaptive management principle to assess the submerged oil in the dynamic riverine system. The purpose of the sediment cores shall be to obtain sediment samples which shall be analyzed to evaluate remaining submerged oil in the Kalamazoo River.

Sediment samples from the sediment cores shall be analyzed for TPH that includes DRO and ORO, and other parameters as directed by the U.S. EPA. The total TPH value provides a potential measure of submerged oil present in the sediments. In the absence of specific TPH data for various elevations at a given location, existing TPH data from that location shall be applied to all depth horizons where qualitative evaluation (i.e., UV fluorescence) indicates the presence of oil.

Information regarding location and methodology for sediment core collection is outlined herein related to the hydrodynamic assessment.

Results for TPH and other variables in the model shall be compared between areas delineated by the light, moderate, and heavy poling designations. An analysis of uncertainty shall be performed for all variables in the model, and for the model outputs (volumes of oil) that considers and incorporates all known sources of error and uncertainty. TPH concentrations shall be presented with standard deviations and the statistical confidence interval(s) shall be presented and discussed in accordance with the statistical validation described herein.

4.5.3.1.1 Background TPH

At a total of 36 background sediment sampling locations (collected upstream of the affected portions of the Kalamazoo River, Battle Creek River, and Talmadge Creek), bed-sediment cores have been collected, sampled, and analyzed. Subject to future U.S. EPA approval, the background data may be included in the submerged-oil volume calculator to account for background TPH concentrations and as a comparison to the presumed historical (i.e., pre-release from Enbridge Line 6B Incident) TPH present in the portion of the Kalamazoo River affected by the Enbridge Line 6B Incident.

The method for incorporating background TPH is currently being evaluated and may be applied to the Spring 2011 submerged oil quantification; therefore, the same method for incorporating background TPH shall be applied to data collected and used as described herein.

4.5.3.2 Variable 2 - Sediment Bulk Density

As described in the hydrodynamic assessment, bed sediment cores paired with each primary core were collected in Fall 2011 to determine the sediment bulk density in the Kalamazoo River. Results from these analyses shall be used for quantification of submerged oil as of Fall 2011.

4.5.3.3 Variables 3 and 4 - Lateral and Vertical Extent of Oil- Impacted Sediment

Poling, analytical data, and core logging data shall be analyzed to infer the lateral and vertical boundaries of sediment impacted by submerged oil. The culmination of these factors shall result in a determination of the volume of sediment containing submerged oil, subject to approval by the U.S. EPA.

The determination of the lateral and vertical extent of submerged oil shall include the area of sediment which poled ~~"~~light", ~~"~~medium", and ~~"~~heavy". The area for sediment which poled ~~"~~medium" and ~~"~~heavy" will be based directly on the field observations during poling assessments. A method will be developed to identify the sediment areas which poled ~~"~~light" and reviewed with the SOSG. The area which poled ~~"~~light" will incorporate fluvial geomorphic environment types. All determinations for lateral and vertical extent of submerged oil shall extend to locations of ~~"~~none", and shall not arbitrarily assign an area to the ~~"~~light" indications category, as was previously performed. As a minimum, the model shall be applied separately to the following three categories: ~~"~~light", ~~"~~moderate", and ~~"~~heavy". The lateral extent of ~~"~~light" poling shall be mapped similar to the ~~"~~moderate" and ~~"~~heavy" categories. Further, categorization and oil-volume modeling by fluvial geomorphic environment types shall also be performed.

This information shall be used in the model to calculate the submerged oil volume from the sediment sample locations.

4.5.3.4 Variable 5 - Density of Released Oil

The density of weathered oil (–ρ_{Oil}") is developed as an adjustment to the assumed density of the crude oil spilled. Based upon a review of Enbridge transportation records and analysis of samples collected by Enbridge after the pipeline restarted, the release appears to have occurred at or about the time that the latter end of a batch of Western Canadian Select (–WCS") was passing through the pipeline near Marshall, Michigan and a batch of Cold Lake (–CL") crude had begun.

The composition of the oil released was approximately 77.5% CL and 22.5% WCS. Using this composition (77.5% CL and 22.5% WCS), and the 5-yr average density for each (0.9283 g/cm^3 for CL and 0.9290 g/cm^3 for WCS from *http://www.crudemonitor.ca/* on August 10, 2011), the estimated combined density for a 77.5% to 22.5% mixture would be 0.9285 g/cm^3, which is equivalent to the CL 5-year average. As the nature and cause of the release is still under investigation by National Transportation Safety Board, this determination is based on a number of assumptions regarding the nature and timing of the release. The estimated density of oil shall be adjusted for the probable loss of volatile constituents/fractions and any other appropriate weathering effects, and the resulting adjusted density shall be used for oil-volume calculations.

4.5.4 Statistical Evaluation of TPH Data

Sediment TPH data shall be evaluated using empirical and statistical methods to assess data distributions and relationships within TPH concentration data to estimate the submerged oil present within the river system. Only data collected under the U.S. EPA and/or MDEQ approved work plans shall be used for this task.

The statistical evaluation shall be used to support the calculation of submerged oil in Talmadge Creek and Kalamazoo River sediment, and shall consist of the following elements:

- Evaluation of the dataset to determine if lithology, depth/thickness, and/or other factors result in specific groupings or populations of data enabling segregation and/or separate statistical evaluation/testing;
- Determining a probability mass function to define the discrete probability distributions of the population(s) identified in the evaluation;
- Calculating interquartile ranges, standard deviation and variance of the populations identified in the evaluation;
- Evaluating the various geomorphic surface types; and
- Developing a statistically-based method for approximating the amount of oil present and confidence interval for this estimate within the Talmadge Creek and Kalamazoo River.

The evaluation shall use collected data in all oil-containing sediment areas (light, moderate, and/or heavy). Depending on the population(s) distributions (i.e., normal vs. not normal or skewed determined by normality tests such as Shapiro-Wilk, Anderson-Darling, or as most appropriate to the dataset), parametric or non- parametric (e.g. Kruskall Wallace, Mann-Whitney) statistical significance tests shall be conducted, as warranted and as approved by the U.S. EPA. If required based on the outcome of the empirical and/or statistical evaluation, approximation of the amount of oil present and confidence interval for this estimate may vary per river segment, with the total amount of submerged oil being the sum of such individual segments. Descriptive statistics (e.g.

mean, median, range, standard deviation, confidence interval) along with quartile plots and other graphical presentations of the data shall be provided.

4.5.5 Reports

A report shall be submitted to the U.S. EPA following the completion of each quantification event. Each report will present the data, calculations, and results.

5.0 OIL RECOVERY

5.1 Objectives

Perform additional oil recovery actions, as necessary, to meet the U.S. EPA Order.

5.2 Submerged Oil Recovery

Submerged oil recovery actions shall be determined by the U.S.EPA FOSC who will consider the results of the studies outlined in this Work Plan. Potential environmental consequences of implementing specific oil recovery actions shall be evaluated by the U.S. EPA. Evaluations may include considerations of the impacts to the environment of specific recovery actions, such as:

- River bank erosion from boat usage;
- Loss of habitat for aquatic life from large woody debris removal;
- Potential for increased erosion during flood conditions;
- Migration of sediment at an abnormally high rate due to agitation techniques;
- Damage to the benthic community from agitation of the river sediments;
- Injury and death of wildlife due to equipment and boats on the river; and
- Loss of wooded wetland habitat due to excavations.

Submerged oil recovery options that shall be considered by Enbridge include, but are not limited to, the following:

- Dredging of oil-containing sediments;
- Agitation of sediments coupled with oil/sheen collection;
- Installation and maintenance of sediment collection structures/devices; and /or
- No further action.

The need for further active oil recovery shall include an evaluation of ecological considerations, as well as an evaluation of the potential benefits and consequences of active oil recovery, or the lack thereof. This evaluation and decision of adverse ecological risk shall be made solely by the U.S. EPA FOSC following consultation with the SSC Group. The OSG, SOSG, and Containment Science Groups (–ESG") will provide information and recommendations to the SSC Group for their consideration in evaluating ecological risks and advising the FOSC.

Submerged oil recovery shall be addressed using a top down approach working upstream to downstream within each of the three defined sections of the river. The first section shall consist of a portion of the river starting at the confluence of the Talmadge Creek and the Kalamazoo River and ending at the Ceresco Dam. The second section begins at the Ceresco Dam and ends at the Battle Creek impoundment. The final section runs from the Battle Creek impoundment to the Morrow Lake Dam.

5.2.1 Winter 2011 Submerged Oil Recovery Actions

Over the winter months, passive recovery locations for submerged oil activities shall be evaluated by the SOSG. Passive recovery techniques shall be used to collect submerged oil mobilized by natural river flow conditions. The identification of these locations shall be informed by the hydrodynamic Model, LSR 2011 results, historic poling data, and fluvial geomorphic observations. Structures designed for collection of submerged oil shall utilize the dynamic nature of the river while minimizing the ecological impact of recovery activities on the river system. Additional discussion of the evaluation, installation, and maintenance of sediment collection devices and locations is provided in Section 7.

Active recovery of submerged oil may occur via the use of approved techniques at select locations as determined by the SOSG, OSCAR, and other advisory groups identified by the U.S EPA.

5.2.2 Spring/Summer 2012 Submerged Oil Recovery Actions

Active and/or passive submerged oil recovery actions shall occur throughout Spring/Summer 2012 based on the results of Spring 2012 reassessment activities, SSC Group and SOSG recommendations to the FOSC, and other factors. Submerged oil recovery activities using agitation techniques shall be conducted only while water and sediment temperatures are conducive to submerged oil recovery as determined through the results of the temperature effects studies described in Section 4 and shall be based on techniques presented in the approved Summer 2011 Strategic Work Plan and Dredging Supplement, or approved alternate means and methods. Although work may be conducted pursuant to the U.S. EPA Order, it shall not obviate the need to comply with all federal, state and local permitting, monitoring, and other requirements.

Addenda to this Work Plan outlining specific active and passive submerged oil recovery locations, activities, equipment, and procedures shall be submitted prior to implementation. Work Plan addenda shall take into account all potential environmental impacts as evaluated by the SOSG and SSC Group when outlining proposed activities.

5.3 Shoreline and Overbank Oil Recovery

Shoreline and Overbank oil recovery actions shall be conducted based on the OSCAR Branch evaluations of reassessment results, location-specific recovery work plans submitted to the U.S. EPA, and based on data obtained from expedited remedial investigation activities pursuant to the MDEQ approved work plans.

If the FOSC determines that additional recovery actions at impacted shoreline and overbank locations shall be addressed under the U.S. EPA Order, the appropriate permits shall be obtained prior to the commencement of oil recovery actions. Permit compliance requirements such as water quality monitoring shall be conducted pursuant to applicable SOPs.

One or more of the approved shoreline and overbank oil recovery techniques shall be implemented to recover oil, sheen, or impacted soils. The selection of the technique or techniques for each impacted area shall consider: accessibility; ecological sensitivity and benefit/consequence; type of oil impact present; depth of oil in soil; and other factors.

Approved oil recovery techniques for impacted floodplain areas are presented in the *Overbank Oil Recovery SOP* (included as Attachment E to this Work Plan). Other overbank oil recovery procedures and requirements shall follow those presented in Sections 2.0 and 3.0 of the approved Summer 2011 Strategic Work Plan, or via alternative procedures and methods approved by the U.S. EPA.

6.0 FALL 2011, WINTER AND SPRING 2012 CONTAINMENT PLAN

The objectives of the containment plan for Fall 2011 and Winter/Spring 2012 are to implement a strategy in the Kalamazoo River/Morrow Lake Delta/Morrow Lake to prevent further migration of oil sheen and/or submerged oil into Morrow Lake and to prevent migration of oil sheen and/or submerged oil from Talmadge Creek into the Kalamazoo River. At the time of document submittal, the Fall 2011 containment removal activities outlined within this section have been completed.

Considerations included in accomplishing these objectives are:

- Personnel and public safety;
- Limit impact to downstream receptors such as culverts, bridge structures, and dams in the river;
- Removal of surface containment features prior to winter freeze up in an efficient manner, particularly in the Morrow Lake Delta and Morrow Lake;
- Development, installation, and maintenance of a submerged oil containment plan to enhance sedimentation in the Morrow Lake Delta, and to control further migration of submerged oil into Morrow Lake and potentially over the Morrow Lake Dam. Submerged oil containment measures may be implemented at other areas in the Kalamazoo River based on results of hydrodynamic modeling;
- Manage any winter containment sites that are left in place; and
- Installation of Spring 2012 containment features according to an addendum to this Work Plan outlining the specific Spring 2012 Containment Plan.

Containment will be removed during Fall 2011 on a priority basis and in a controlled systematic manner under the direction and approval of the U.S. EPA. Containment deployment in Spring 2012 will be based on weather and site conditions, predictive modeling of Spring submerged oil work sites, and at the direction and approval of U.S. EPA.

This containment plan is based on the current strategies that are to be implemented in the fall 2011 and Winter/Spring 2012 work seasons. The identified containment removal and deployment strategies may be modified if any changes in this Work Plan take place based on weather conditions, Spring 2012 reassessment findings, river characteristics, results of hydrodynamic assessment components as detailed in Section 4.2, presence of surface or subsurface residual oil, or any other factor that could cause a change in this Work Plan.

6.1 Fall/Winter Containment Removal Procedure

Containment removal will be executed in a controlled manner at the recommendation of the Containment Branch Science Group and the direction and approval of the U.S. EPA. Visual monitoring of sediment and sheen levels downstream of the containment during containment removal will be conducted by field inspectors and from over-flights. If visual levels of sediment or sheen are noted during the observations, the conditions will be noted and sheen collection will be performed using sheen sweep boat(s). The addition of temporary downstream containment may be required.

Containment approved for removal shall be decommissioned as follows:

- Non-impacted debris accumulated in the retention area of the boom shall be collected and properly disposed. Residual sheen in the contained area shall be removed with sorbent sweep. Boom determined to be collecting new sheen shall not be removed without prior approval from the U.S. EPA.
- The lines securing the downstream end of the containment shall be released starting with the shoreline protection. The retention area line shall then be slowly released allowing the containment to settle onto the upstream anchor. If excessive levels of sediment or sheen are noted the shoreline retention line can be re-secured to allow them to settle out.
- Any sediment or X-Tex curtain attached to the boom shall then be cut free and loaded into boats and taken for disposal.
- Boom shall be towed to the nearest boat launch where it shall be loaded directly from the water into roll-off bins. Boom shall be taken for decontamination and repairs. Boom shall then be sorted and properly stored for winter to prevent dry rot and UV damage. Any boom that is too damaged shall have the metal fittings removed and be properly disposed.

6.2 Removal Priority and Scheduling

Priority sequence for removal is as follows:

- Removal of containment associated with submerged oil sites;
- Removal of control point containment; and
- Removal of protective containment points associated with OSCAR sites.

This sequence is based on several factors listed below:

- Areas with the potential to have ongoing sheen issues should be removed last to prevent additional impact to downstream receptors.
- Control points should be left in place until submerged oil operations are completed.
- Enbridge shall continue consultation with STS Utilities regarding placement and removal schedules for all containment between Morrow Lake and Morrow Lake Delta (35th Street to Morrow Lake Dam).
- OSCAR locations should be removed as late as reasonably possible. OSCAR sites that are in sheltered locations, where ice damage is not anticipated, may be left in place and monitored through the winter.
- Containment shall be removed from OSCAR sites that have received determination as being consistent with the U.S. EPA Order.

- The presence of frazil ice or dislodged sheet ice flowing within the main river channel.

The schedule for the containment removal plan shall be based on the above priority sequence. The implementation of the containment removal plan is largely dependent on fluctuating weather and river conditions and may be delayed by a down turn in either of these factors. If, due to fluctuations in the weather, the potential for ice or debris dams increases once containment removal has begun, removal activities shall be limited. Additionally, any remaining boom shall be monitored for a potential loss of integrity so that corrective actions can be taken.

6.2.1 Submerged Oil Containment Removal Schedule

Submerged oil containment shall be removed as sites after the U.S. EPA has directed Enbridge to discontinue submerged oil recovery activities due to low water and sediment temperatures and has approved the removal. Removal of submerged oil containment sites shall generally be conducted following the top down approach.

6.2.2 Control Point and Protective Containment Removal Schedule

Control point and protective containment removal shall begin after the completion of submerged oil activities, with the approval of the U.S. EPA. High priority sites in the Kalamazoo River, Morrow Lake Delta, and Morrow Lake that shall require further evaluation for removal are:

- MP 36.6N;
- MP 36.8 N;
- Morrow Lake Delta Channel 6;
- MP 37.25; and
- MP 37.75.

Enbridge shall remove all surface containment between 35th Street Bridge and Morrow Lake Dam by November 18, 2011 as per the request of STS Utilities or as otherwise negotiated at the direction of the U.S. EPA. The confluence containment point (MP 2.25) shall remain in place throughout the winter. The projected order of removal shall be:

1. MP 6.0;
2. MP 10.8;
3. D 3 (MP 19.25);
4. C 6 (MP 15.25);
5. E 4.5 (MP 38.25);
6. E 4.75 (MP 38.25);
7. E 6 (MP 39.75);
8. Ceresco (MP 5.75);
9. MP 15.75;
10. E 4 (MP 37.75); and
11. E 5 (MP 38.25).

This sequence is subject to change dependent on site conditions, weather, operational activities and approval or direction from the U.S. EPA.

6.2.3 OSCAR Containment Removal Schedule

OSCAR containment shall be removed at the direction of the U.S. EPA. Removal of the OSCAR containment sites shall generally be from upstream to downstream. OSCAR sites that do not receive a determination as being consistent with the U.S. EPA Order will be evaluated by the U.S. EPA for potential to leave containment in place during the winter months.

6.2.3.1 Fall 2011

Site monitoring shall be conducted during Fall 2011 utilizing boats, as well as land and air based observations. During monitoring, crews shall observe river characteristics such as freezing, movement of flowing ice, debris movement (including vegetation/debris dislodged during fall vegetation die back and accumulated organic matter), and visual checking for the presence of surface oil/sheen. The information collected during these activities shall be utilized for determining the priority sequence and timing of containment removal.

6.2.3.2 Winter 2011/2012

Site monitoring shall be conducted during the winter, utilizing boats, as well as land and air based observation. During monitoring, sites shall be evaluated for ice buildup, debris accumulation and containment integrity as well as visual checking for the presence of surface oil/sheen. The information gathered during monitoring shall be utilized for determining required boom maintenance, as well as adjustment and installation of additional containment measures.

6.2.3.3 Spring 2012

Site monitoring shall be conducted during the spring months, utilizing boats as well as land and air based observation. During monitoring, crews shall observe river characteristics such as freezing, movement of flowing ice, debris movement (including vegetation/debris dislodged during spring runoff and accumulated organic matter), and visually checking for the presence oil/sheen. The information collected during these activities along with the Spring 2012 Containment Plan shall be utilized for determining the priority sequence and timing of containment deployment.

6.2.4 Submerged Oil Containment to Prevent Migration of Oil Past Morrow Lake Dam

As directed by the U.S. EPA in a letter to Enbridge (dated November 4, 2011), Enbridge shall prepare a plan for preventing oil from migrating past the Morrow Lake Dam during the Winter 2012. This plan, once approved by the U.S. EPA, shall be incorporated as an addendum to this Work Plan. The work plan for Preventing the Migration of Oil Past the Morrow Lake Dam shall describe in detail the necessary actions that Enbridge will take to contain and prevent the migration of oil, sheen, submerged oil, and oil-containing sediments past/downstream of the Morrow Lake Dam. The plan shall describe methods for enhancing submerged oil deposition in the Morrow Lake Delta and shall include options that decrease river velocities and promote and enhance deposition such as installation

of bed structures and adjusting the level of the Morrow Lake Dam during flood events to reduce velocities in the Morrow Lake Delta and promote deposition and reduce sediment migration.

6.2.5 Winter Maintenance Procedure

Throughout winter operations all locations requiring boom, if any, shall be monitored. Any site that becomes damaged or dislodged by ice or other causes shall be removed, replaced or repaired depending on the potential for downstream impacts versus the potential for additional damage as approved by the U.S. EPA. All locations shall be monitored on a weekly basis to ensure their integrity.

6.2.6 Spring 2012 Containment Plan

6.2.6.1 Control Point Booming

Control point booming is the use of containment boom, curtain boom, silt fence and/or X-Tex curtain to prevent the downstream migration of surface and/or subsurface oil. Control point booming, when properly deployed, shall aid in facilitating the recovery of migrating surface and subsurface oil. There are several booming strategies that shall be used in control point booming, including the following:

- Shore to Shore Booming: This strategy involves a single span of boom that is deployed to cover the entire width of the river. The upstream end of the boom is secured to an anchor point on the upstream bank. Hand lines or in-stream anchors are used to maneuver the boom at the appropriate angle (dependent on current velocity) down to a recovery area. A small section of boom is then deployed along the downstream shoreline to prevent impact to the river bank (shoreline protection).
- Gate Booming (also referred to as ―Open Chevron"): This strategy involves two segments of boom that are deployed across the width of the river to allow for vessel traffic up and down the river. The upstream ends of both booms are secured in an overlapping position using in-stream anchors. Hand lines or in-stream anchors are used to maneuver the boom at the appropriate angle (dependent on current velocity) down to a recovery area. A small section of boom is then deployed along the downstream shoreline to prevent impact to the river bank (shoreline protection).
- Cascade Booming: The cascade boom system is the deployment of multiple booms across the width of the river to allow for vessel traffic up and down the river or to reduce the strain that current places on individual spans of boom. The upstream boom is secured to the shore at its upstream point. Using hand lines or in stream anchors, the boom is maneuvered at an appropriate angle (dependent on current velocity) to a point in the river where it is secured with an in-stream anchor. Each additional segment is then placed downstream in an overlapping position and secured with in-stream anchors. The last span of boom is secured on its downstream end to the shore. A small section of boom is then deployed along the downstream shoreline to prevent impact to the river bank (shoreline protection).
- Chevron Booming: The chevron boom system is a single span of boom that is deployed to deflect oil/sheen around a sensitive area or to recovery points on both banks. The center of the boom is secured in the middle of the channel using an in-stream anchor. Hand lines or in-stream anchors are used to maneuver both of the downstream booms at appropriate angles (dependent on current velocity) down to recovery areas. Small sections of boom are then deployed along the downstream shoreline to prevent impact to the river bank (shoreline protection).

Control point booming location sites shall be selected based on the following criteria:

- River characteristics (current speed, depth, width and bottom material);
- Site access (ease of oil recovery and maintenance);
- Suitable anchor points;
- Distance to upstream control points;
- Distance to upstream sources of impact (identified impacted depositional areas and impacted overbank areas); and
- Access control to prevent impact to the public.

Currently, control points have been identified as likely locations for installation of surface containment. The number of control points to be deployed shall be dependent on information gathered during spring monitoring activities, the Spring 2012 reassessment, and potential river reopening activities. The likely control point locations for Spring 2012 are:

- MP 2.25 (confluence of Talmadge Creek and Kalamazoo River);
- MP 5.75 (Ceresco Dam);
- MP 15.75, C 6 (Battle Creek Dam); and
- Morrow Lake Delta and Morrow Lake.

Due to the increase in water levels associated with spring runoff, all control points shall be installed at a greater angle. This shall lessen the force applied to them by the increased current velocity and reduce the risk of containment failure.

Subsurface containment may also be installed based on the monitoring and reassessment activities. The locations of these sites shall be based on the observations made by the monitoring team as well as the locations of any identified subsurface concerns.

All control points shall be monitored for ice buildup. If there is significant ice buildup, the boom shall be released to prevent an unsafe condition or uncontrolled containment failure.

6.2.6.2 Sediment Trap Containment

During winter operations, engineered sediment traps (passive sediment collectors) may be installed within the Kalamazoo River as detailed in Section 7. During the Spring and Summer 2012 seasons, dependent on site conditions and the presence of surface or subsurface oil, additional containment shall be installed immediately downstream of each sediment trap if directed by the U.S. EPA. This containment, if necessary, would potentially consist of surface and subsurface containment.

6.2.6.3 Protective Containment

Protective containment is the use of surface and subsurface containment to prevent impact to a sensitive area or to prevent impact to the river from a small impacted area. Containment is deployed between a source of impact and the selected area of the river to shield the area from impact. Protective containment can also be used to isolate impacted areas until recovery methods have been completed and regulatory sign-off has been received. The containment shall usually be deployed:

- At the mouth of an inlet;
- Around the entire area; and
- In a chevron (see control point booming) configuration upstream of the area.

The selection of locations for protective containment shall be based on the following criteria:

- Areas that have the potential to cause impact to downstream receptors; and
- Areas of significant ecological value.

Deployment at these locations will be dependent on information gathered during monitoring activities and may vary pending the results of those activities. Additional areas may be added based on inspection results and the identification of unknown areas of impact.

6.2.6.4 Oil Recovery

Oil recovery involves the removal of oil from the surface of the water. All containment locations shall be monitored for the accumulation of oil and impacted debris. When identified, this material shall be recovered and disposed of according to the accepted waste handling practices. Several recovery methods are listed below but are not limited to:

- Hand Skimming: Hand skimming is the removal of oil by physical labor. Personnel shall utilize hand tools such as dip nets, strainers, and pitchforks to lift the oil and debris out of recovery areas and place it into a container for disposal.
- Rotary Skimming: Rotary skimming is the removal of oil by a mechanical rotary skimmer. There are several types of rotary skimmers including drum, mop skimmers and brush skimmers. All rotary skimmers work by rotating a surface with oil adhering qualities. The oil is then mechanically removed from the surface and collected into a container for disposal.
- Vacuum Truck: Utilizing a vacuum unit to remove oil or impacted sediment out of a containment area.

Due to the low volume of oil expected to accumulate during operations, hand skimming shall be the preferred method of oil recovery.

6.3 Deployment Priority and Scheduling:

Priority sequence for deployment is as follows:

- Deployment of surface containment from downstream to upstream;
- Deployment of protective containment at areas of high ecological value;
- Deployment of protective containment from upstream to downstream; and
- Deployment of submerged oil containment (not including submerged oil work sites) from downstream to upstream.

The schedule for the Spring 2012 containment plan shall be based on the above priority sequence. The deployment of containment in spring conditions is largely dependent on fluctuating weather and river conditions and may be delayed by either of these factors. Due to the potential for the formation of ice and or debris dams, booming activities shall be triggered by the absence of the potential for

migration of ice and or debris to downstream areas. If, due to fluctuations in the weather the potential for ice or debris dams increases once deployment has begun, booming activities may be limited. Additionally, any deployed boom shall be monitored for a potential loss of integrity so that corrective actions can be taken.

During all work in the river, special consideration shall be given to the following:

- The safety of personnel working in, around, and on the water.
  - Boat traffic shall be kept to a minimum to reduce the risk to workers;
  - If personnel are working in the water from the shoreline a tag line shall be required for any work completed in water greater than waist depth; and
  - Boats working in the vicinity of containment shall do so under a no wake restriction.
- The safety of the public.
  - All sites that are accessible to the public shall be clearly marked with signage warning of the dangers associated with site.

7.0 PASSIVE SEDIMENT COLLECTION AREAS AND DEVICES

Design, installation, maintenance, and removal of passive sediment collection devices described herein will be conducted by the Containment Branch in consultation with the SOSG.

7.1 Objectives

The objective of the installation and use of passive sediment collection devices (~~"~~sediment traps") is to collect submerged oil in a minimally invasive manner. Installation of sediment traps in key areas of the Kalamazoo River will be used to more efficiently and less intrusively recover remaining submerged oil.

Sediment traps shall be designed to efficiently take advantage of, and/or enhance, existing flow and depositional patterns in the river. This may include stand- alone traps, a series of traps, or a combination of flow-directing techniques and trap(s), pursuant to recommendations generated from the process outlined below.

7.2 Background

Various geomorphic settings along the active channel and off-channel areas of the Kalamazoo River have been identified as preferential to the deposition of submerged oil and oil-containing sediment. These settings include riparian wetlands, oxbows, flood chutes, cut-off channels, backwaters, point bars, deltas, and impounded areas. In the active channel, areas that may be scoured during floods can be depositional during low flows. Ice jams can also play a factor in determining flow obstructions during winter and spring melts. The location and function of these depositional areas can change depending on whether the river is in flood stage or sustained low flow and will impact the distribution of submerged oil within the river (Figure 7.1). Oil deposits in off-channel/overbank areas from the July 2010 flood may later become sources of oil to channel margins during subsequent floods or as seeps if hydrologically connected during low flows. Such geomorphic considerations are important to proper sediment trap design and site selection (Figure 7.2).

Figure 7.1. Results from the 2011 LSR poling, showing frequency of occurrence of none, light, moderate, and heavy oil indications.

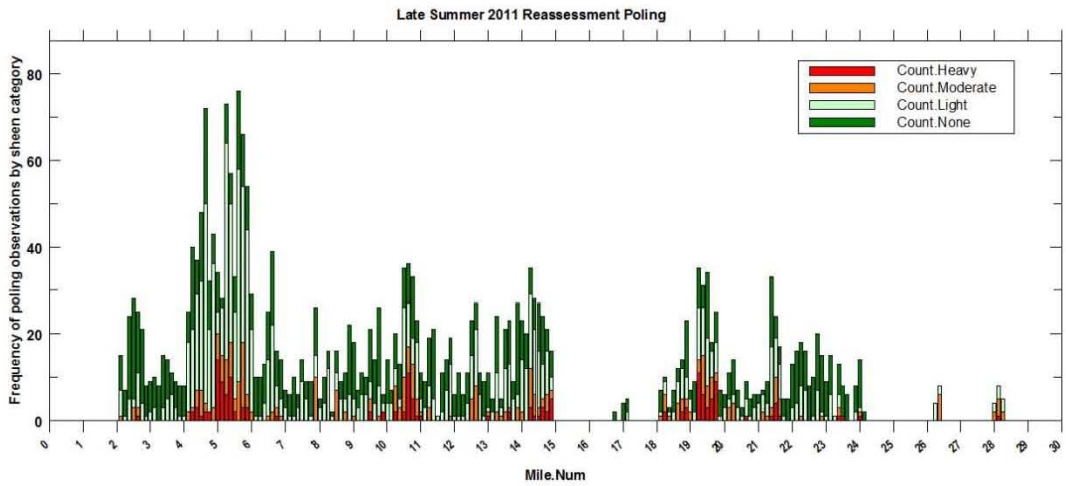
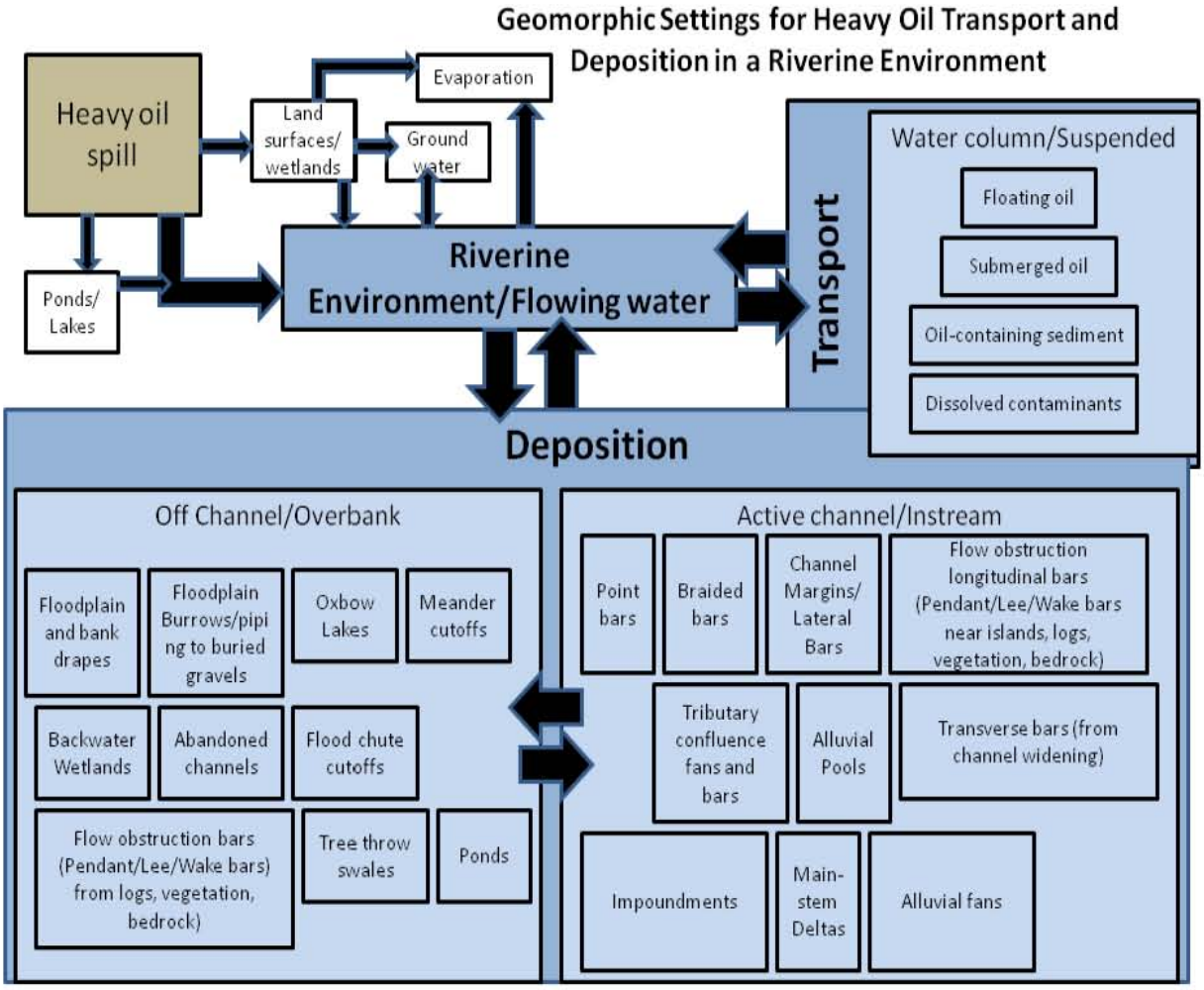


Figure 7.2 Geomorphic Settings for Heavy Oil Transport and Deposition in a Riverine Environment



7.3 Design and Site Selection

Results from 2011 LSR poling and mid- and post- recovery poling activities, along with existing geomorphic knowledge of the river, shall help guide trap locations and specific trap design. In addition, the hydrodynamic model shall be used to help guide selection of locations and to test proposed designs.

The SOSG and CSG shall provide recommendations of locations and design for the sediment collection techniques, to be guided by the following:

- Evidence of re-deposition of submerged oil following recovery;
- Amount and nature of submerged oil;
- Geomorphic setting, including location of major depositional areas;
- Location outside of sensitive habitat areas;
- Proximity to existing access paths for cleanout and monitoring;
- Safety of the public and workers;
- Utility for eventual habitat improvement; and
- A review of appropriate literature relating to techniques successfully implemented in similar settings on other rivers.

The development, design, and location selection of the enhanced sediment collection techniques shall begin in Fall 2011 and continue into 2012 in consultation with the SOSG and CSG. Sediment traps may be installed during the winter months under frozen conditions if appropriate. Structures shall be designed, permitted (as necessary), and installed for longer term maintenance and presence until oil recovery is completed. Devices and locations will be selected to maximize sediment trapping effectiveness and efficiency while minimizing harm to benthic organisms, mussels, fish, amphibians, turtles, mammals, and birds (including diving ducks). In addition, such devices will be implemented in such a way as to minimize barriers to fish passage and to minimize river navigation hazards and obstructions, while still remaining effective and efficient in the primary objective of less intrusive recovery of remaining submerged oil. Consideration will be given to devices that provide habitat diversity and bank protection.

An addendum to this Work Plan shall be provided to the U.S. EPA and USGS that outlines the location and design of each sediment trap. The addendum shall specify any additional field investigation or modeling work deemed necessary to complete the location evaluation and/or the design, and shall include a schedule for completing the evaluation and design tasks. The addendum shall also include a schedule and scope for operations and maintenance of the device(s).

8.0 SCHEDULE

A schedule is presented (Attachment F) for general scheduling purposes only and shall be modified based on numerous factors including river conditions, access, permitting, re-prioritization of areas and the U.S. EPA approval. Updates to the schedule shall be ongoing throughout the project and shall be presented to the U.S. EPA, USGS and MDEQ as needed to indicate significant change.

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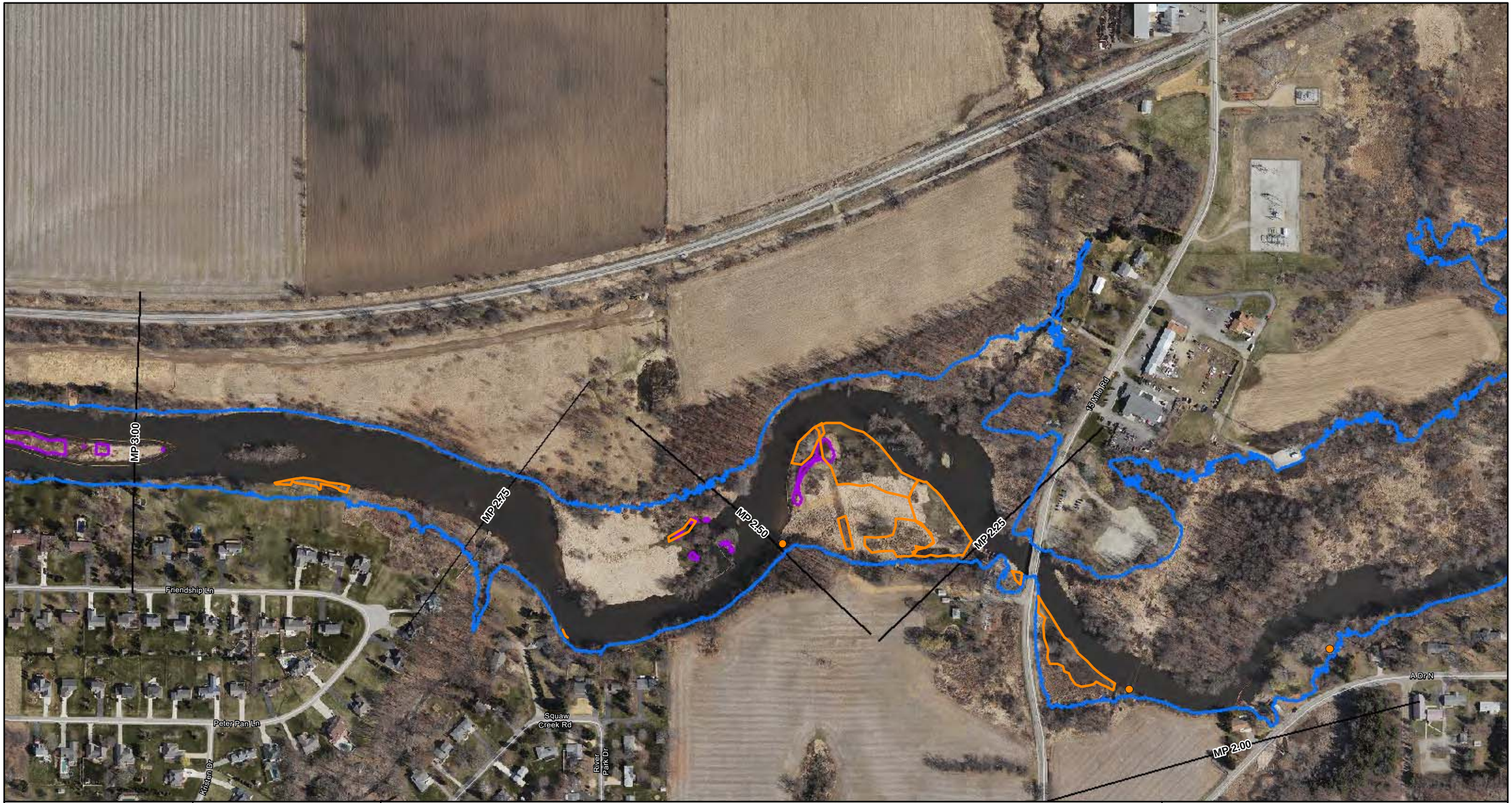
Attachment A

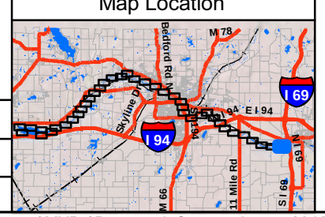
Overbank Oil: Spring 2012 Reassessment



ENBRIDGE

Drawn:	NS	12/02/2011
Approved:	DB	12/02/2011
Project #:	60162778	

Map Location



Legend

Spring 2011 Reassessment Data

- Pooled Oil Observation
- Film (Sheen) Observations
- Innundated Areas - Reassess
- Excavated Areas
- 2011 Inundation Model
- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 1 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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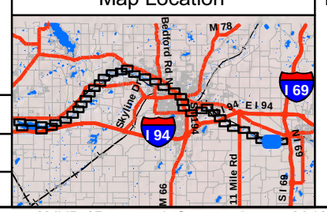
Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	NS	12/02/2011
Approved:	DB	12/02/2011
Project #:	60162778	

Map Location



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- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 2 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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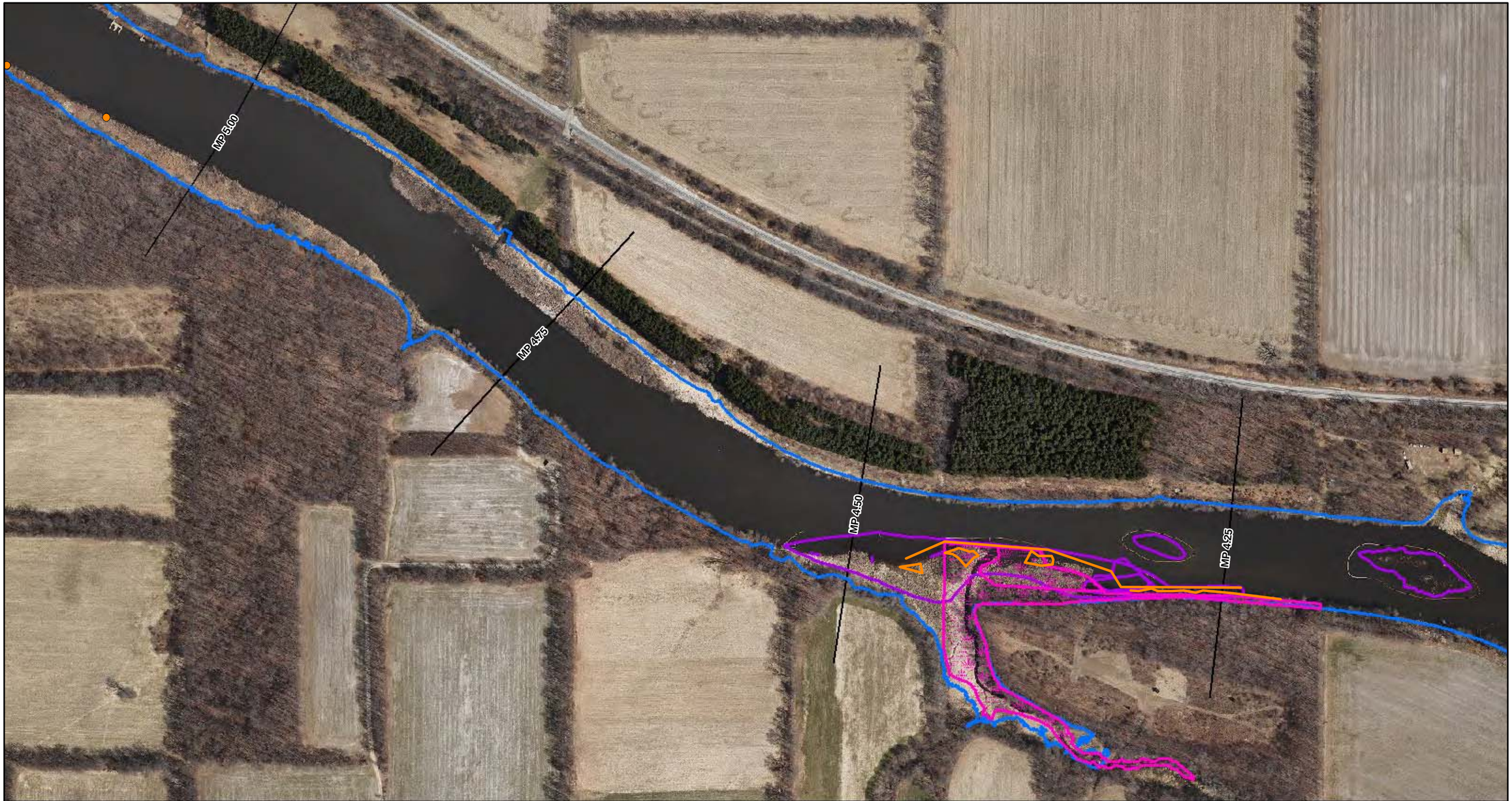
Aerial Photography Date: April 2011



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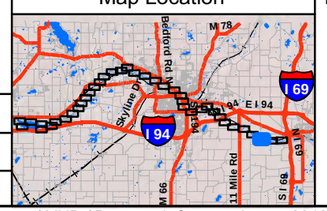

Legend

Spring 2011 Reassessment Data

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- Film (Sheen) Observations
- Innundated Areas - Reassess
- Excavated Areas
- 2011 Inundation Model
- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 3 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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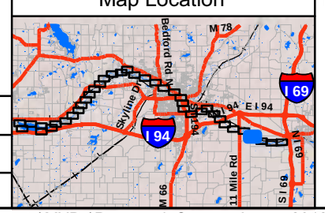
Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	NS	12/02/2011
Approved:	DB	12/02/2011
Project #:	60162778	

Map Location



Legend

Spring 2011 Reassessment Data

- Pooled Oil Observation
- Film (Sheen) Observations
- Innundated Areas - Reassess
- Excavated Areas
- 2011 Inundation Model
- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 4 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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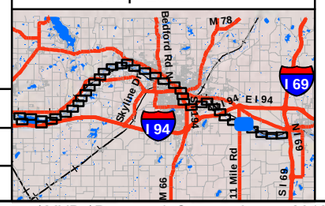
Map Location



Legend

Spring 2011 Reassessment Data

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 5 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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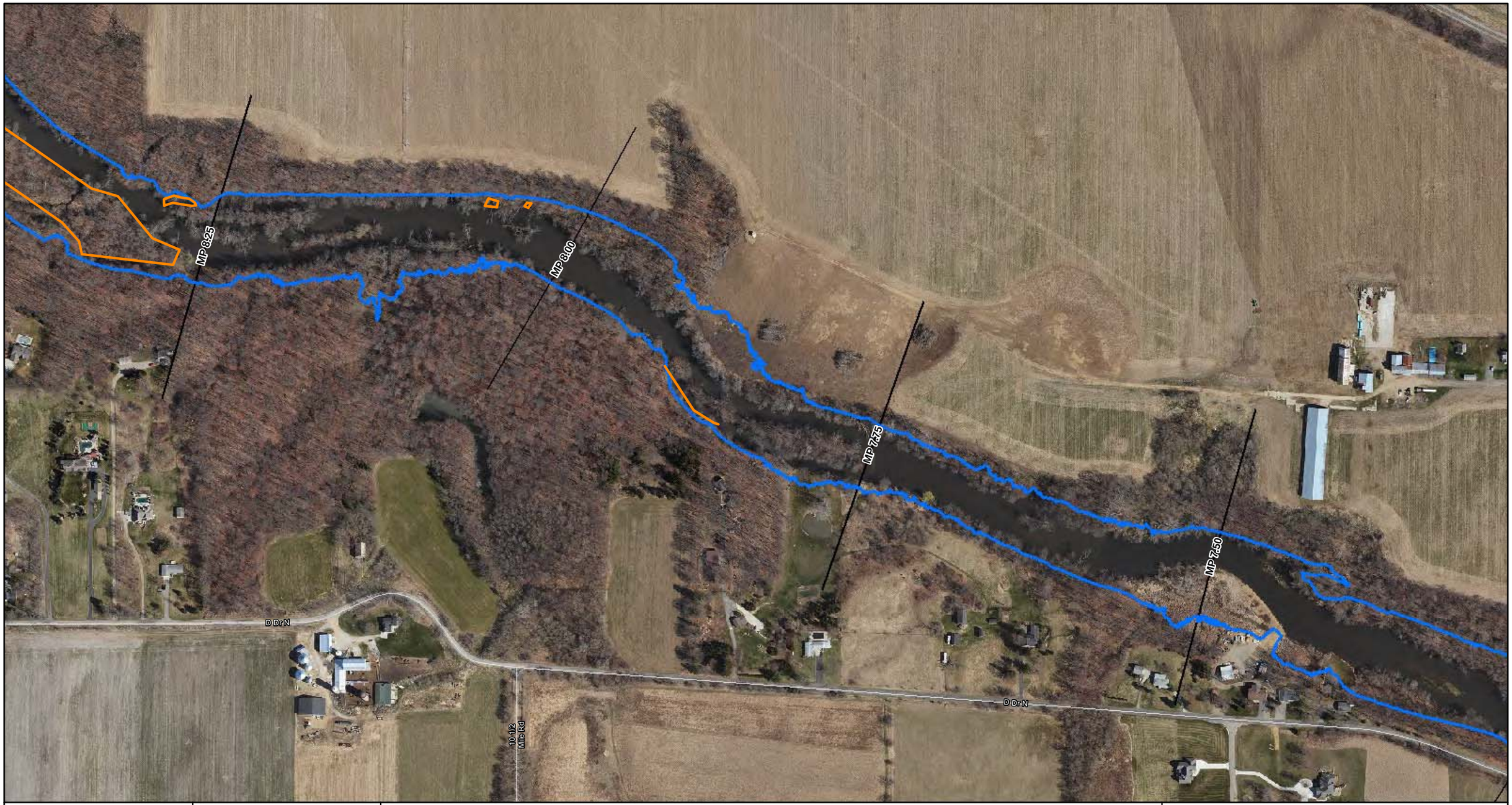

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Project #:	60162778	

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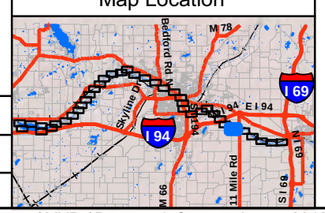

Legend

Spring 2011 Reassessment Data

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- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 6 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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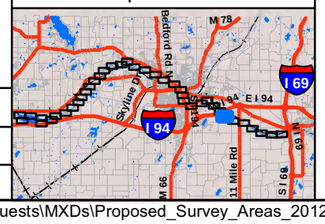

Legend

Spring 2011 Reassessment Data

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 7 of 39

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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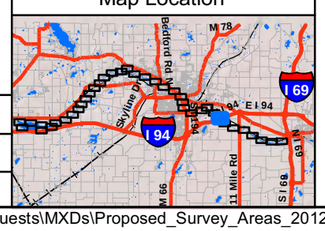

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 8 of 39

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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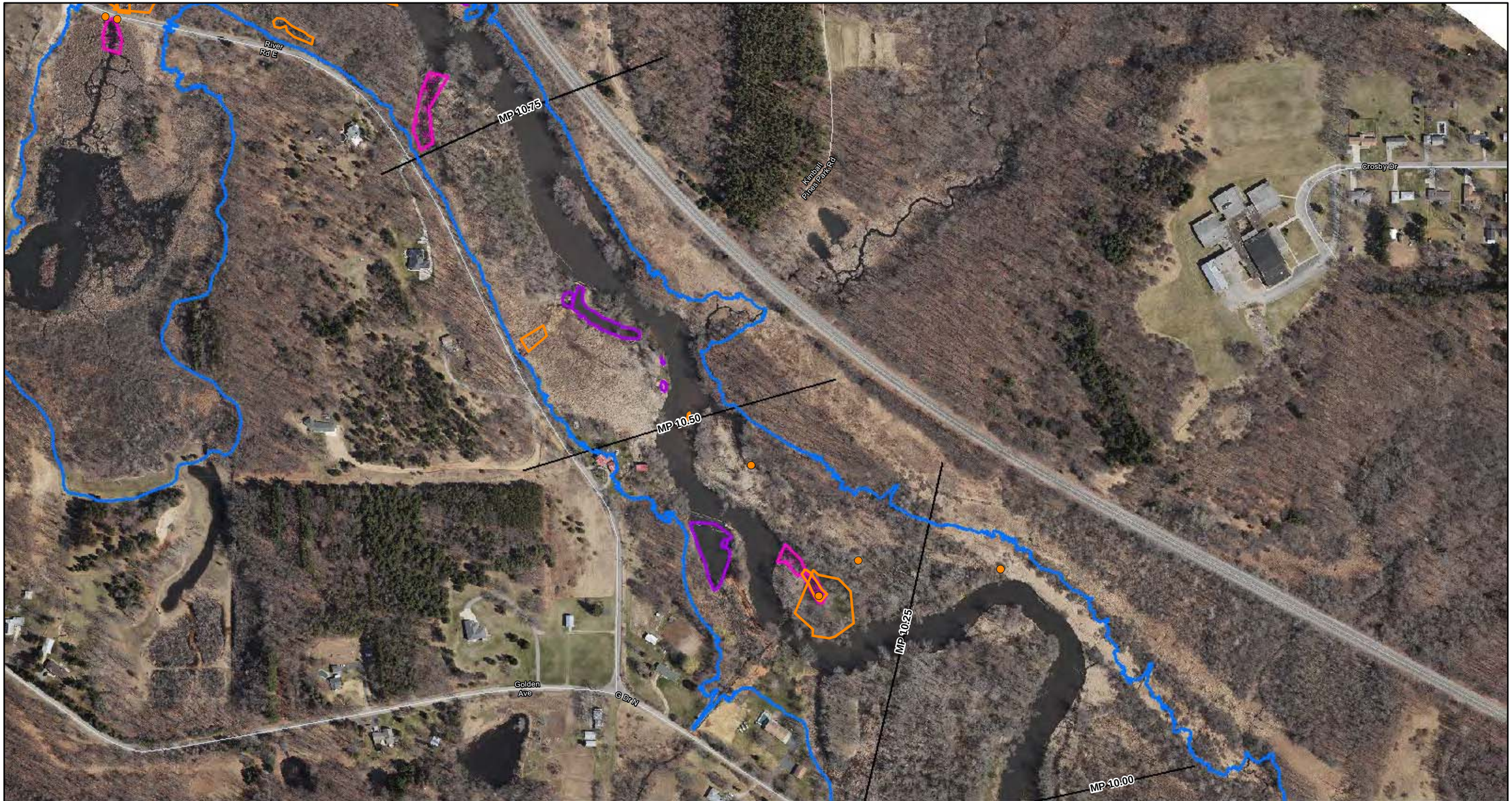

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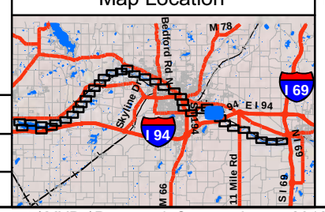

Legend

Spring 2011 Reassessment Data

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- 2011 Inundation Model
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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 9 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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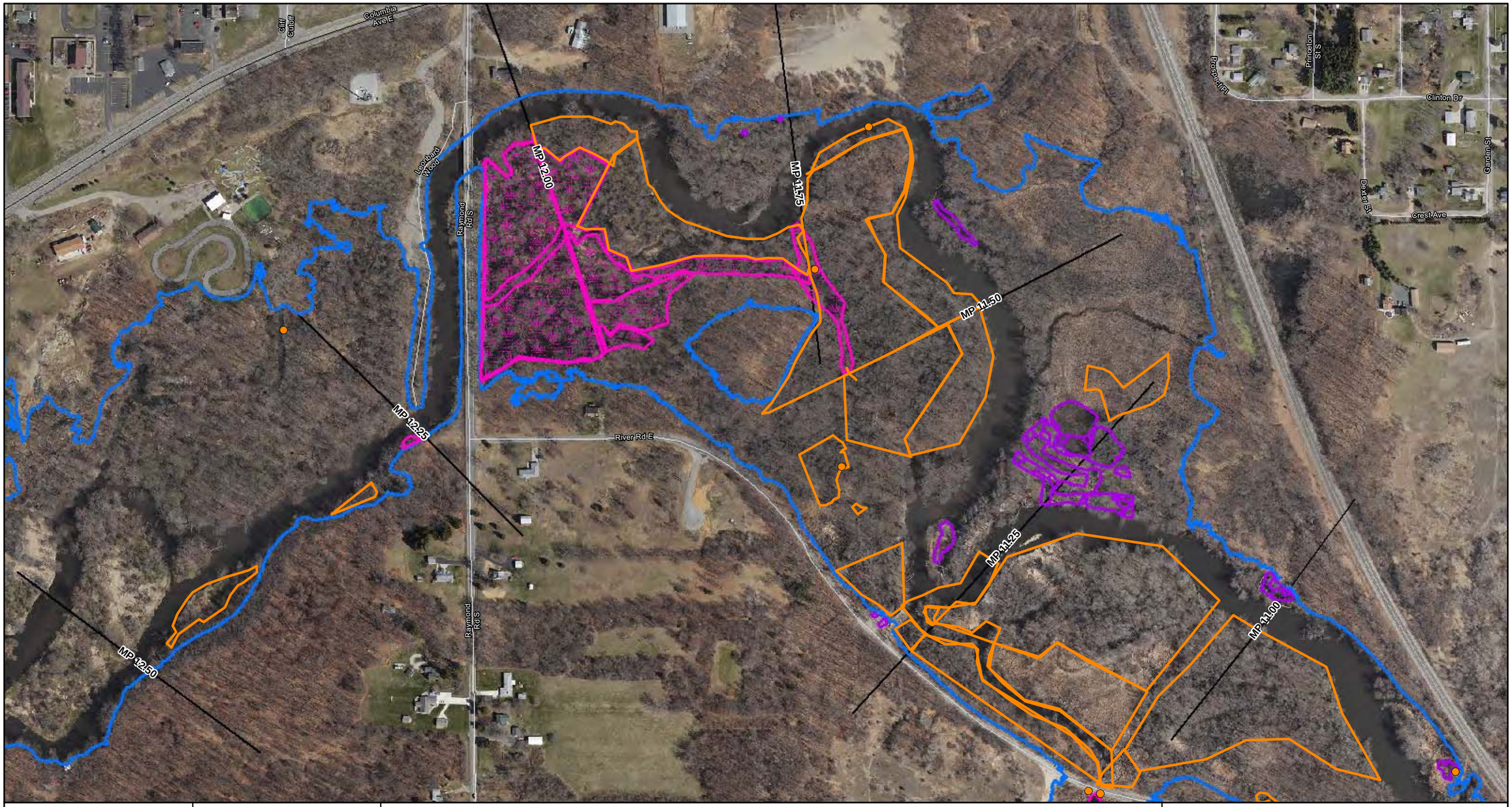

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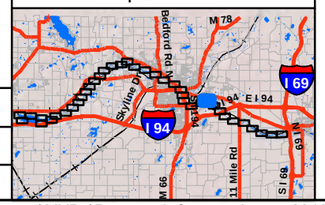
Map Location



Legend

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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ENBRIDGE

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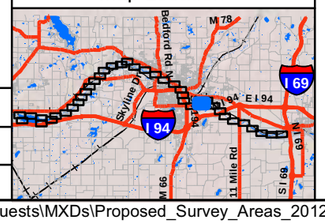
Map Location



Legend

Spring 2011 Reassessment Data

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- Film (Sheen) Observations
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- Excavated Areas
- 2011 Inundation Model
- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 11 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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ENBRIDGE

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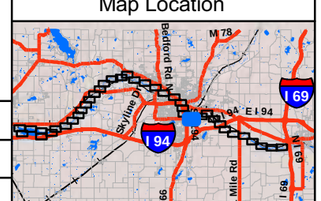
Map Location



Legend

Spring 2011 Reassessment Data

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- 2011 Inundation Model
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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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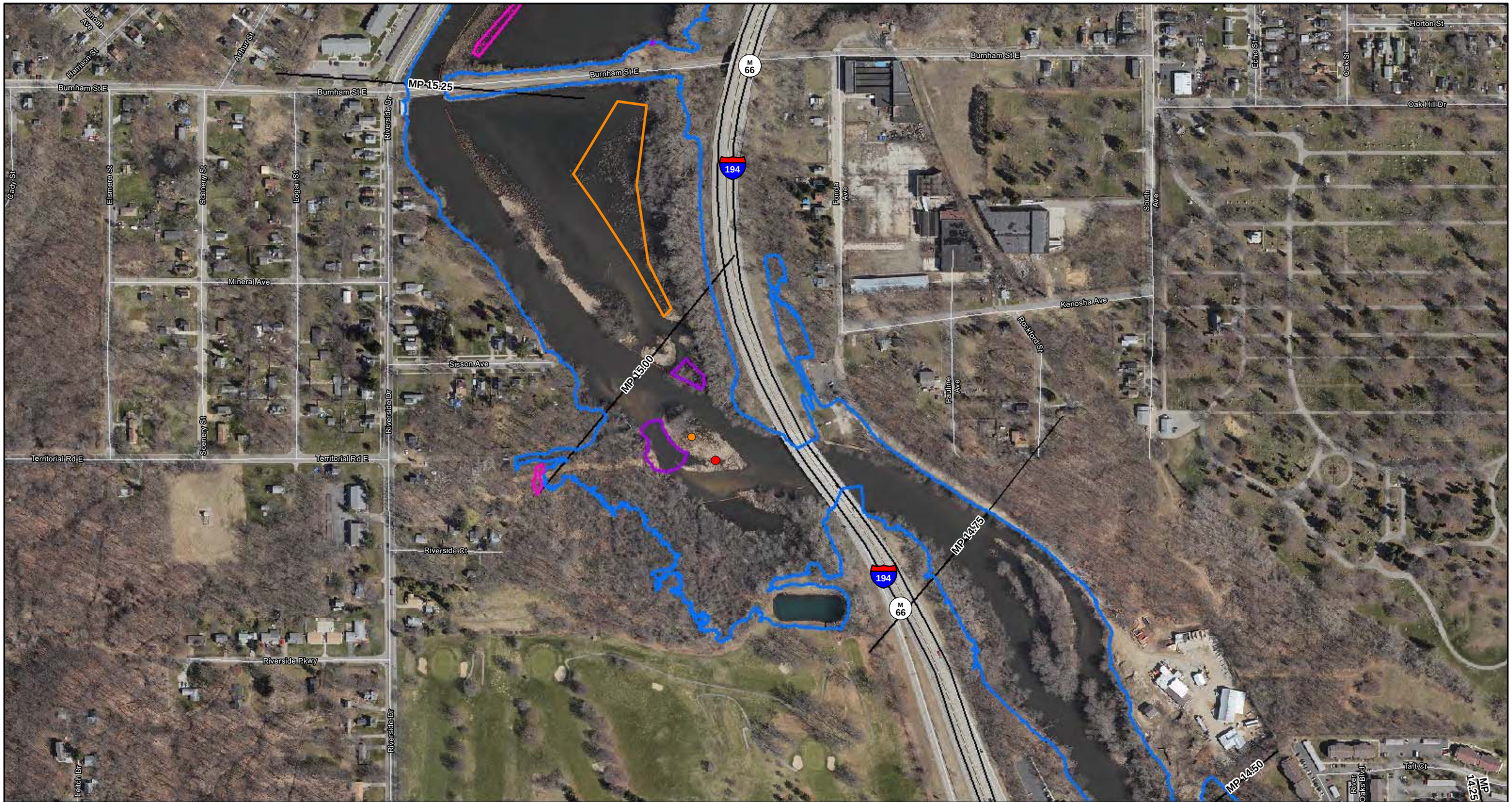

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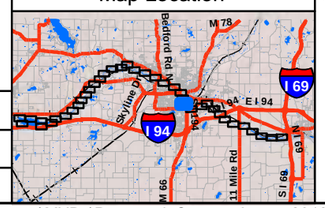

Legend

Spring 2011 Reassessment Data

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- 2011 Inundation Model
- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 13 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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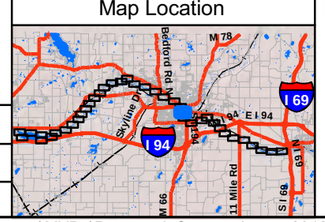
Map Location



Legend

Spring 2011 Reassessment Data

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 14 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
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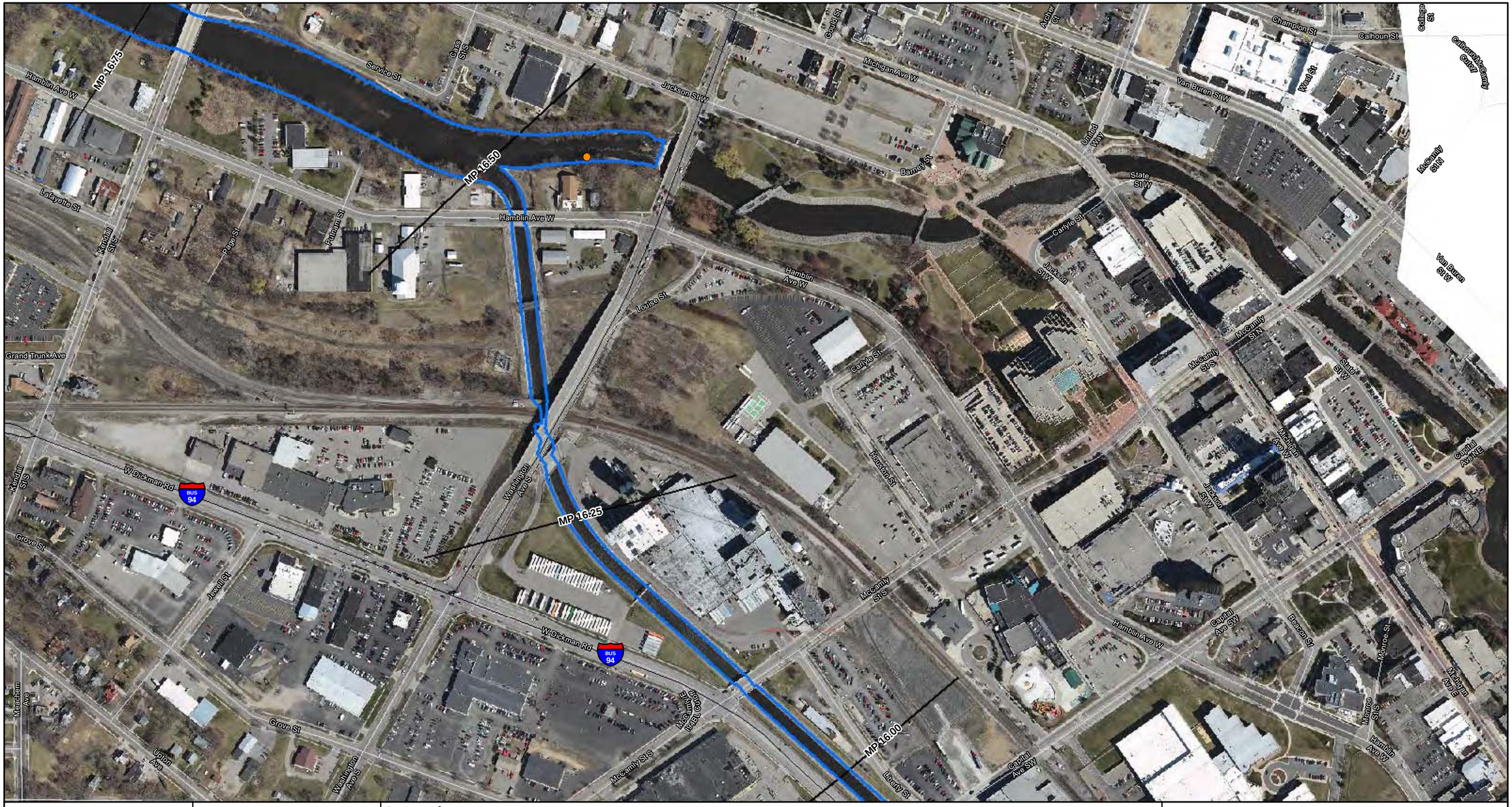

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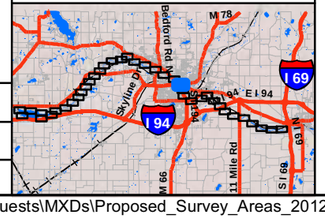

Legend

Spring 2011 Reassessment Data

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- 2011 Inundation Model
- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 15 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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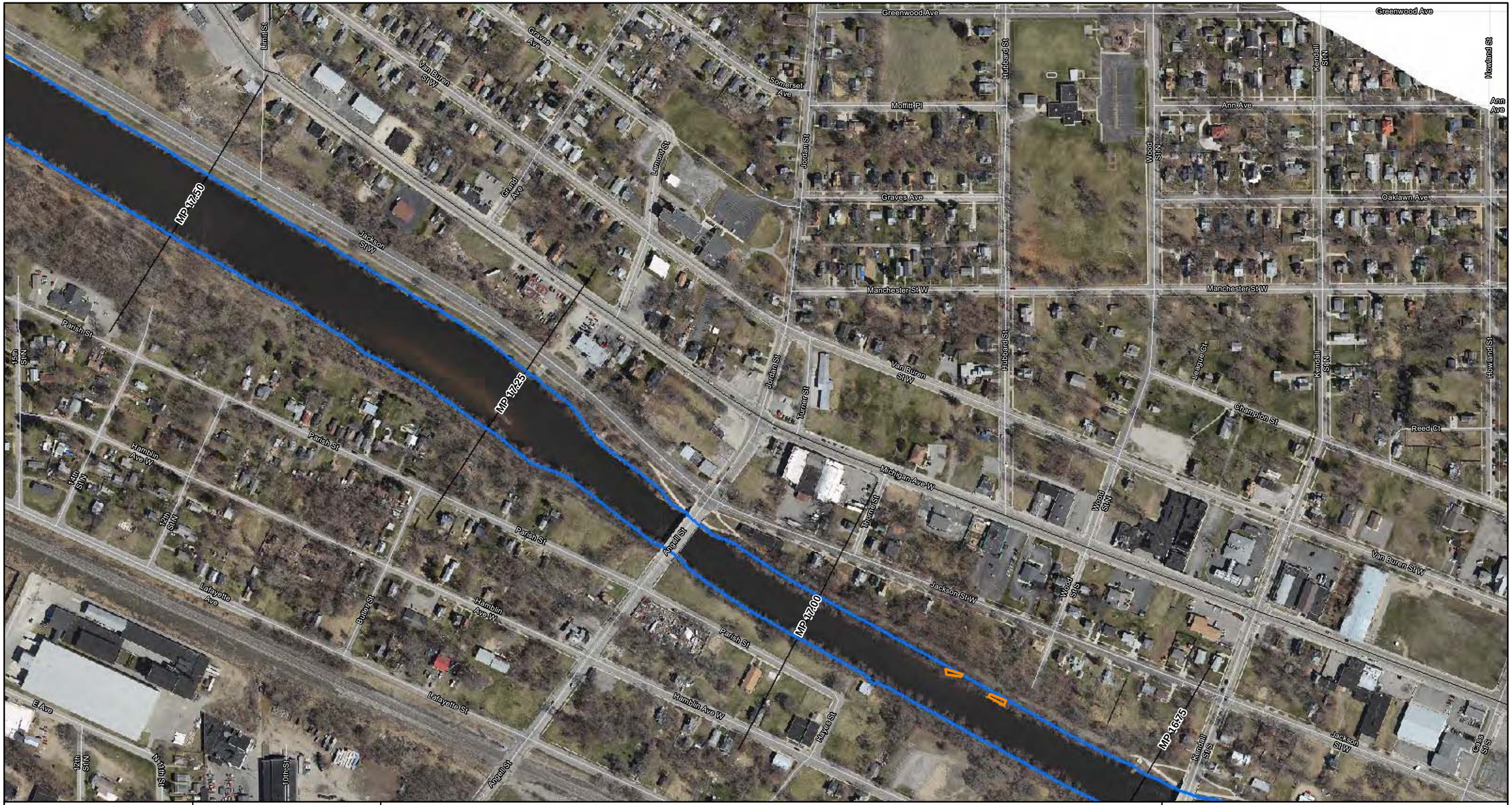

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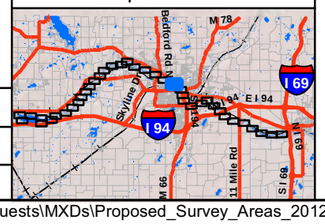

Legend

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 16 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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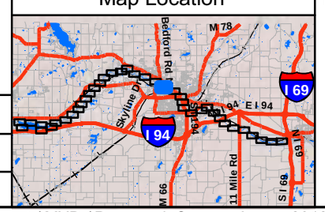

Legend

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- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 17 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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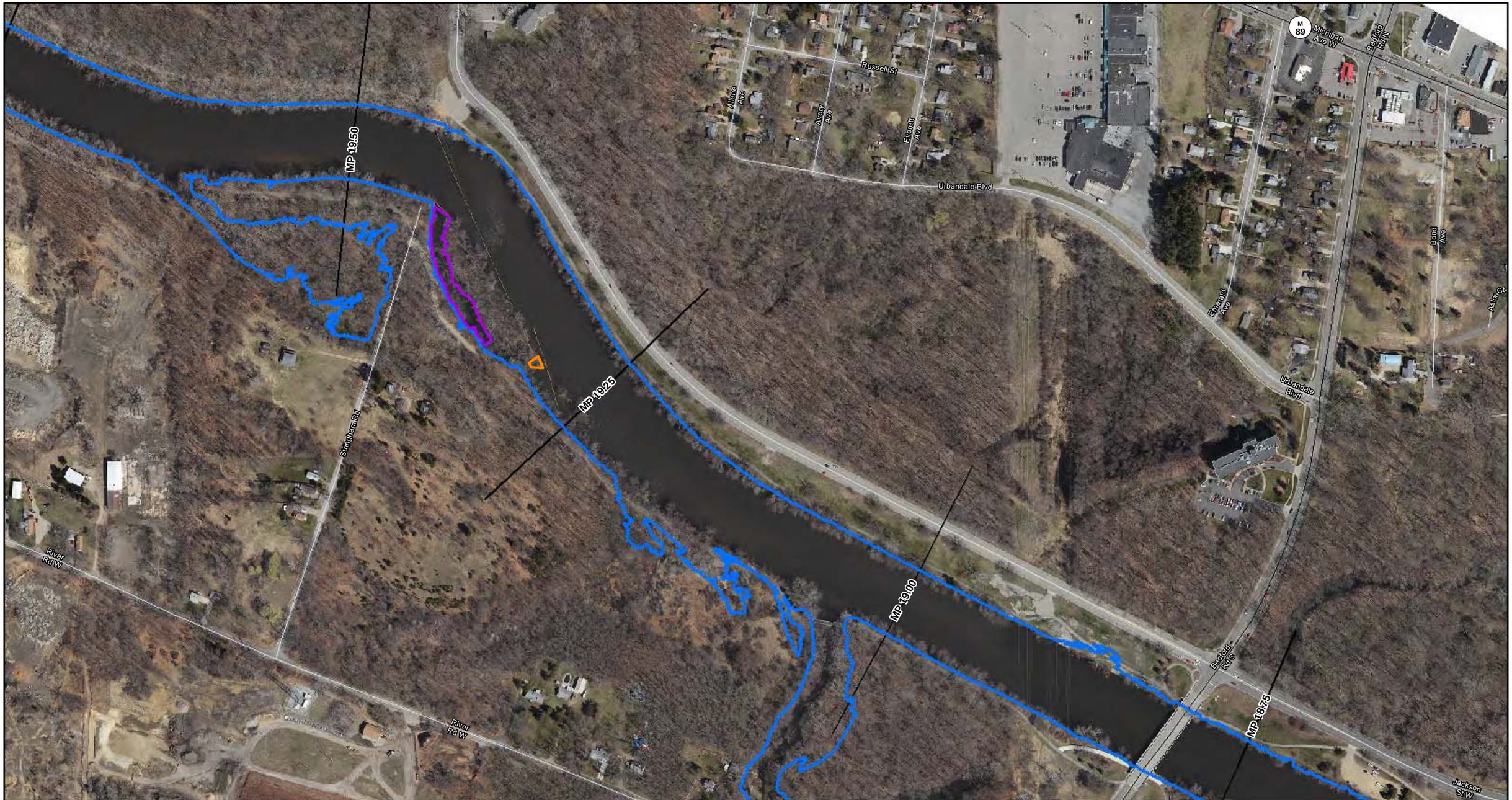

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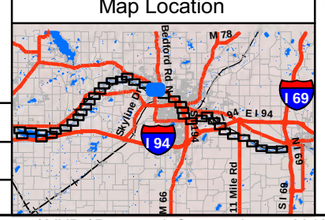

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Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 18 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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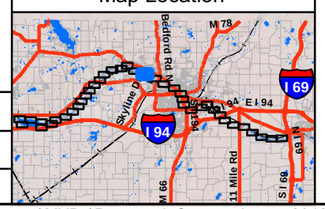

Legend

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 19 of 39

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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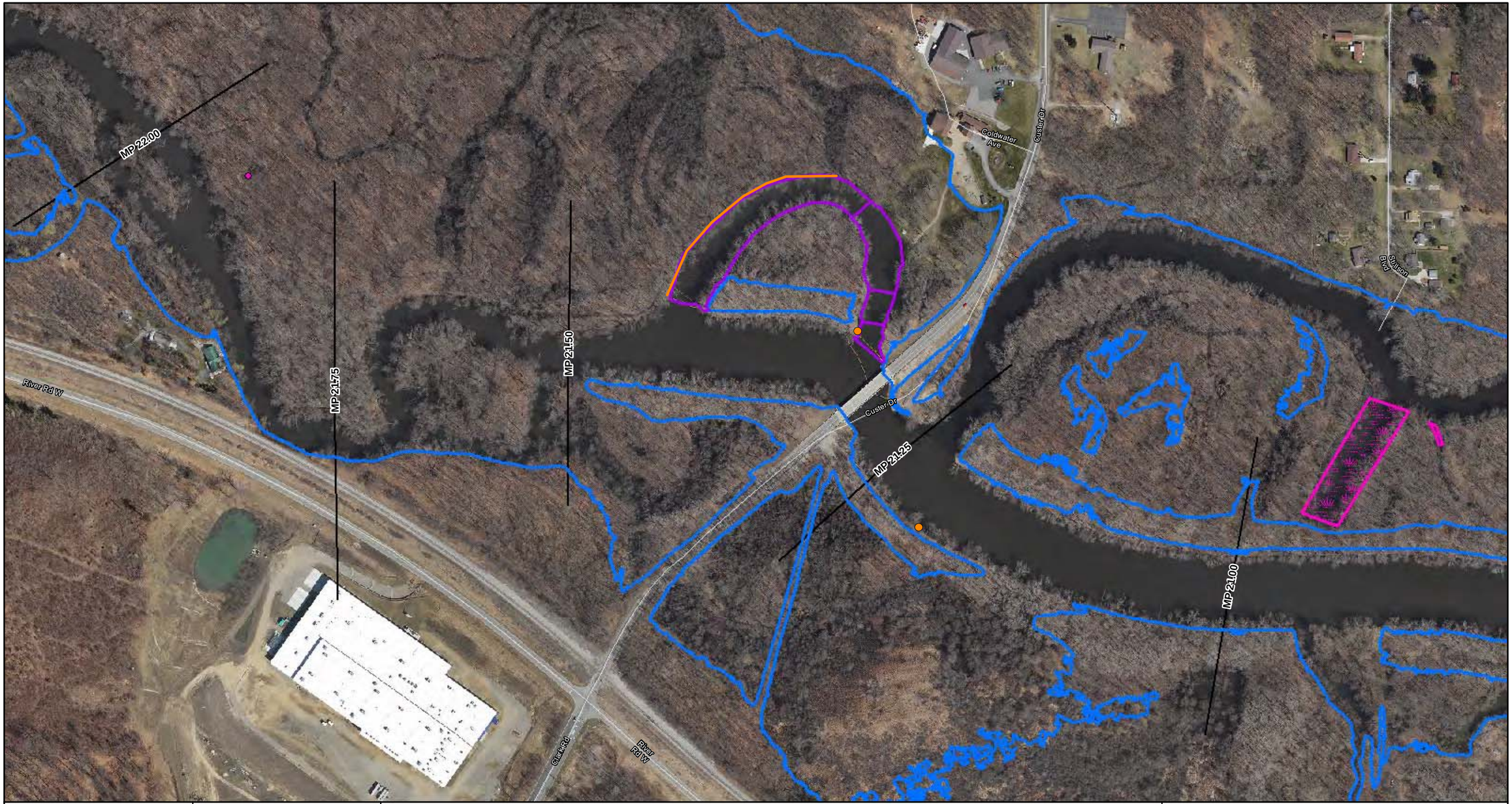

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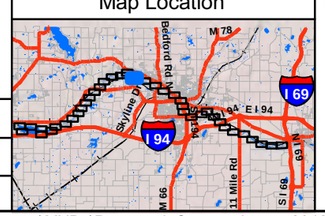

Legend

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0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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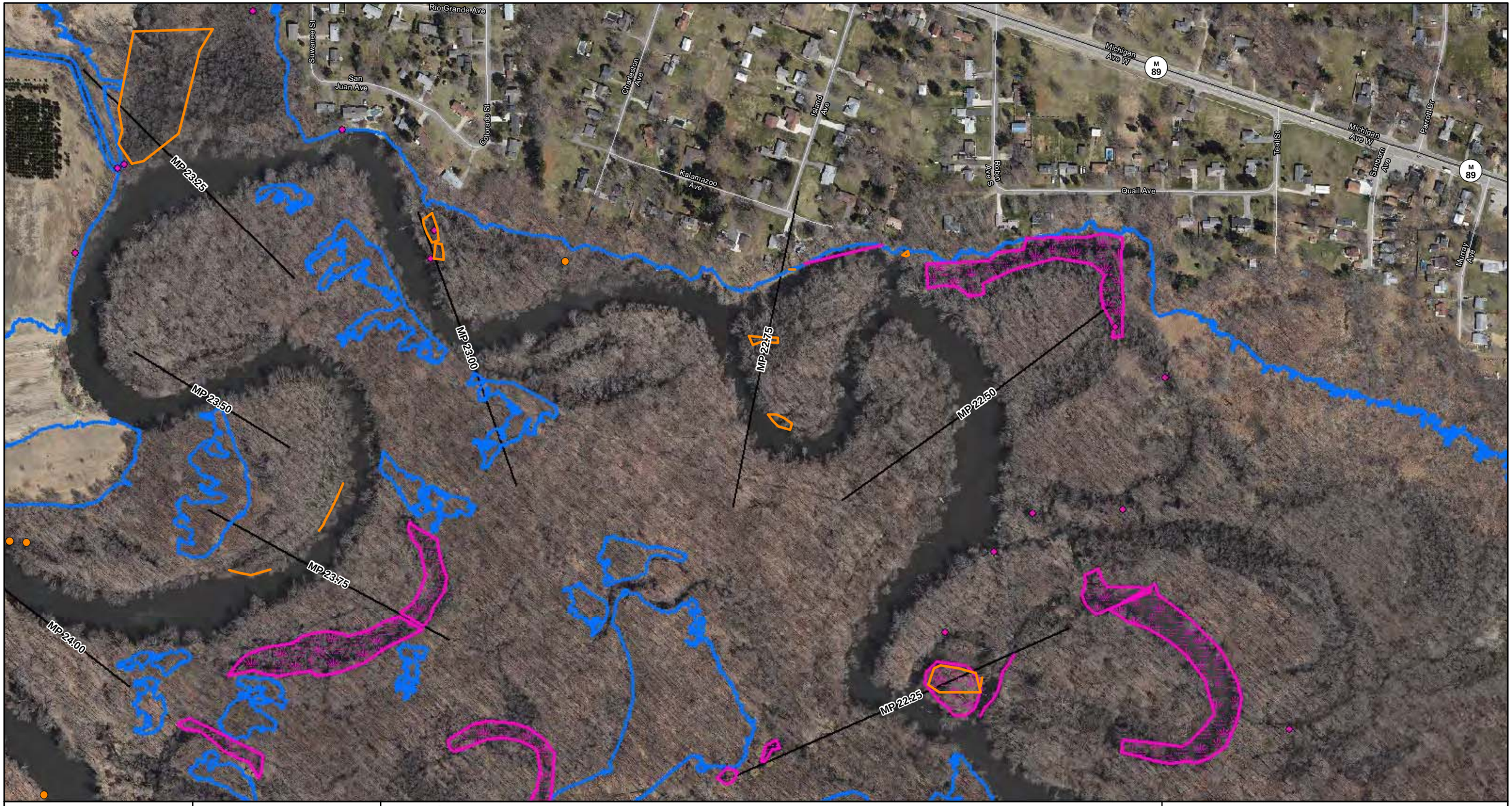

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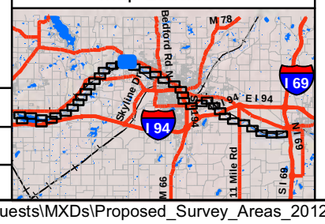

Legend

Spring 2011 Reassessment Data

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 21 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
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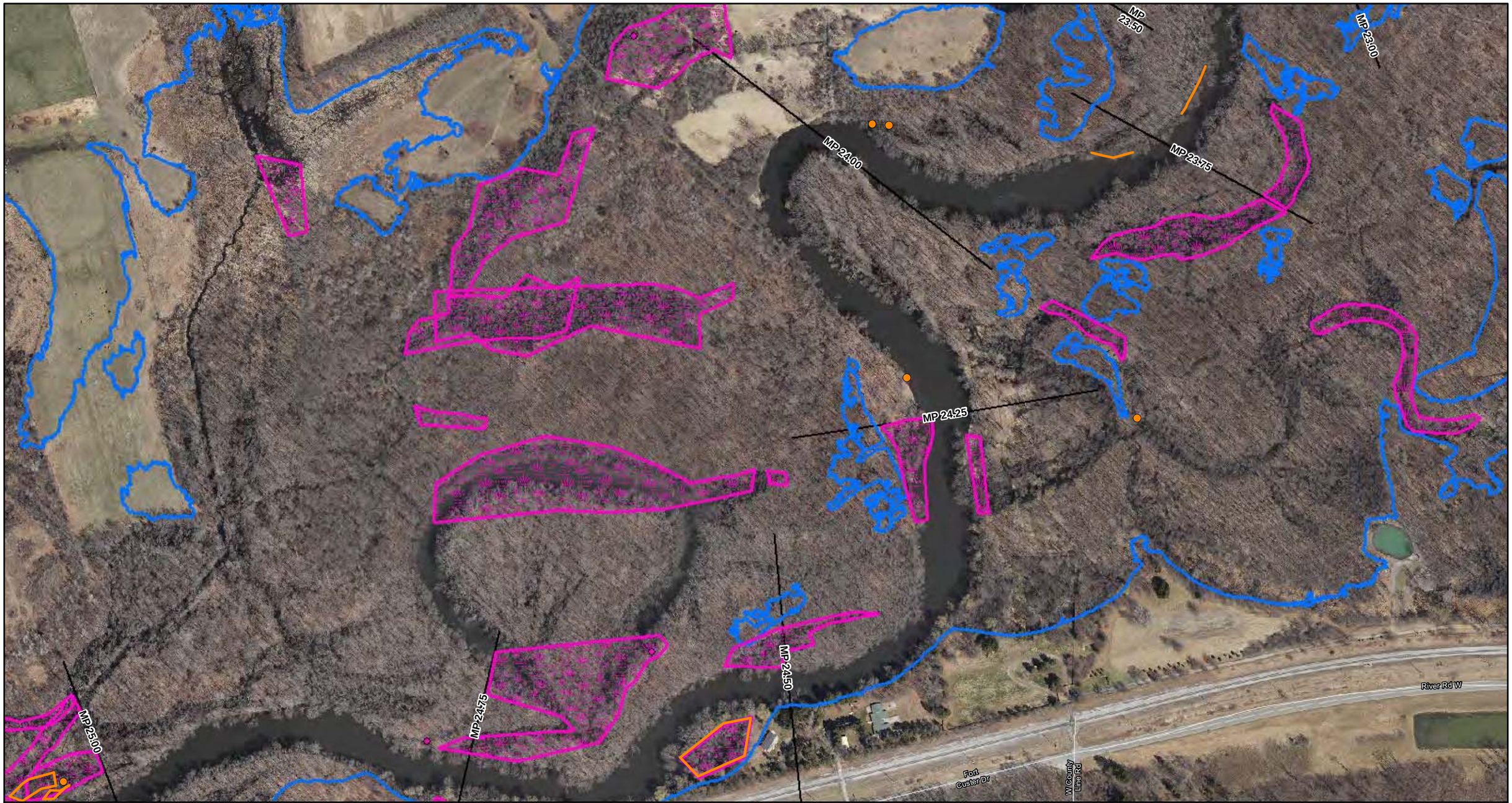

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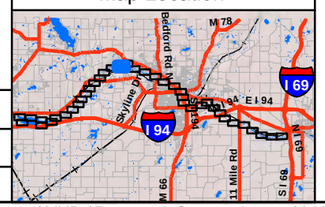
Project #:	60162778	

Map Location



Legend

Spring 2011 Reassessment Data

- Pooled Oil Observation
- Film (Sheen) Observations
- Innundated Areas - Reassess
- Excavated Areas
- 2011 Inundation Model
- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 22 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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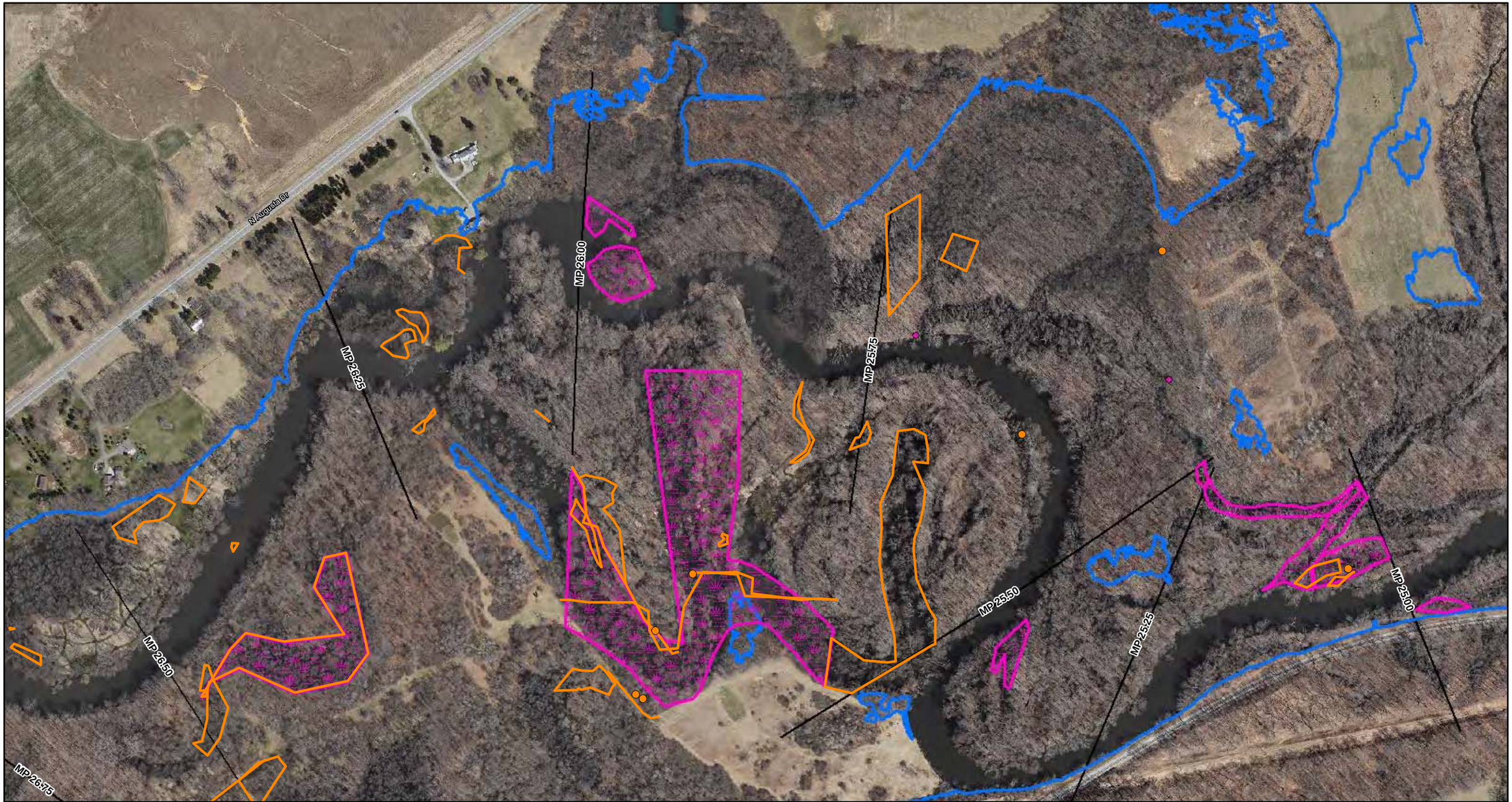
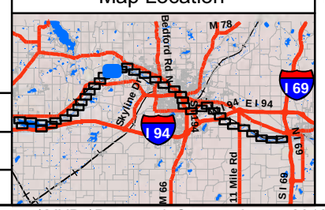
Aerial Photography Date: April 2011



ENBRIDGE

Drawn:	NS	12/02/2011
Approved:	DB	12/02/2011
Project #:	60162778	

Map Location



Legend

Spring 2011 Reassessment Data

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0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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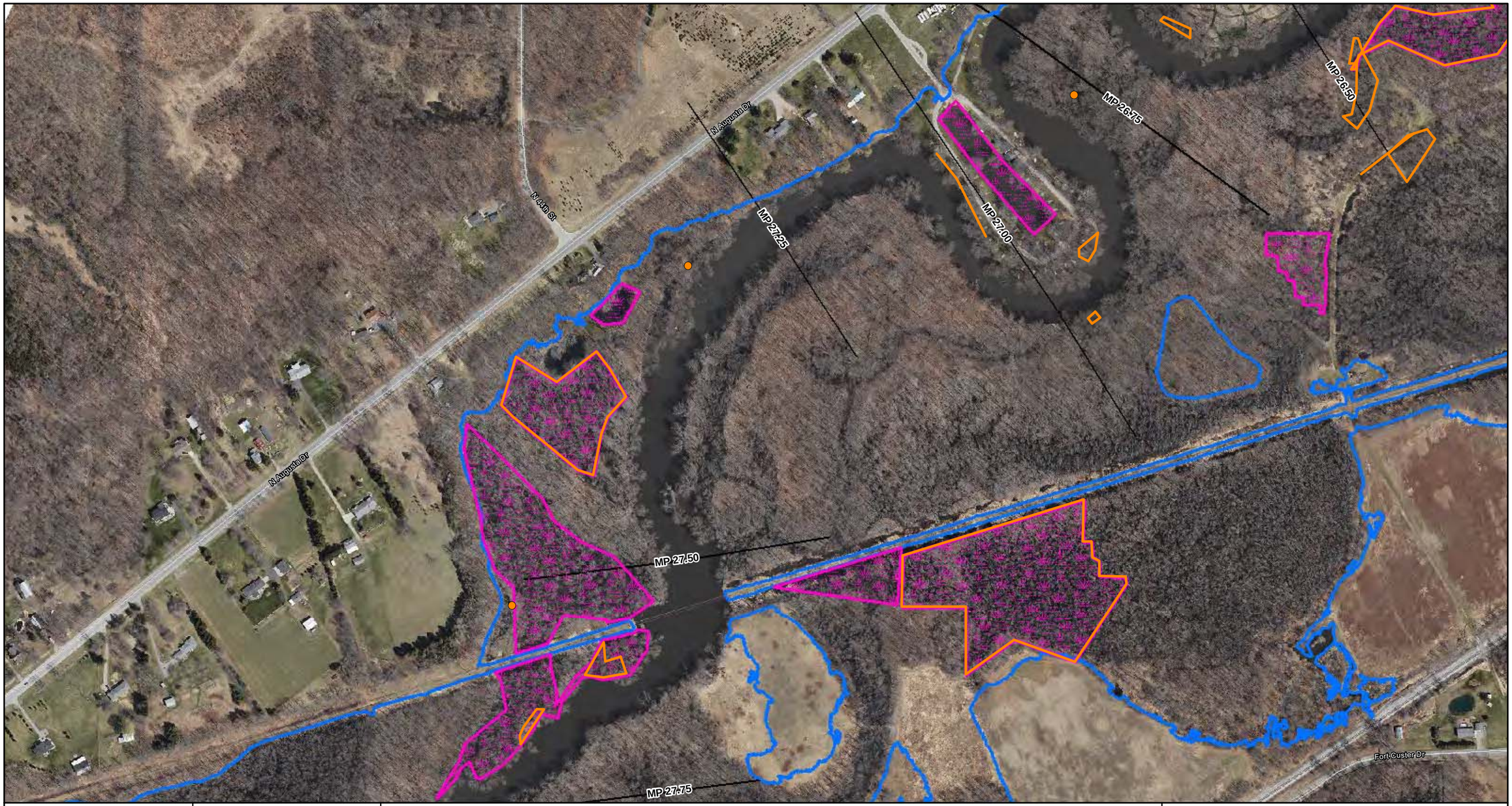

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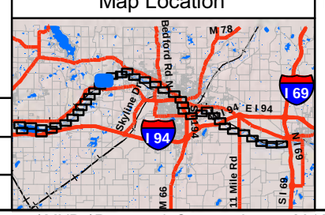
Map Location



Legend

Spring 2011 Reassessment Data

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Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
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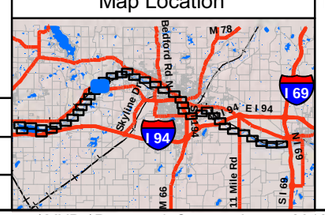

Legend

Spring 2011 Reassessment Data

- Pooled Oil Observation
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- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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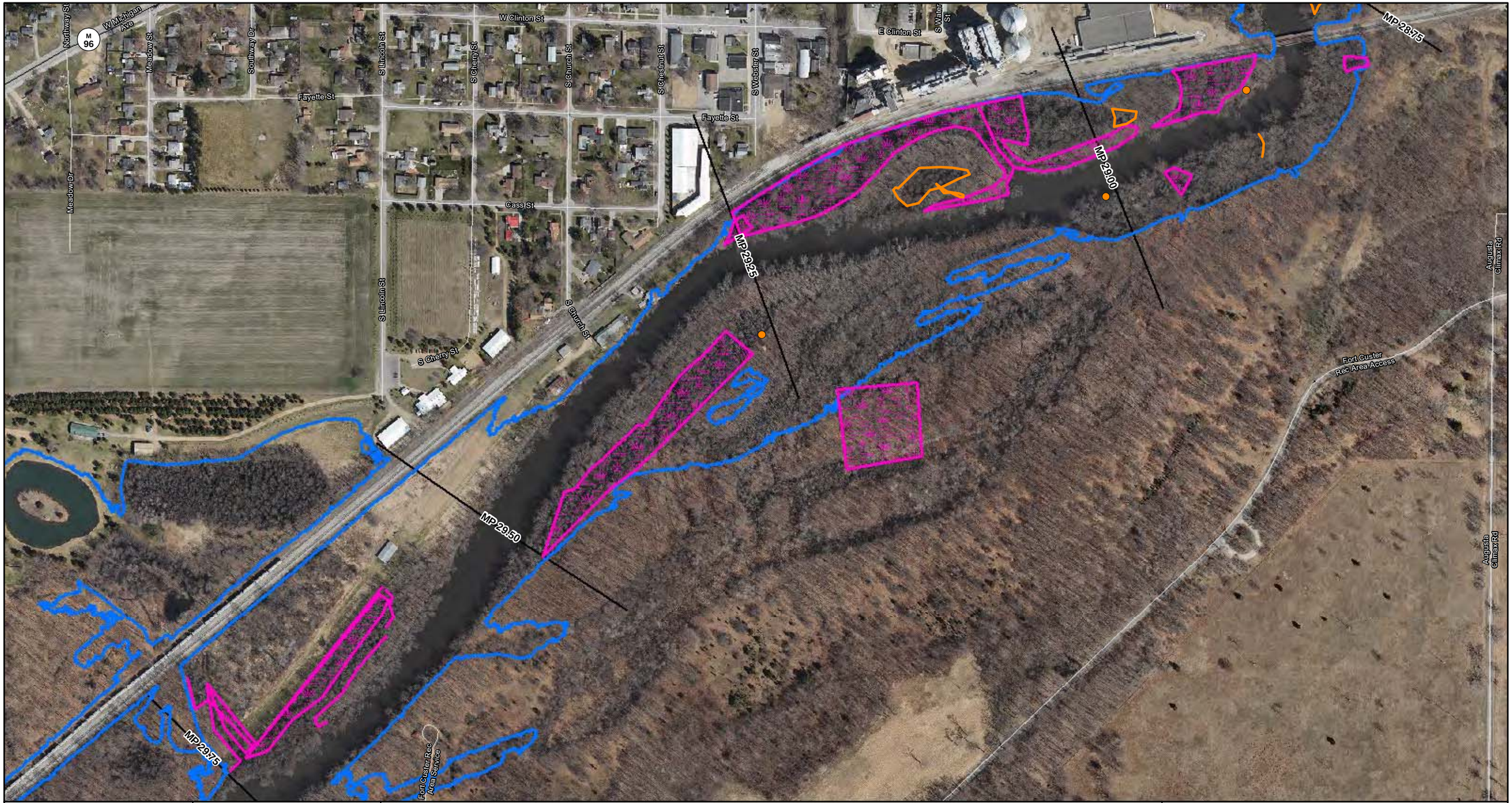

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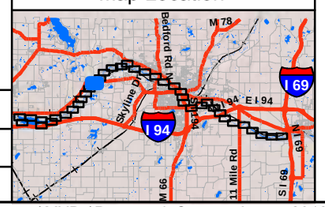
Map Location



Legend

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
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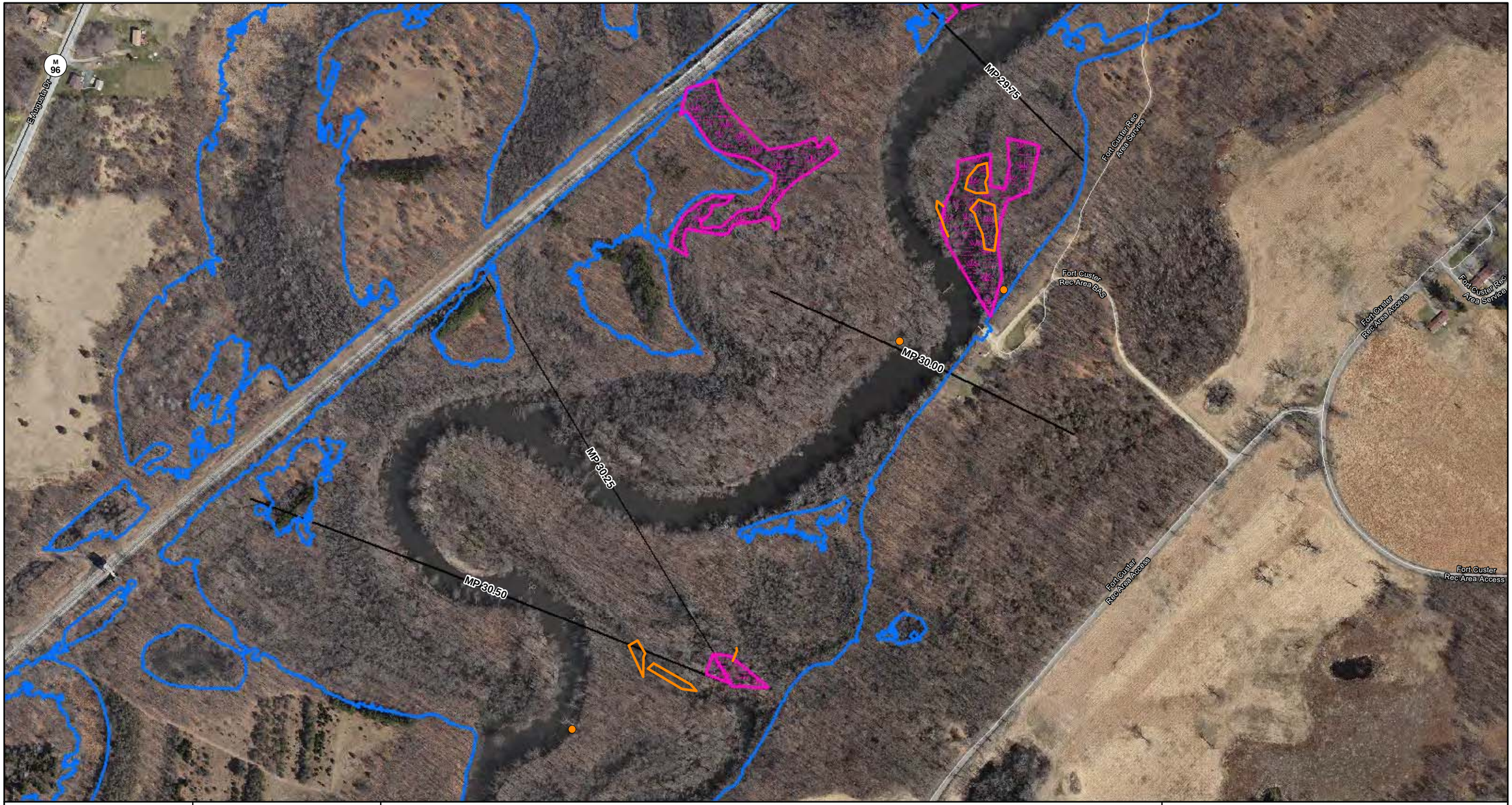

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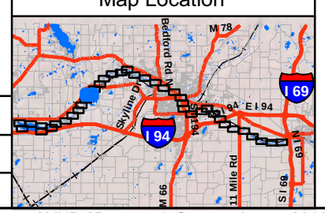

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Scale in Feet

FIGURE 1
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ENBRIDGE LINE 6B MP 608
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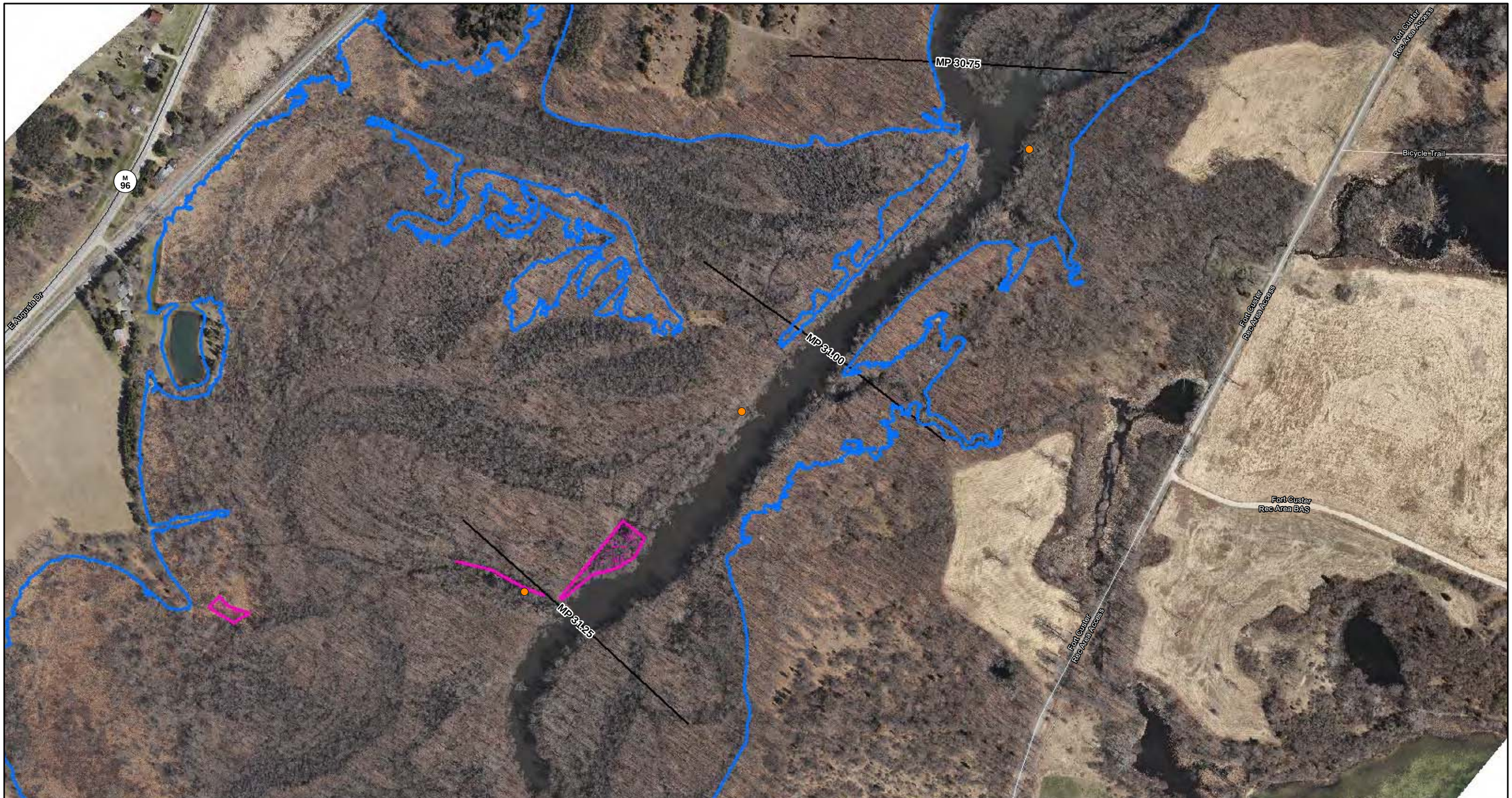

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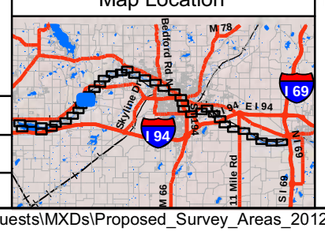

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
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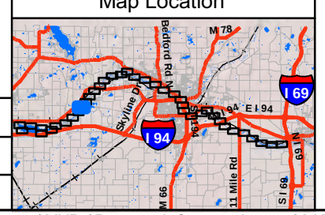

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Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
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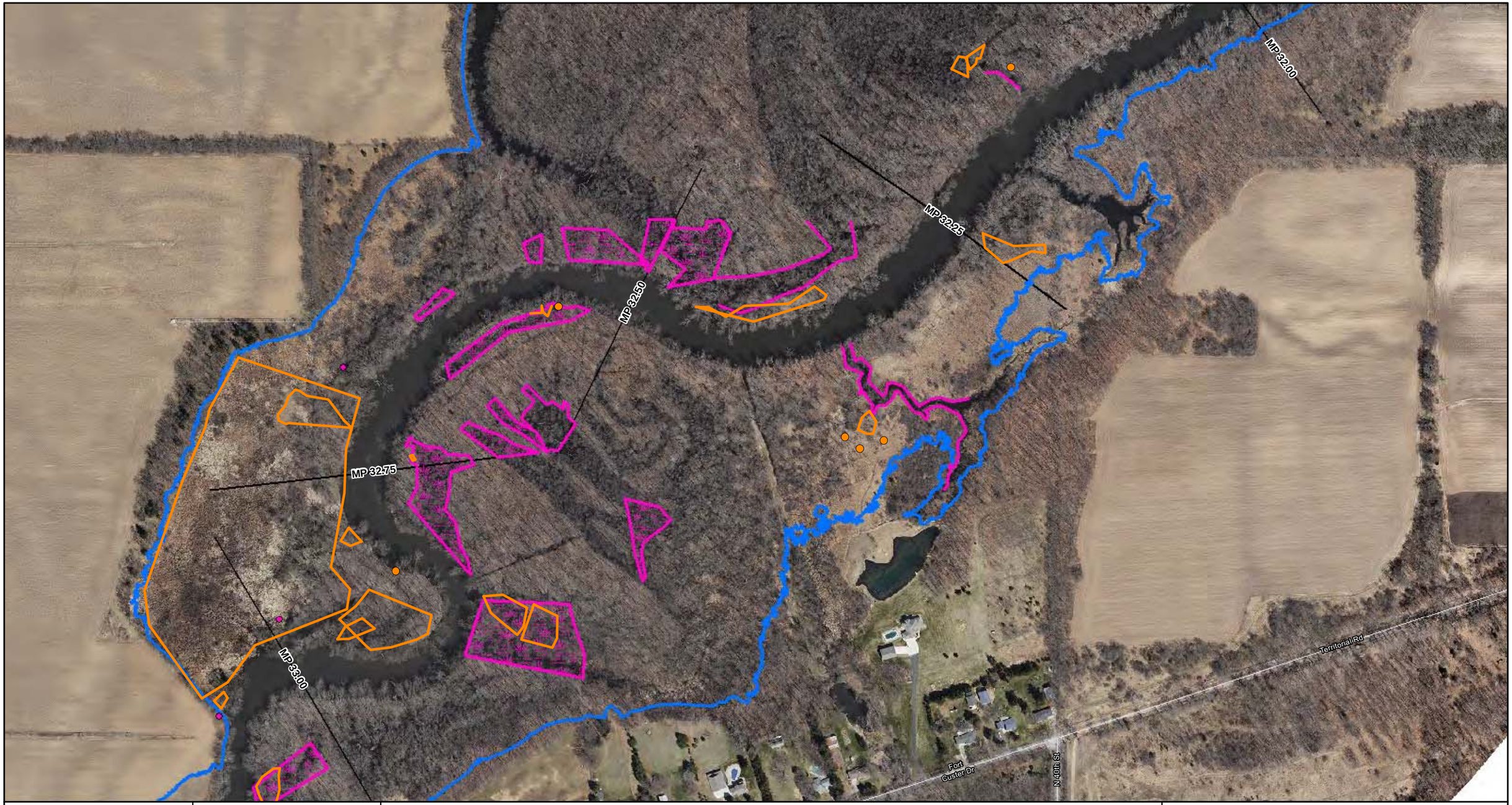

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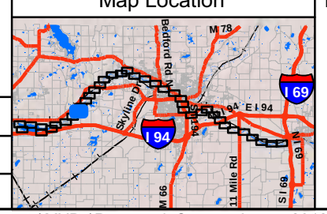
Map Location



Legend

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 30 of 39

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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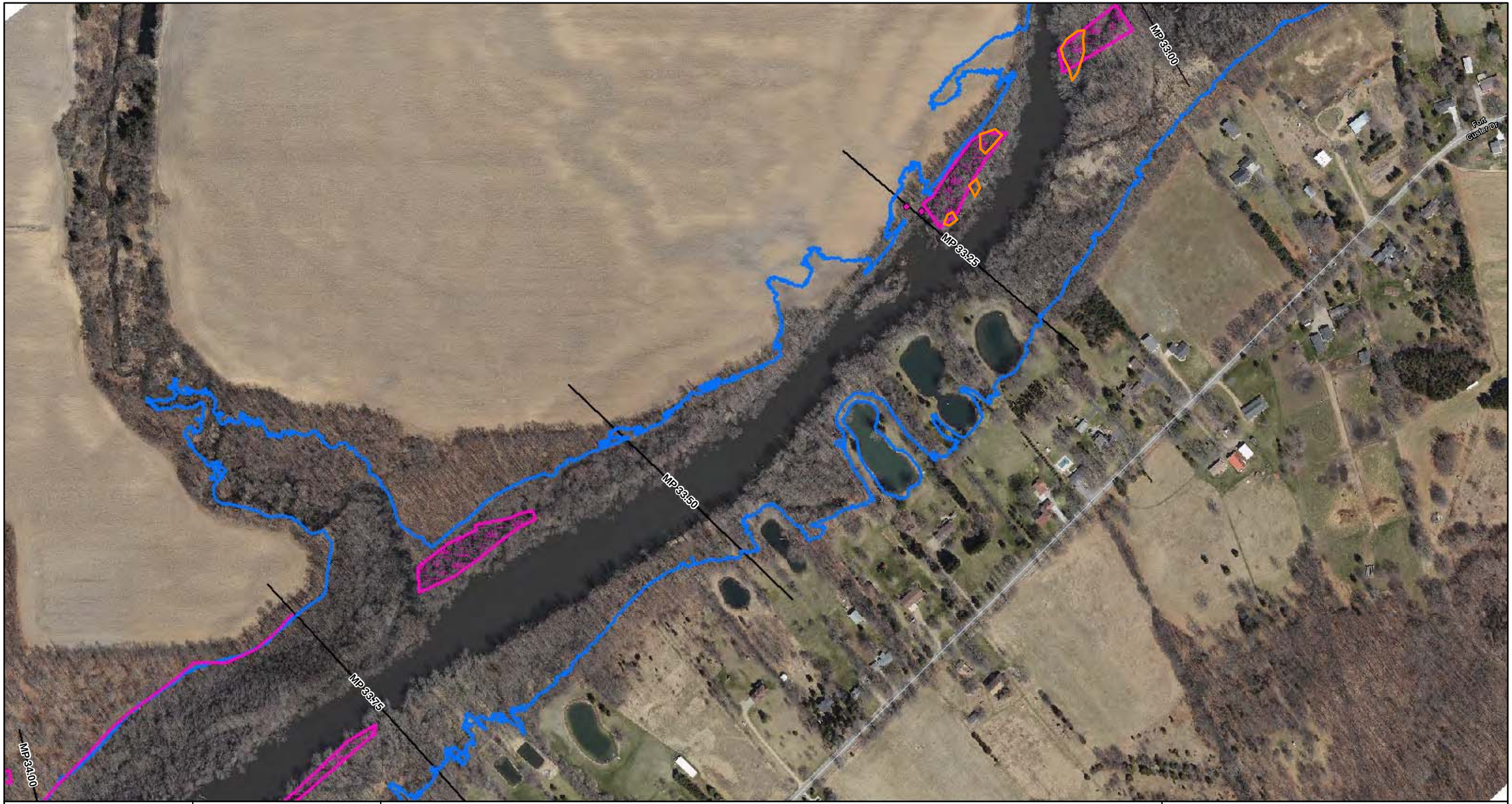

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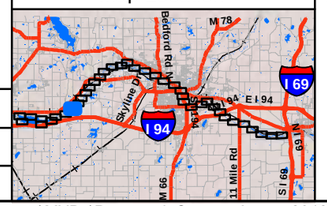
Map Location



Legend

Spring 2011 Reassessment Data

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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 31 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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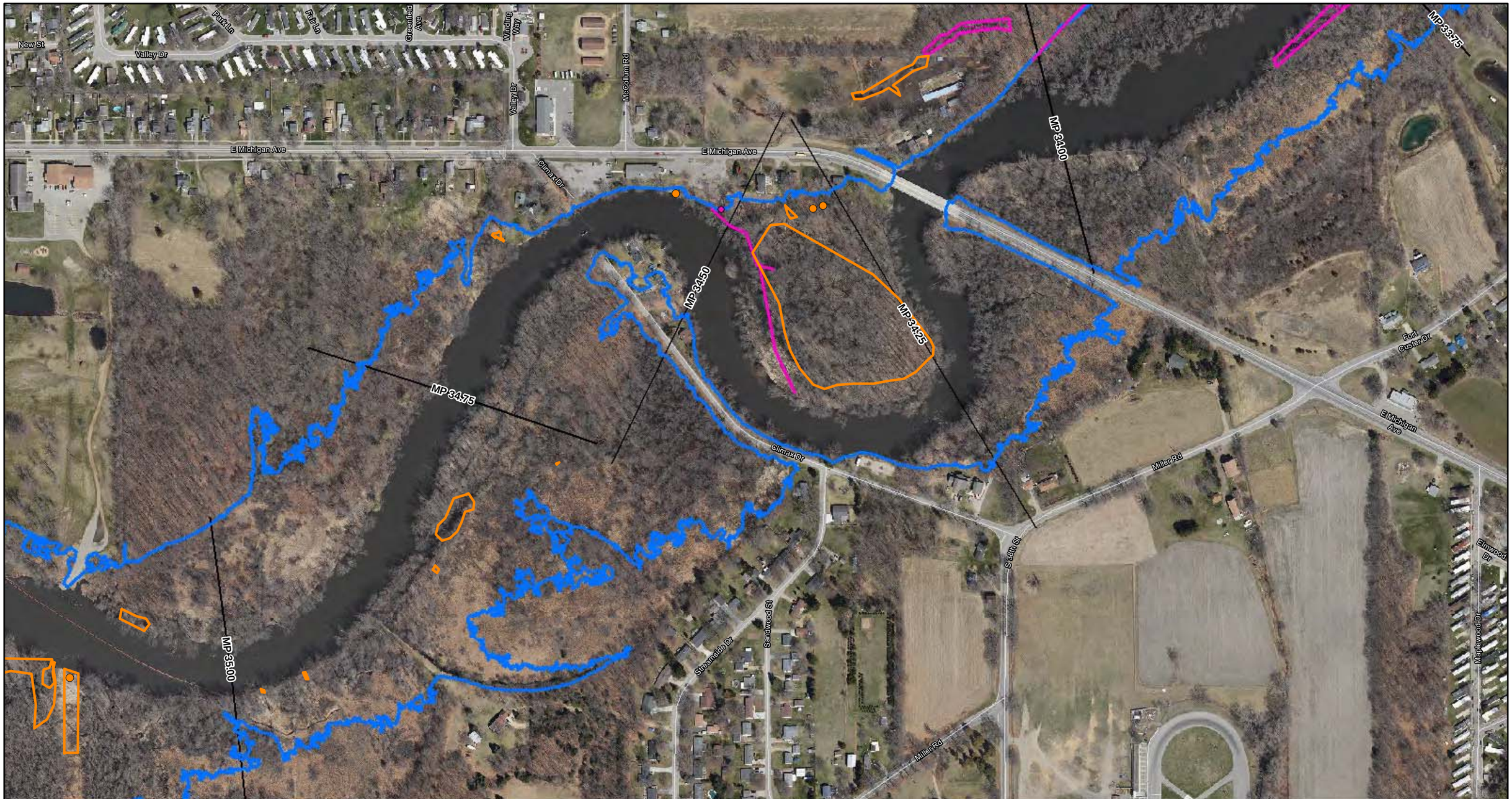

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Approved:	DB	12/02/2011
Project #:	60162778	

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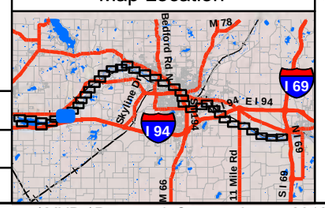

Legend

Spring 2011 Reassessment Data

- Pooled Oil Observation
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- 2011 Inundation Model
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N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 32 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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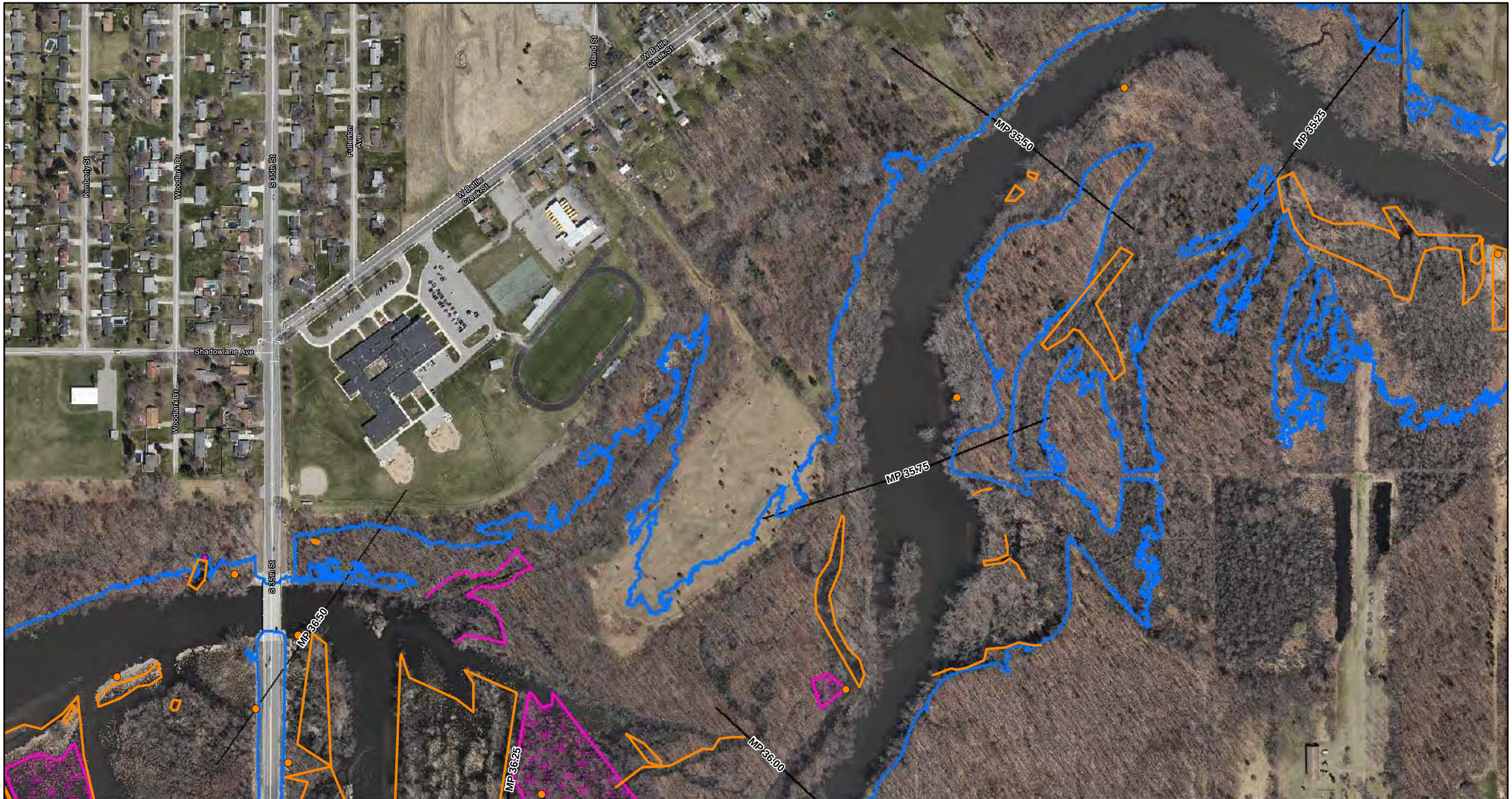

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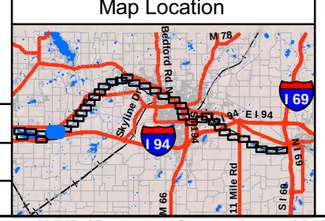

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0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 33 of 39

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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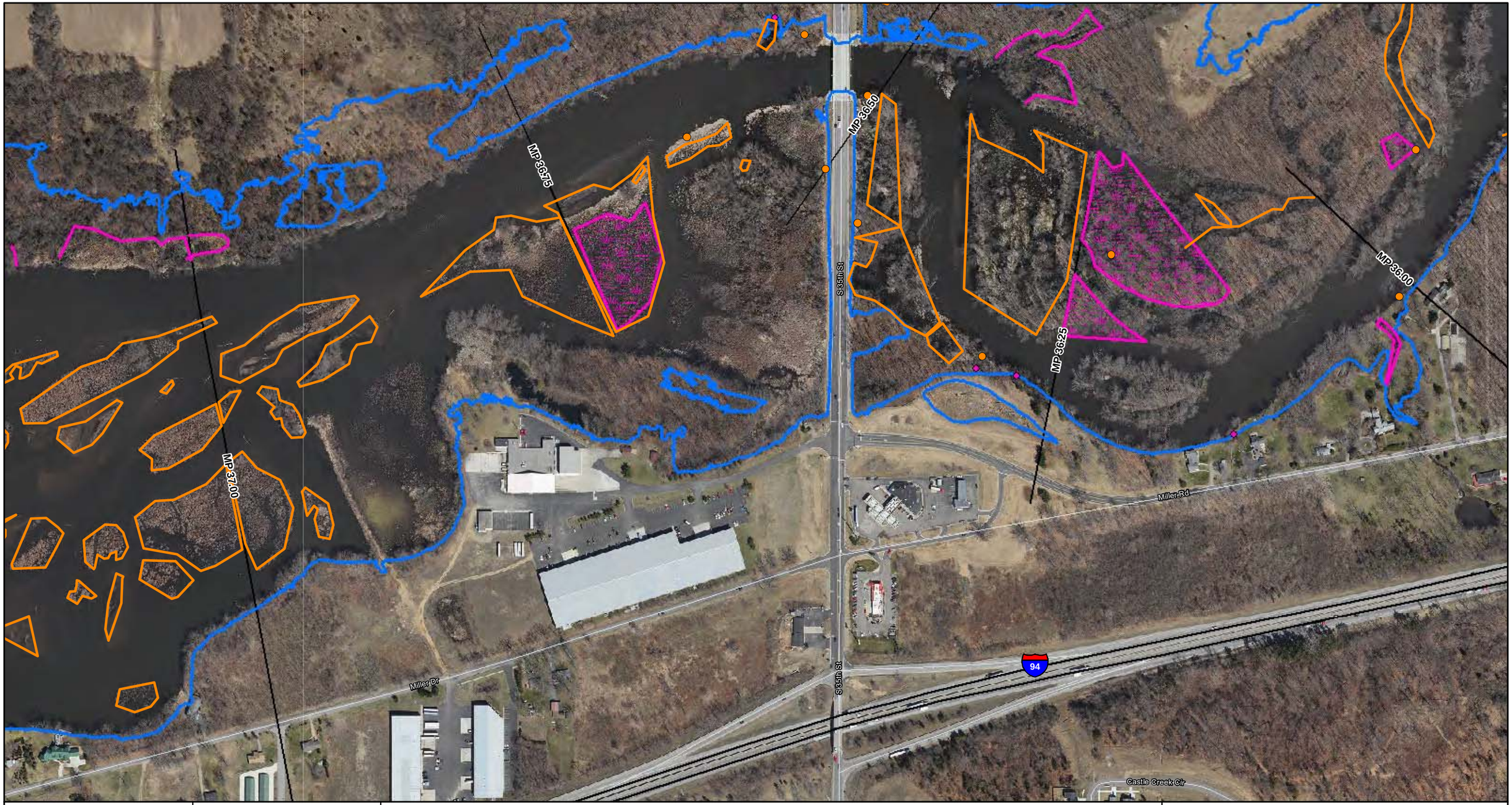

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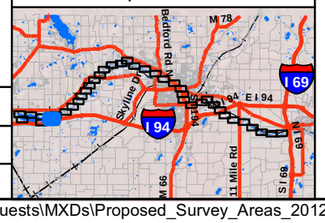

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Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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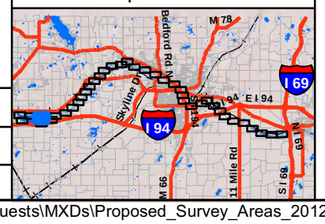

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Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 35 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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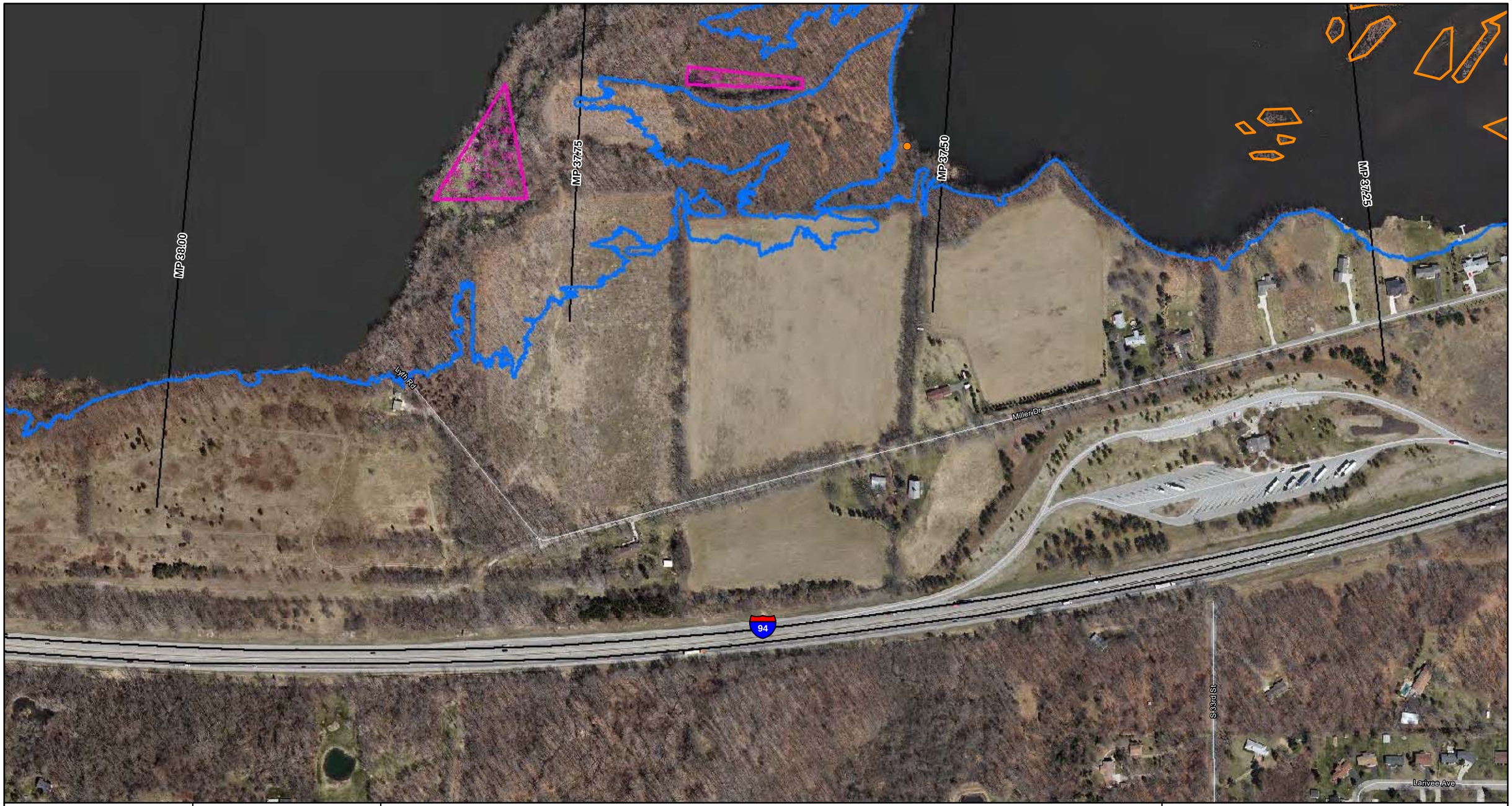

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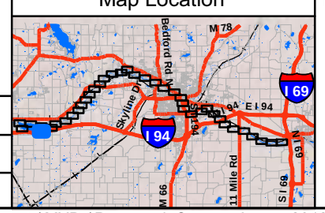

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FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
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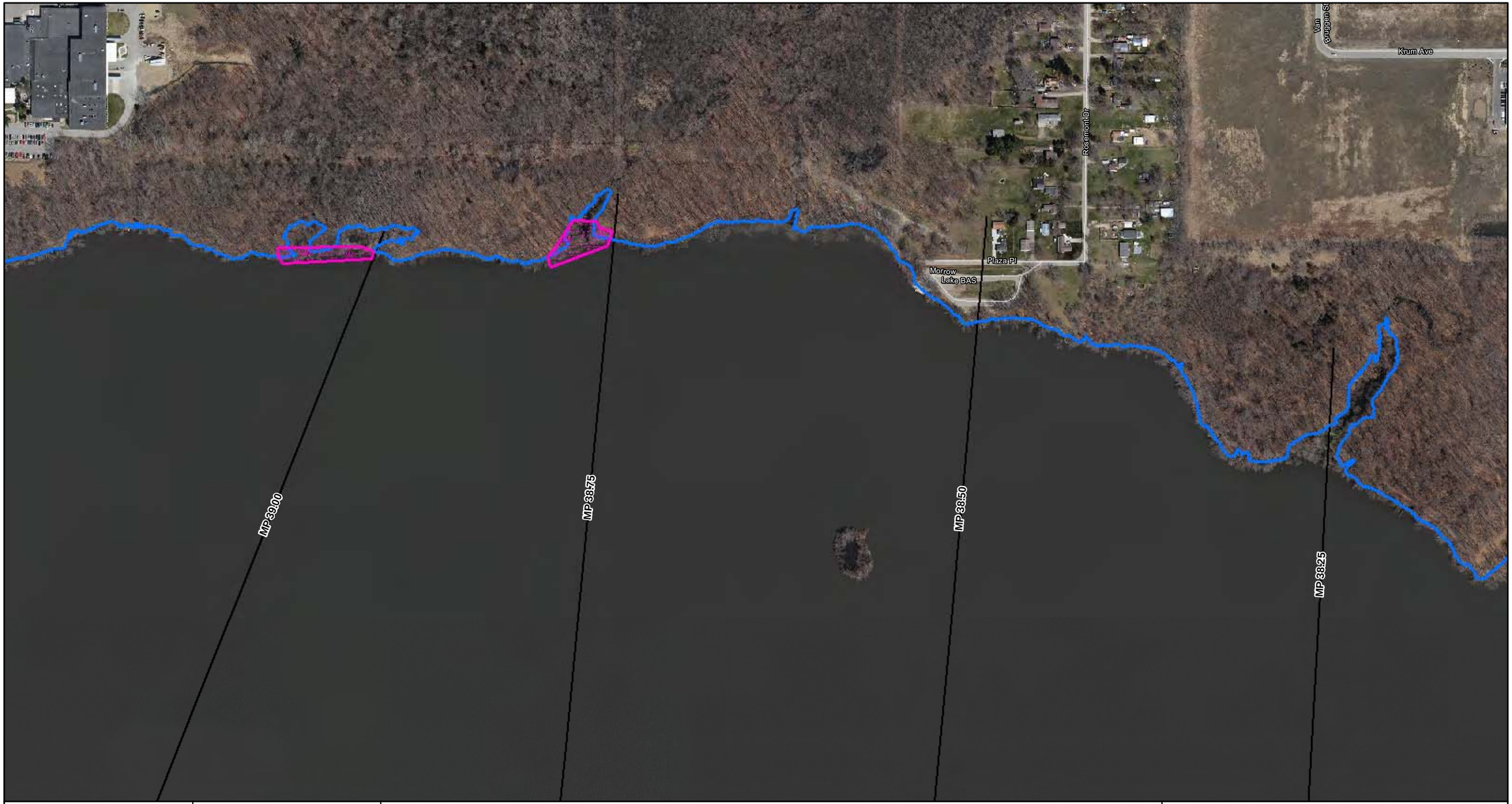

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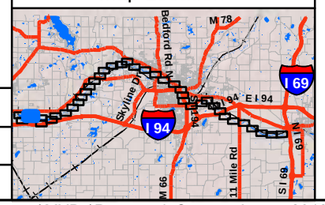

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Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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ENBRIDGE LINE 6B MP 608
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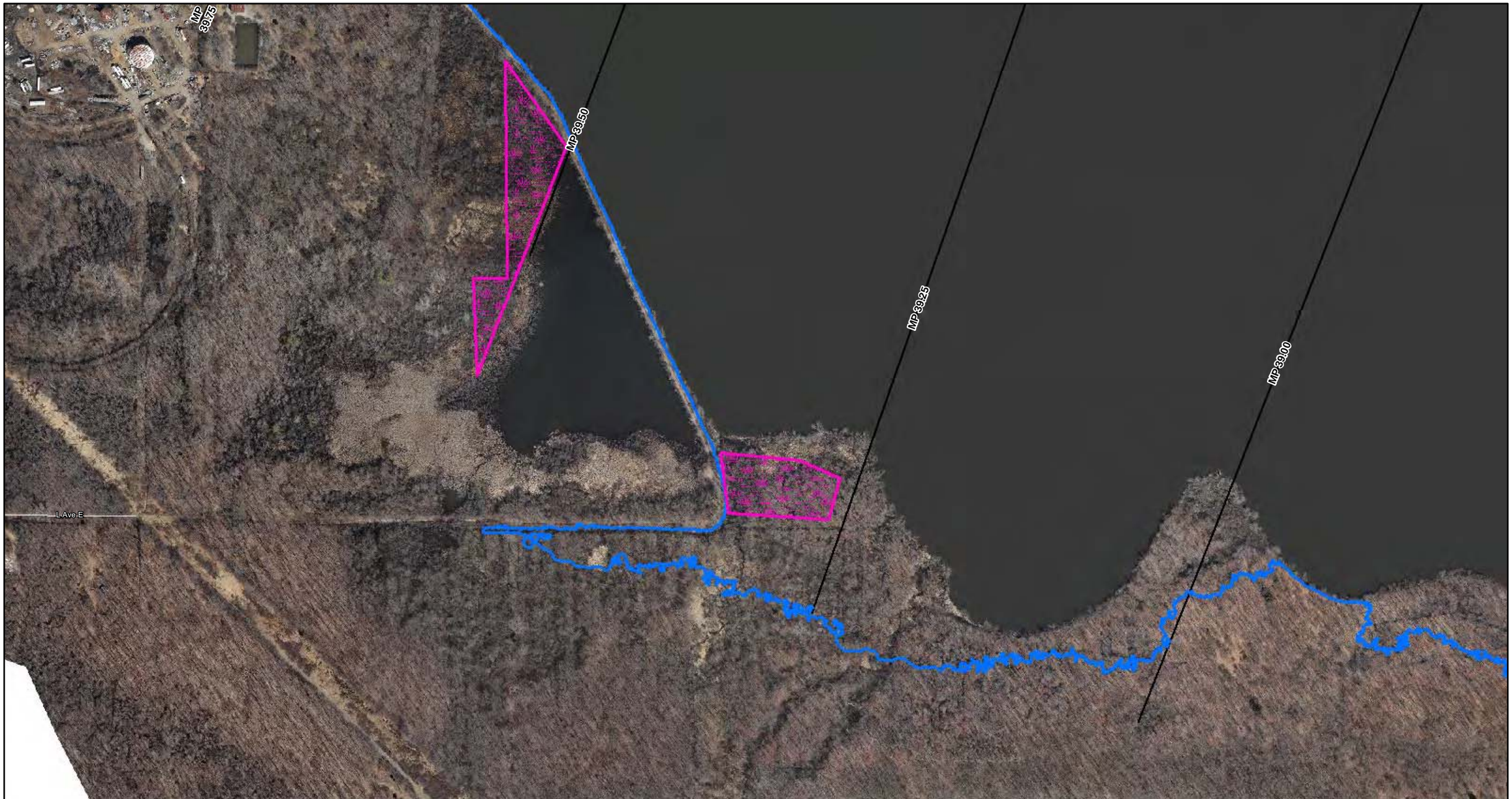

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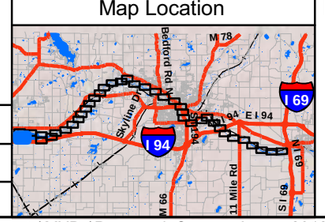

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Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
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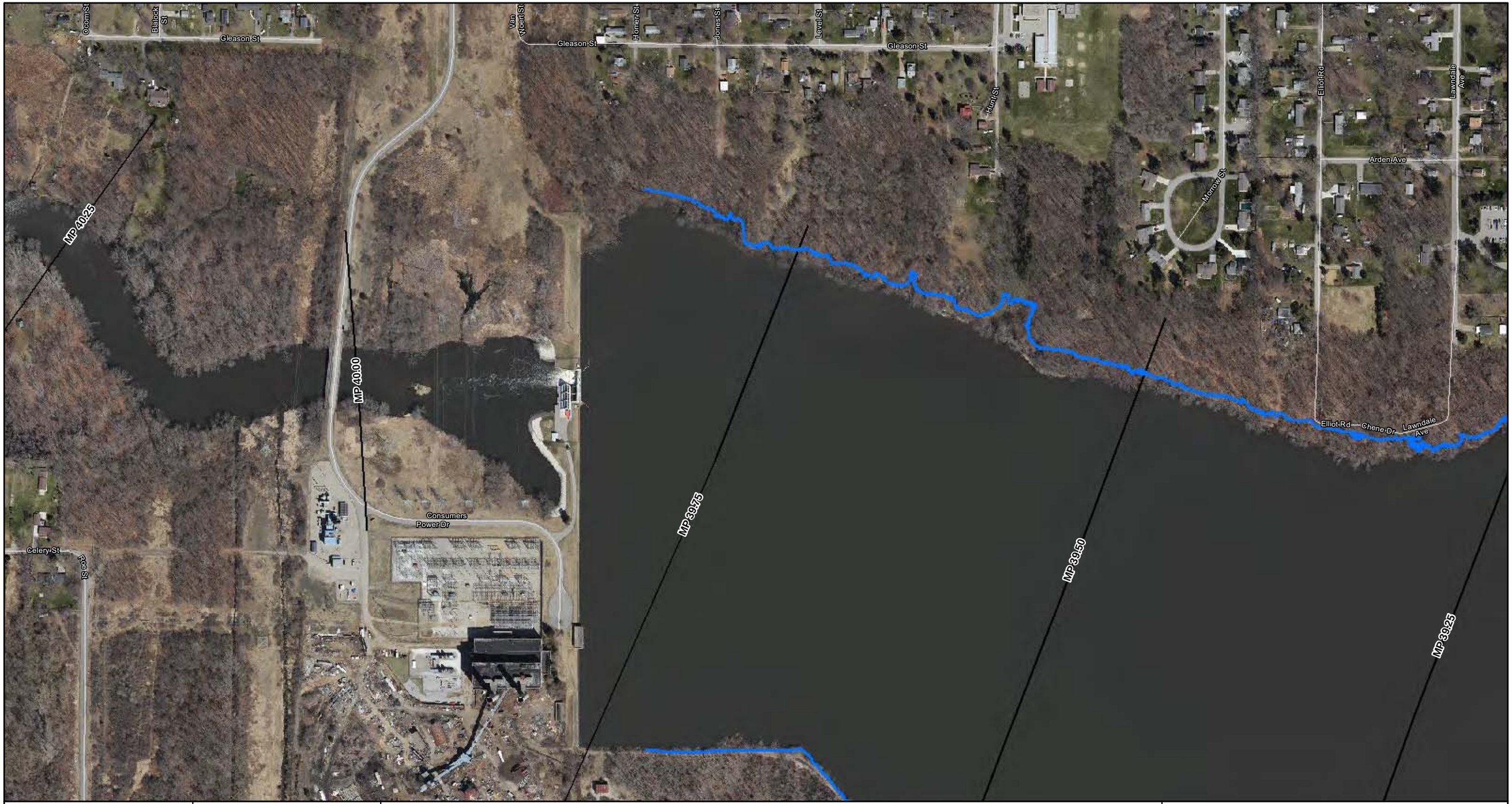

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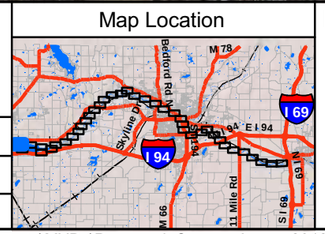
Project #:	60162778	

Map Location



Legend

Spring 2011 Reassessment Data

- Pooled Oil Observation
- Film (Sheen) Observations
- Innundated Areas - Reassess
- Excavated Areas
- 2011 Inundation Model
- Quarter Mile Grid Segments

N

0 125 250 500

Scale in Feet

FIGURE 1
PROPOSED SURVEY AREAS
SPRING 2012 REASSESSMENT
Sheet 39 of 39

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

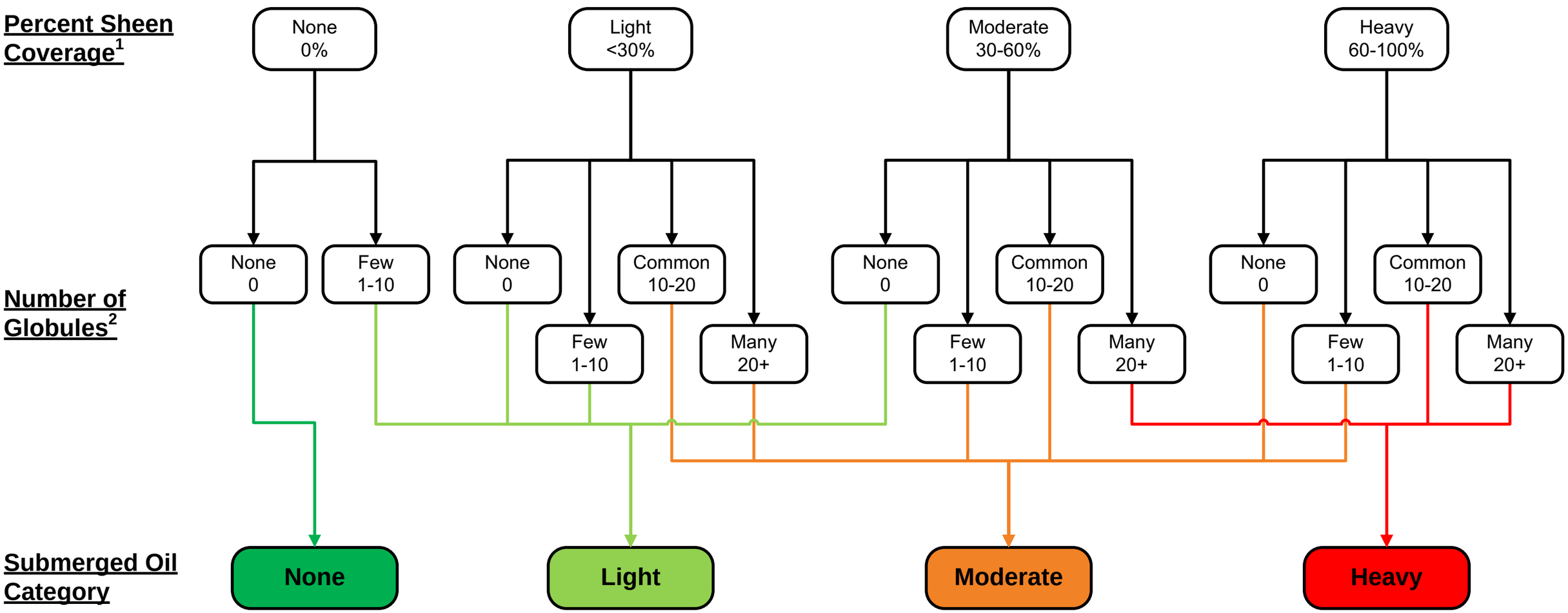
Z:\Work\GIS\2011_Reassessment\Requests\MXDs\Proposed_Survey_Areas_2012_Reassessment.mxd

Aerial Photography Date: April 2011

Attachment B

Submerged Oil: Spring 2012 Reassessment

Figure1: Submerged Oil Field Observation Flowchart



Notes:
1. Percent coverage per square yard
2. Number of globules per square yard

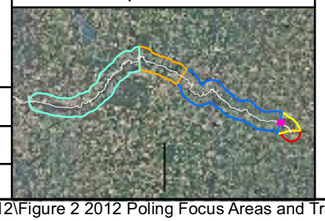
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



Legend

- November 2011 Delineation Area
- Spring 2011 Delineation Area
- *2011 Poling Focus Areas*
- Additional Poling Focus Areas

Transects

- 2011 transect to be poled in 2012
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- Bridge Access Poling Areas
- Quarter Mile Grid Segment

Poling will be conducted +/- 25 feet of all transects, focus areas, and delineation areas

Number of poling locations within each area will be dependent on site conditions. Full transects will have a minimum of 3 locations.

N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 9 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 10 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 11 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

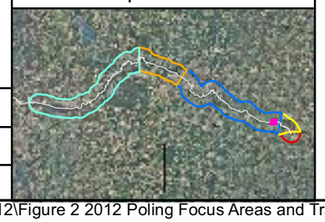
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 12 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
Project #:	106-4186

Map Location

Legend

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N

0 50 100 200
Scale in Feet

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 13 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

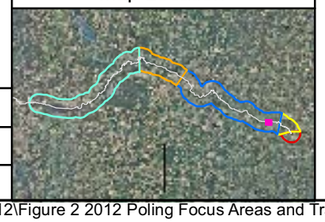
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



Legend

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N

0 50 100 200

Scale in Feet

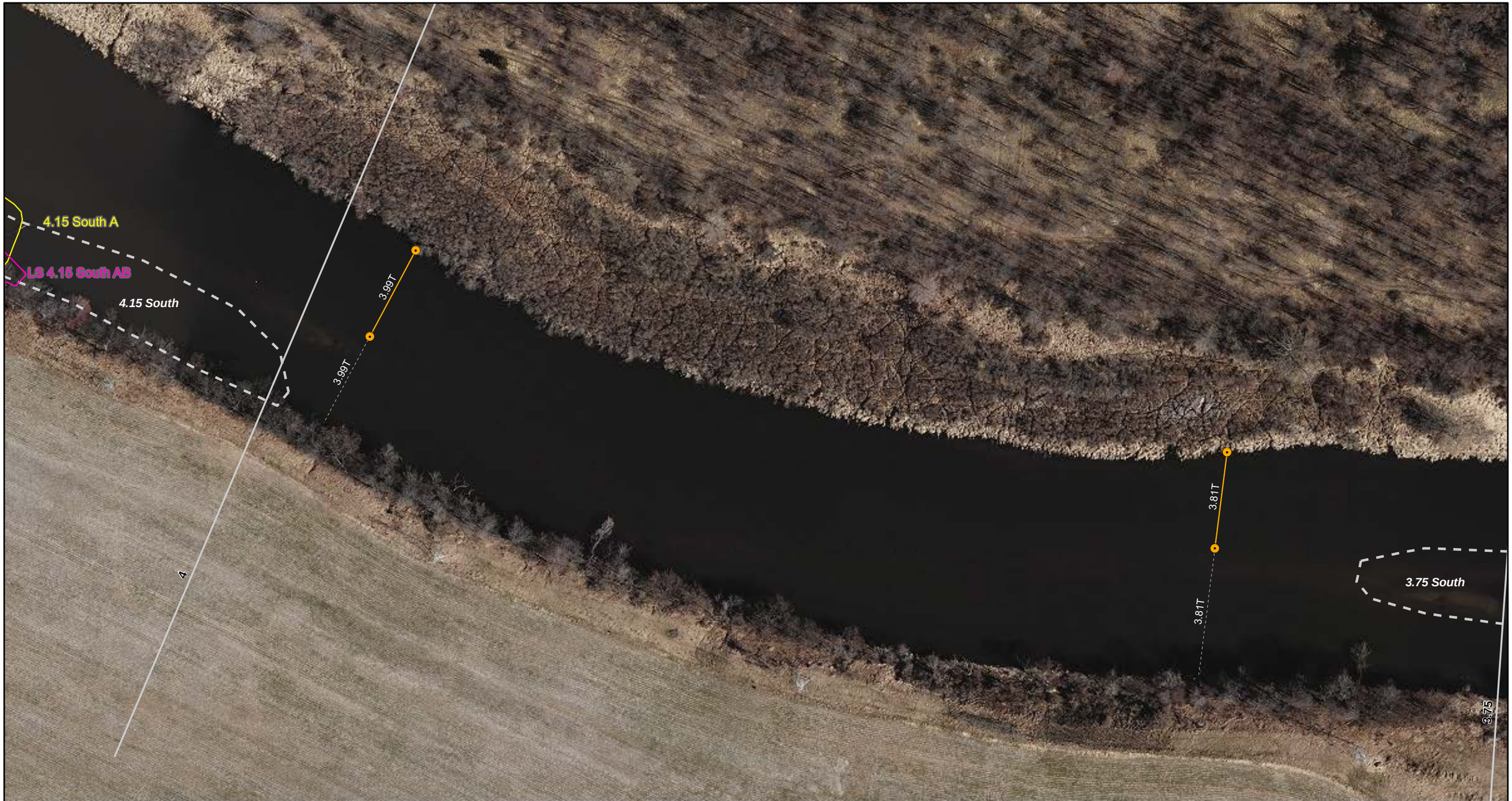
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 14 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

- November 2011 Delineation Area
- Spring 2011 Delineation Area
- *2011 Poling Focus Areas*
- Additional Poling Focus Areas

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N

0 50 100 200

Scale in Feet

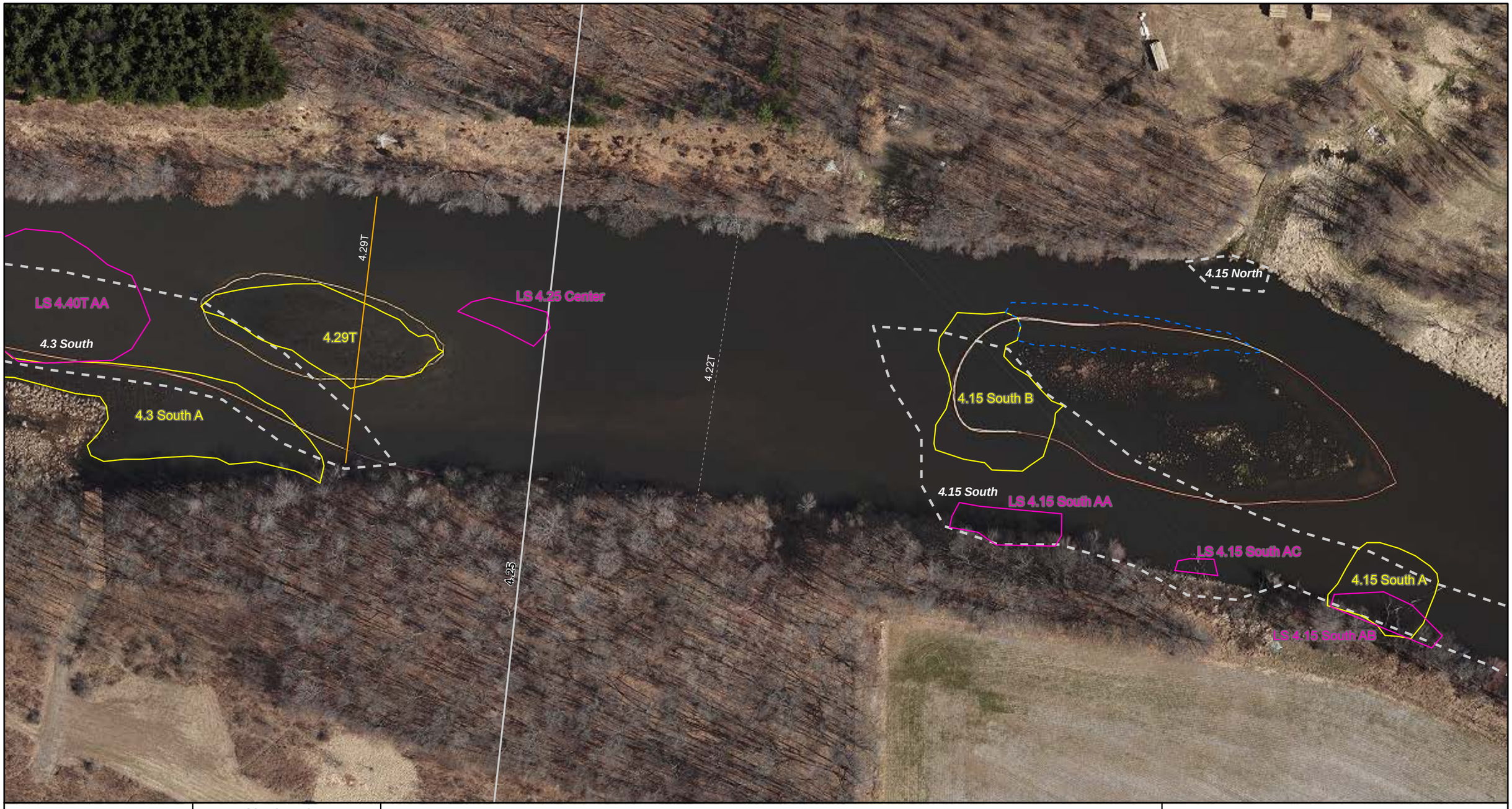
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 15 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



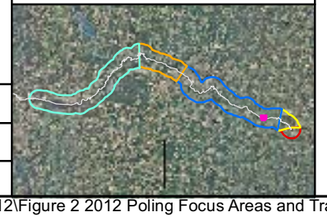
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



Legend

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N

0 50 100 200

Scale in Feet

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 16 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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N

0 50 100 200

Scale in Feet

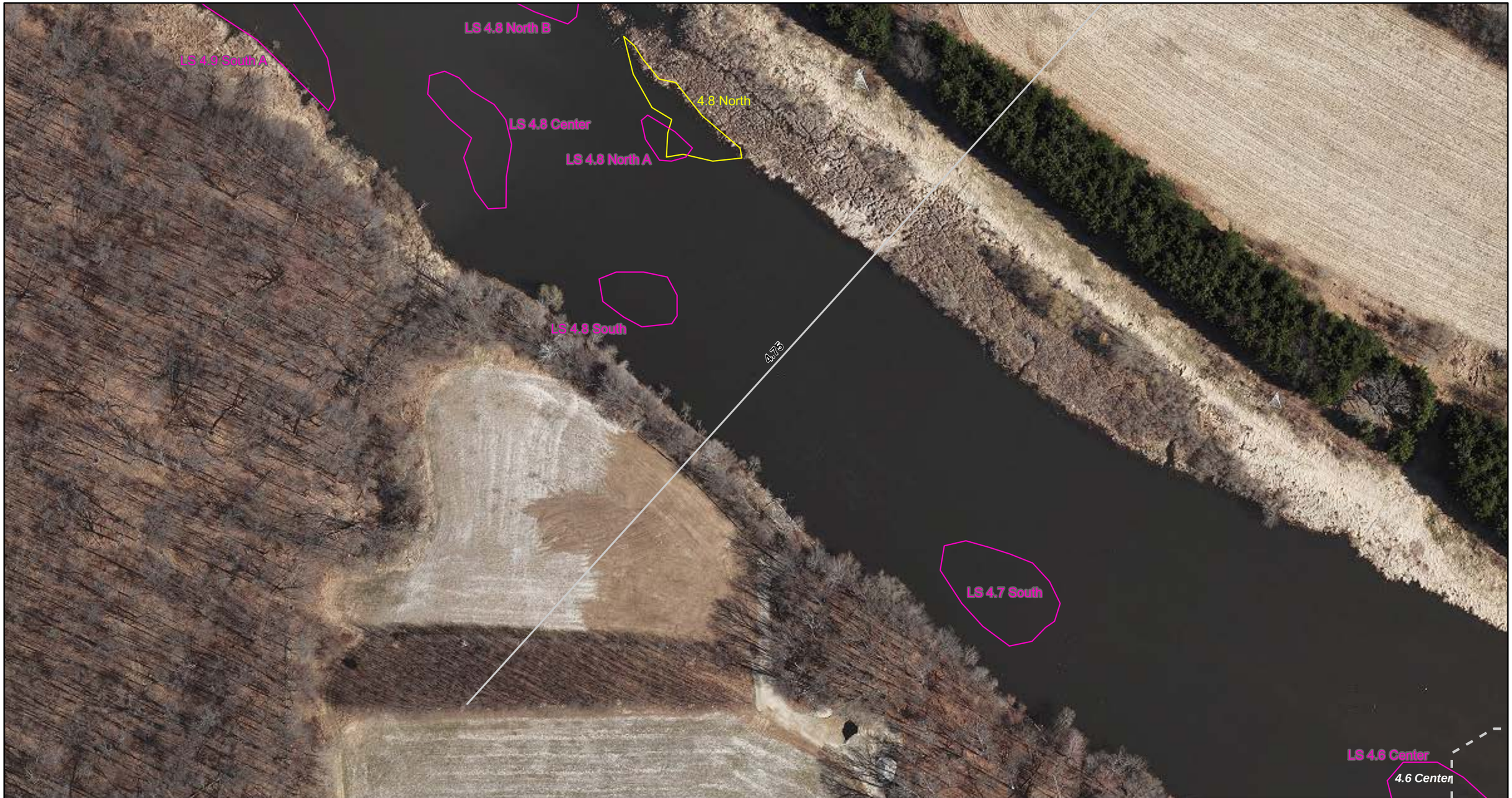
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 17 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 18 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
Project #:	106-4186

Map Location

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N

0 50 100 200
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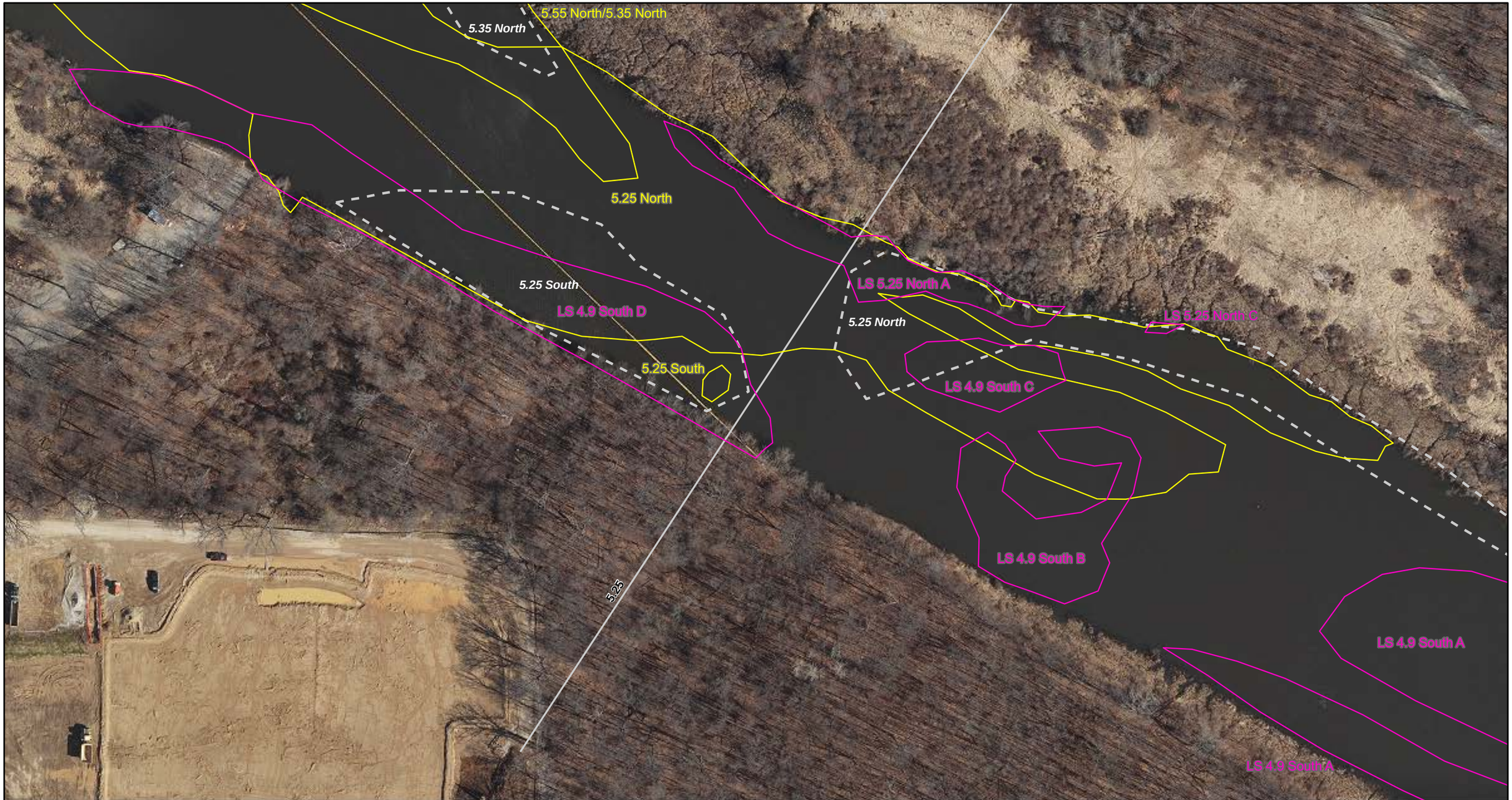
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 19 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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N

0 50 100 200

Scale in Feet

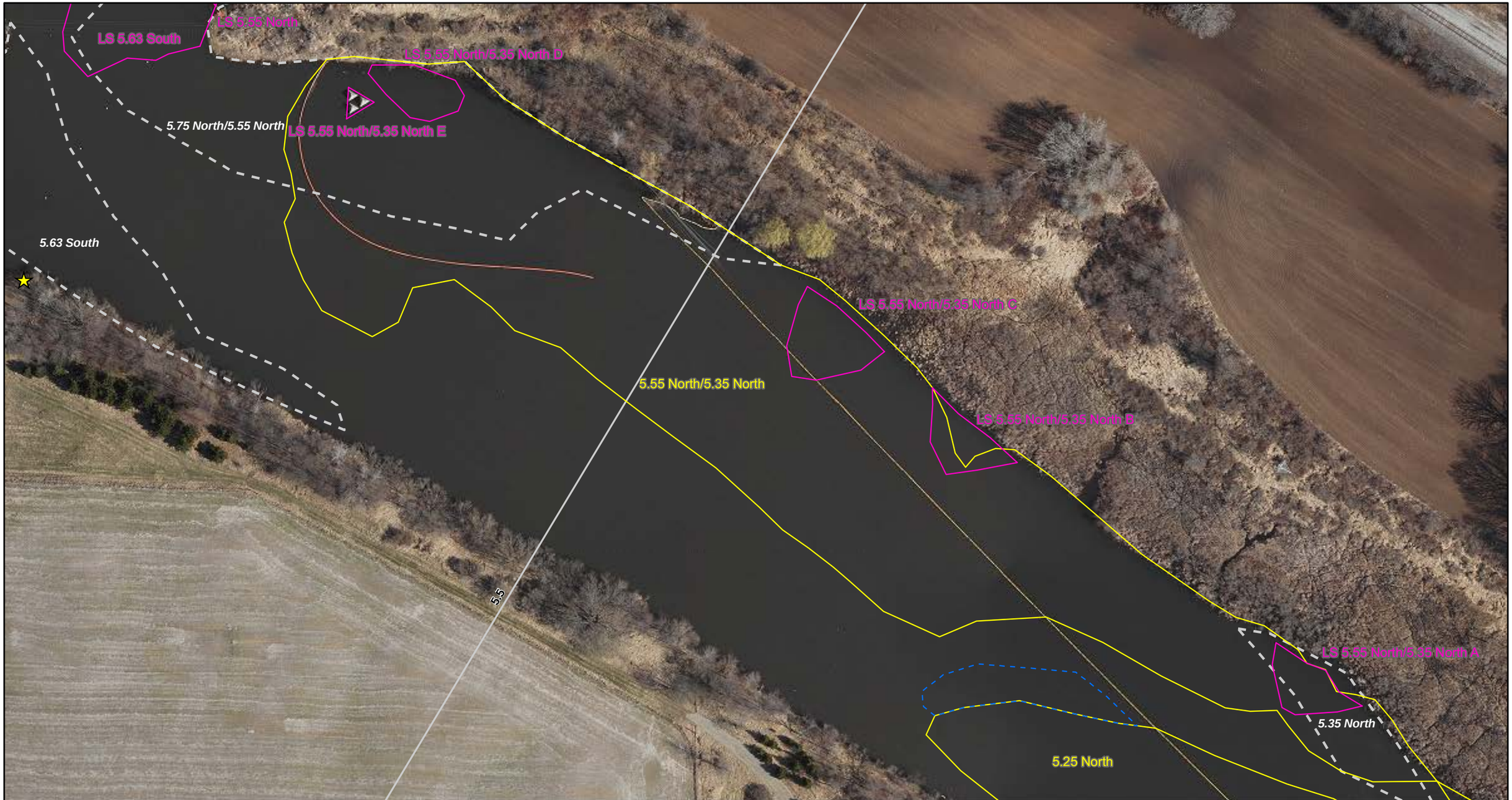
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 20 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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0 50 100 200

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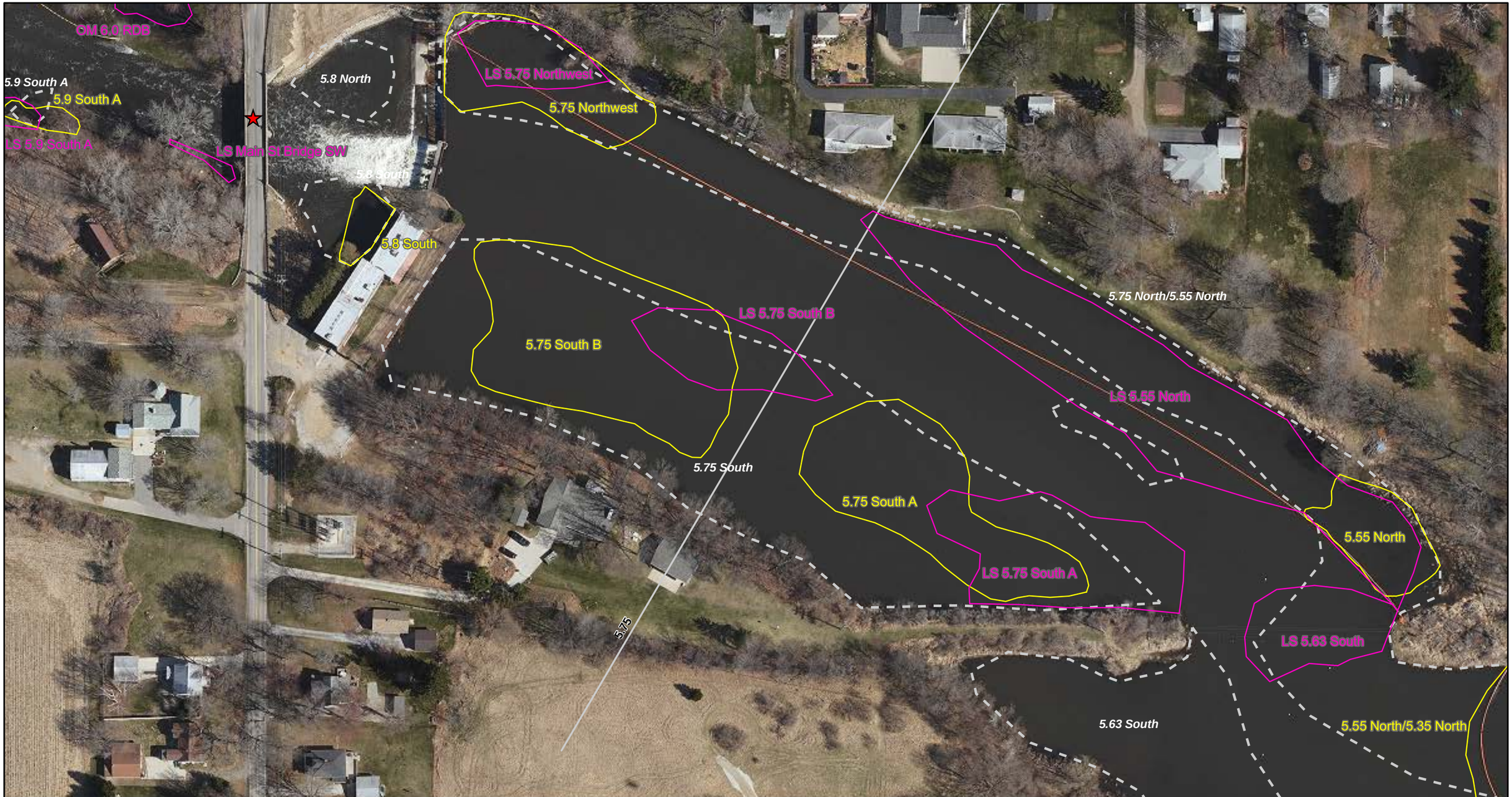
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 21 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 22 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
Project #:	106-4186

Map Location

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N

0 50 100 200
Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 23 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 24 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

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N

0 50 100 200

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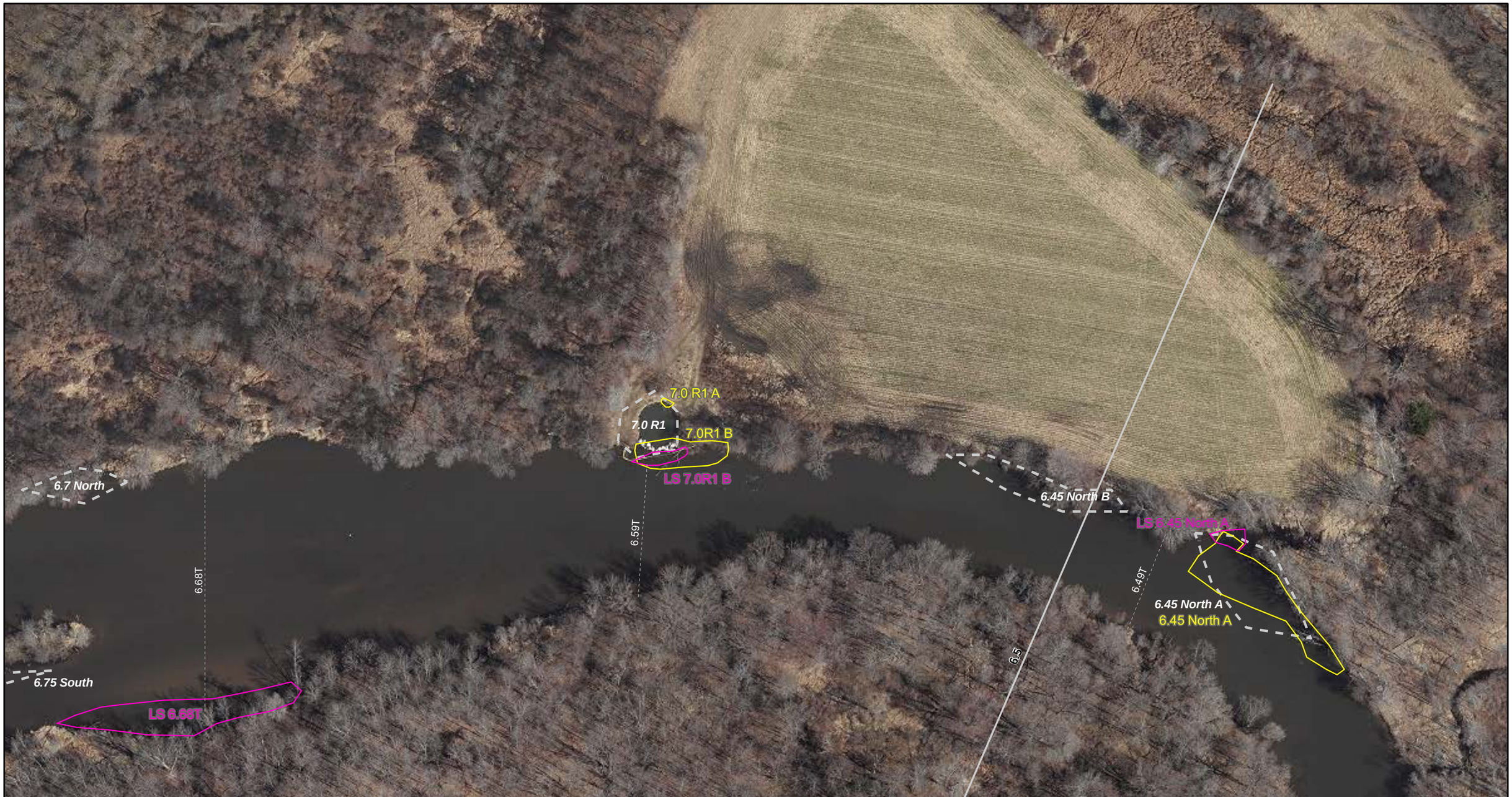
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 25 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
Project #:	106-4186

Map Location

Legend

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0 50 100 200
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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 26 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
Project #:	106-4186

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N

0 50 100 200
Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 27 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

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0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 28 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

- November 2011 Delineation Area
- Spring 2011 Delineation Area
- *2011 Poling Focus Areas*
- Additional Poling Focus Areas

Transects

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- Park/Launch Access Poling Areas
- Bridge Access Poling Areas
- Quarter Mile Grid Segment

Poling will be conducted +/- 25 feet of all transects, focus areas, and delineation areas

Number of poling locations within each area will be dependent on site conditions. Full transects will have a minimum of 3 locations.

N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 29 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 30 OF 170

ENBRIDGE LINE 6B MP 608
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0 50 100 200

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 31 OF 170

ENBRIDGE LINE 6B MP 608
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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 32 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

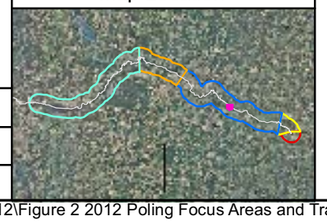
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



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0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 33 OF 170

ENBRIDGE LINE 6B MP 608
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0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 34 OF 170

ENBRIDGE LINE 6B MP 608
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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 35 OF 170

ENBRIDGE LINE 6B MP 608
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Approved:	DBR 12/21/2011
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0 50 100 200
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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 36 OF 170

ENBRIDGE LINE 6B MP 608
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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 37 OF 170

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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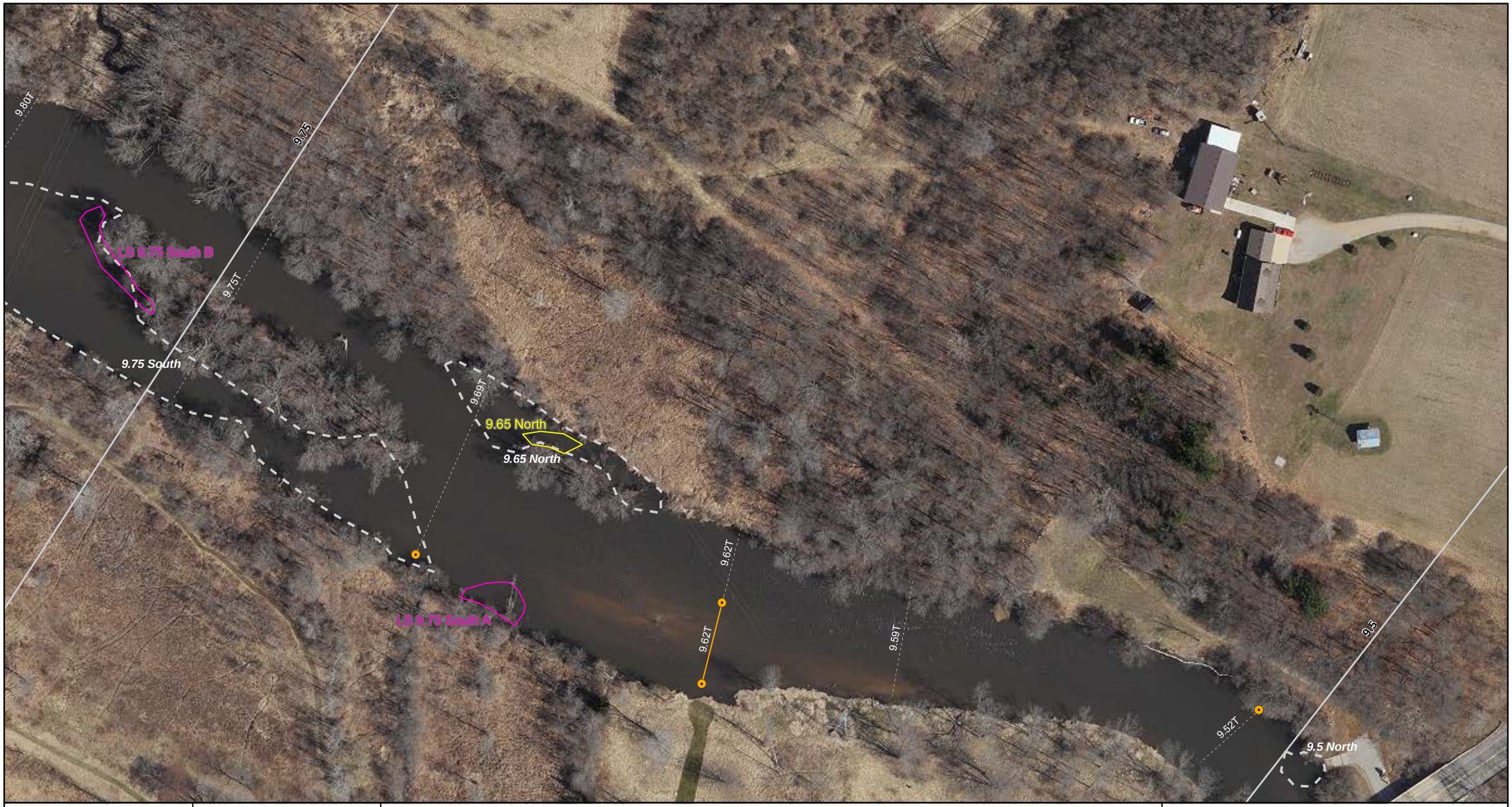
Aerial Photography Date: April 2011



ENBRIDGE

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Project #: 106-4186

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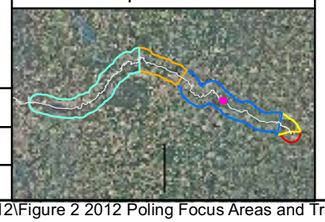

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 38 OF 170

ENBRIDGE LINE 6B MP 608
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0 50 100 200
Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 39 OF 170

ENBRIDGE LINE 6B MP 608
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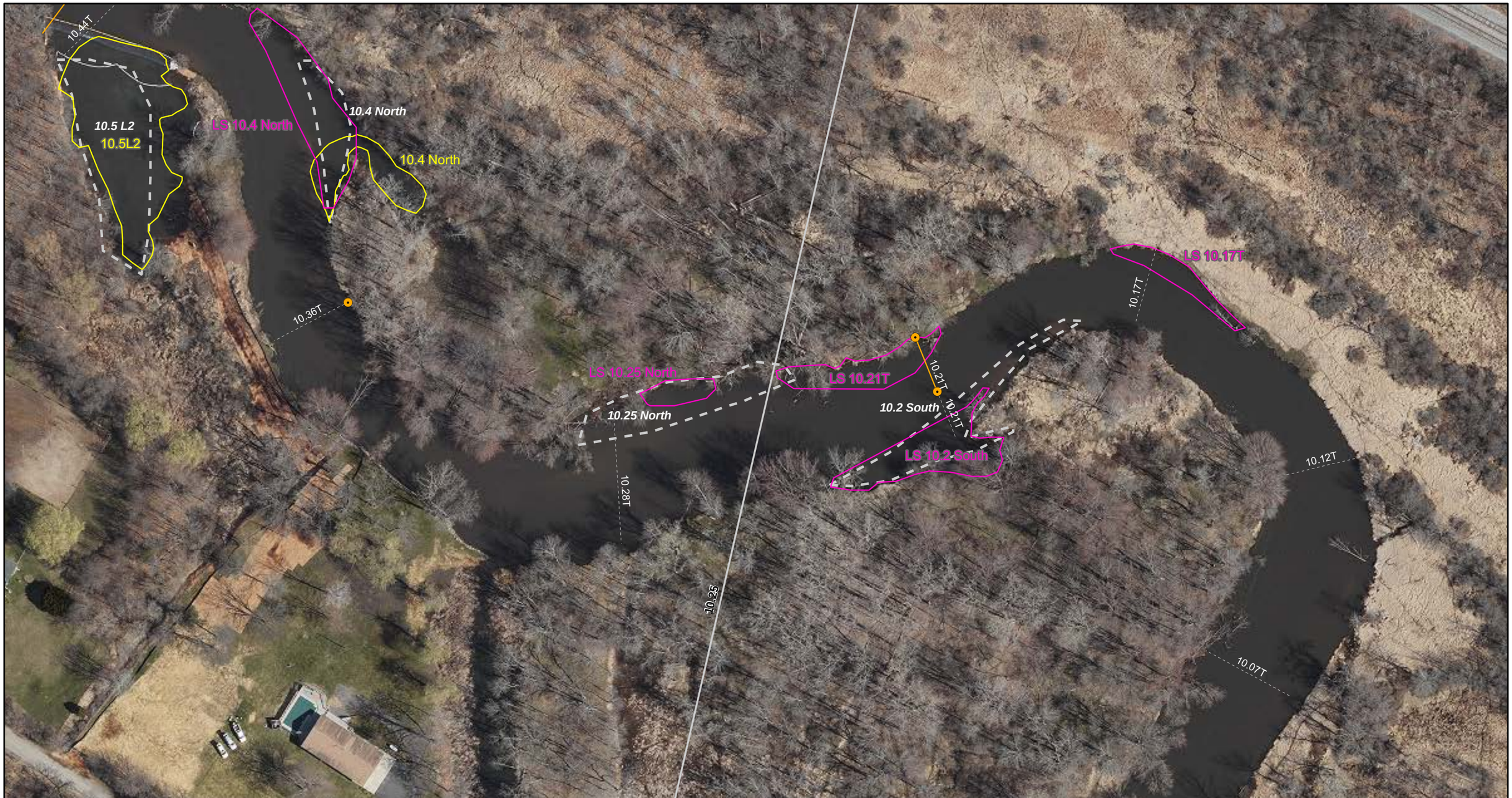

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N

0 50 100 200
Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 40 OF 170

ENBRIDGE LINE 6B MP 608
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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 41 OF 170

ENBRIDGE LINE 6B MP 608
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N

0 50 100 200
Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 42 OF 170

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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0 50 100 200

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 43 OF 170

ENBRIDGE LINE 6B MP 608
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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 44 OF 170

ENBRIDGE LINE 6B MP 608
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Project #: 106-4186

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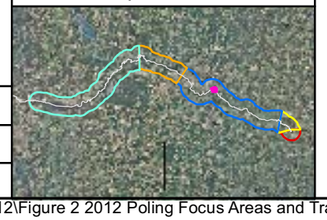

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 45 OF 170

ENBRIDGE LINE 6B MP 608
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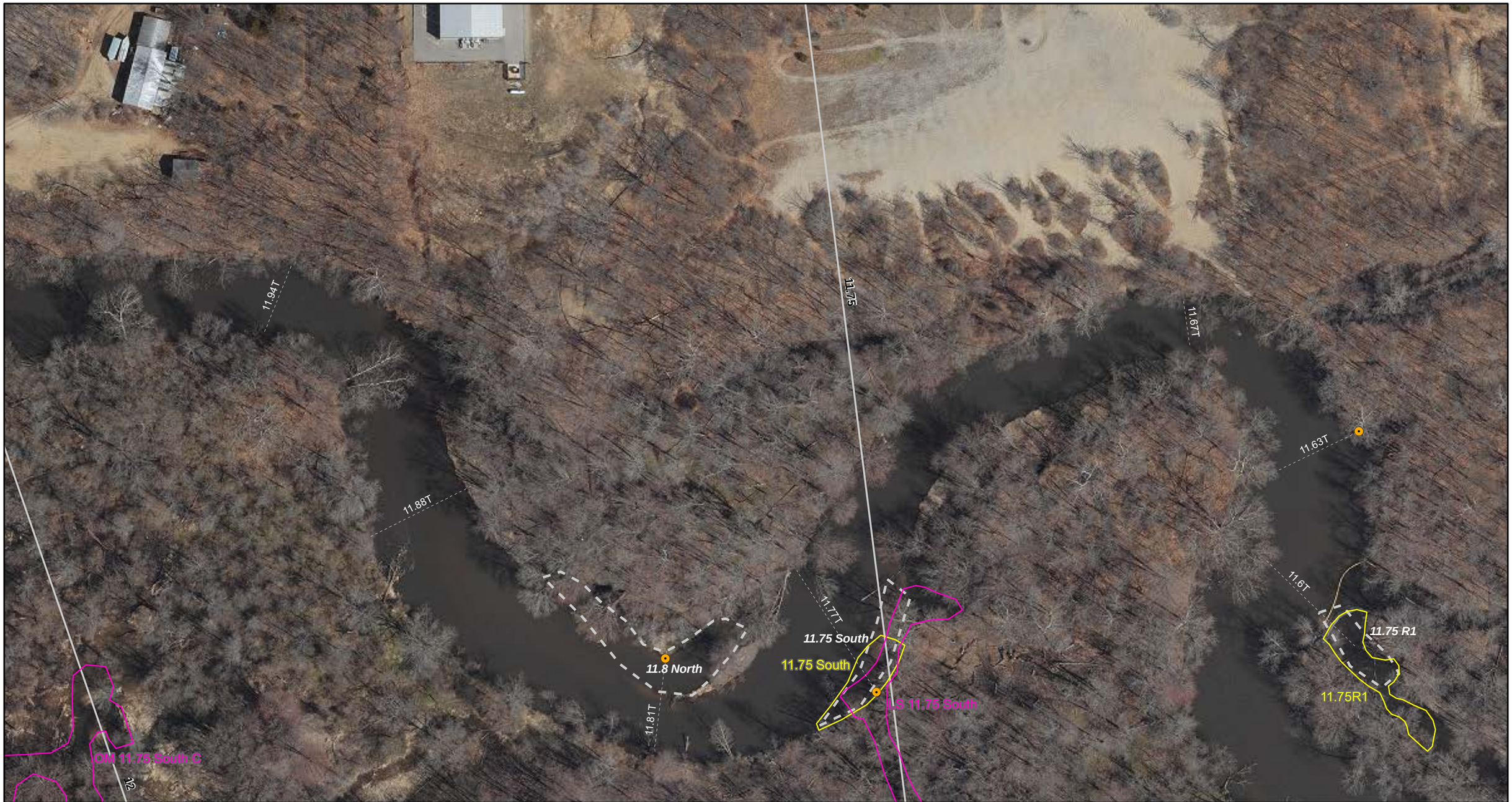

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N

0 50 100 200
Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 46 OF 170

ENBRIDGE LINE 6B MP 608
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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 47 OF 170

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2012 POLING FOCUS AREAS & TRANSECTS

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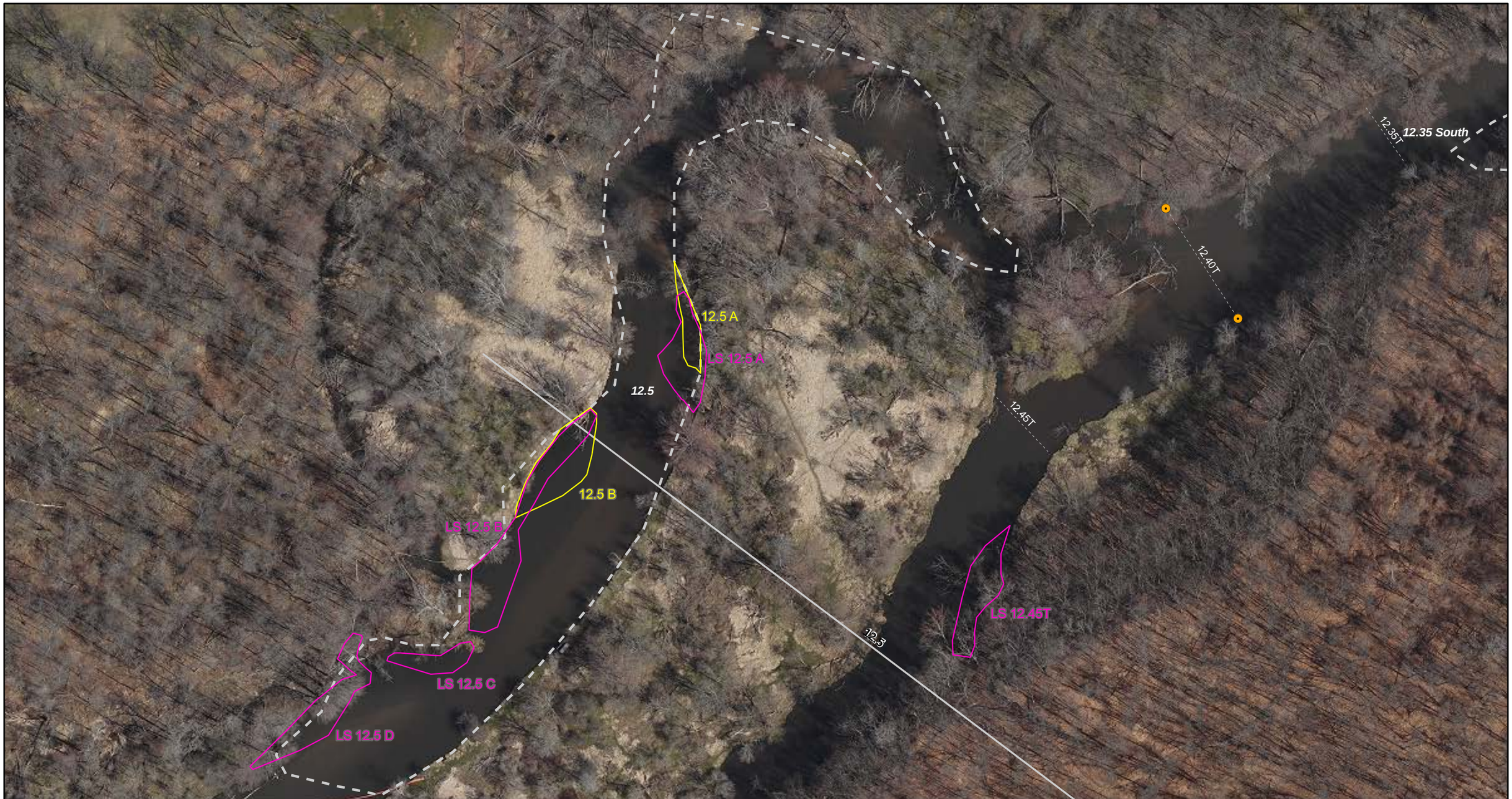

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0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 49 OF 170

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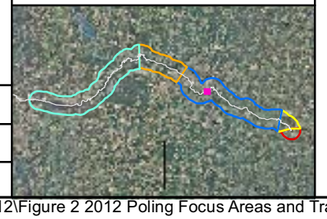

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SHEET 50 OF 170

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Transects

- 2011 transect to be poled in 2012
- 2011 transect not slated for poling in 2012
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- Park/Launch Access Poling Areas
- Bridge Access Poling Areas
- Quarter Mile Grid Segment

Poling will be conducted +/- 25 feet of all transects, focus areas, and delineation areas

Number of poling locations within each area will be dependent on site conditions. Full transects will have a minimum of 3 locations.

N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 51 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

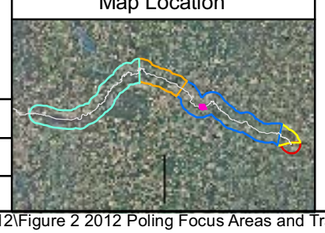
X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
Project #:	106-4186

Map Location



Legend

- November 2011 Delineation Area
- Spring 2011 Delineation Area
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- Additional Poling Focus Areas

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- Bridge Access Poling Areas
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N

0 50 100 200
Scale in Feet

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 52 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

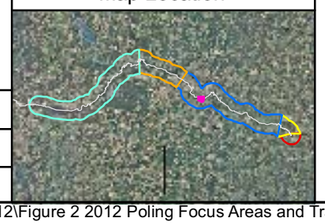
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



Legend

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N

0 50 100 200

Scale in Feet

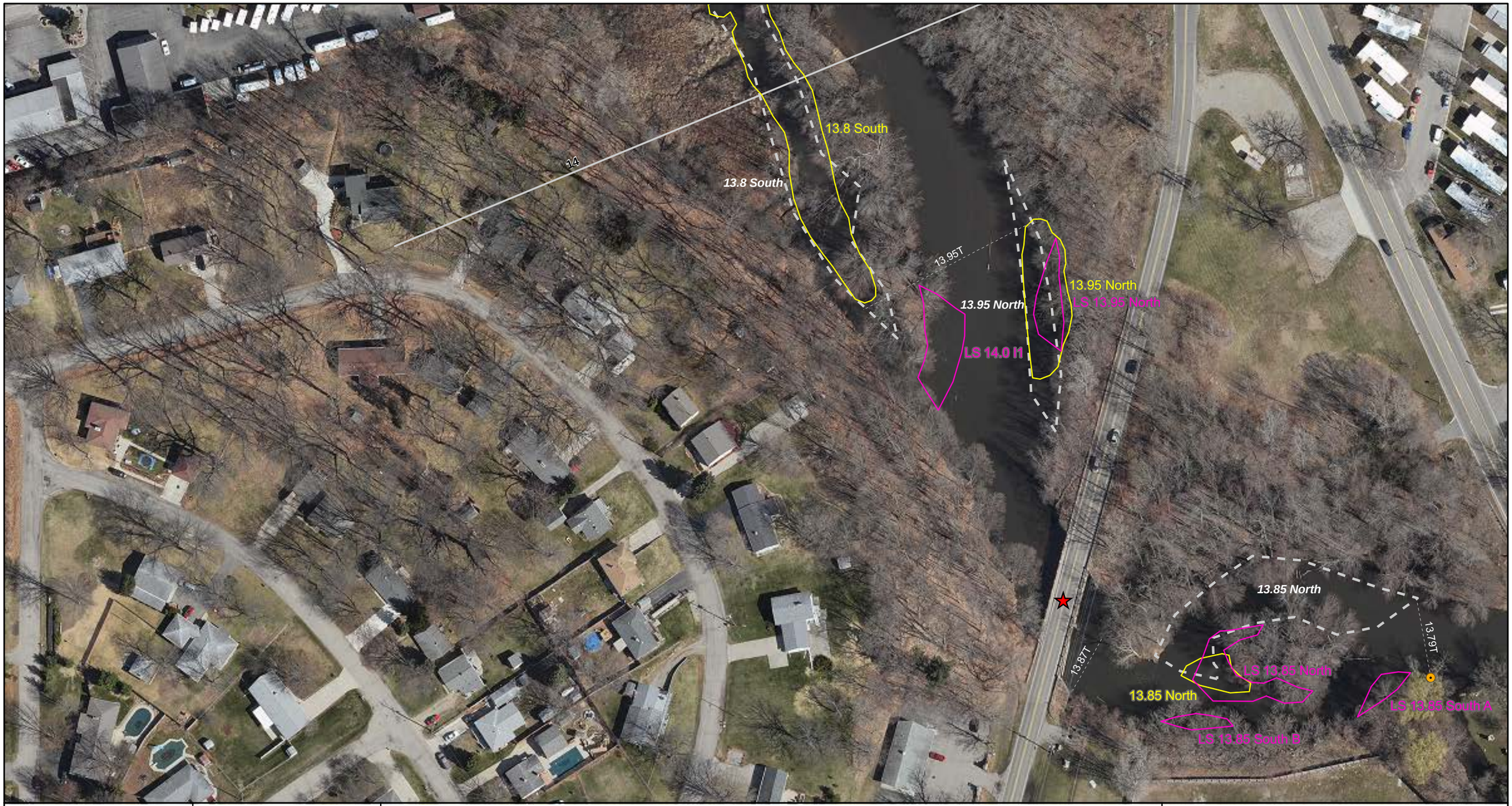
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 53 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



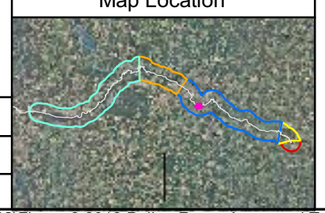
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



Legend

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N

0 50 100 200

Scale in Feet

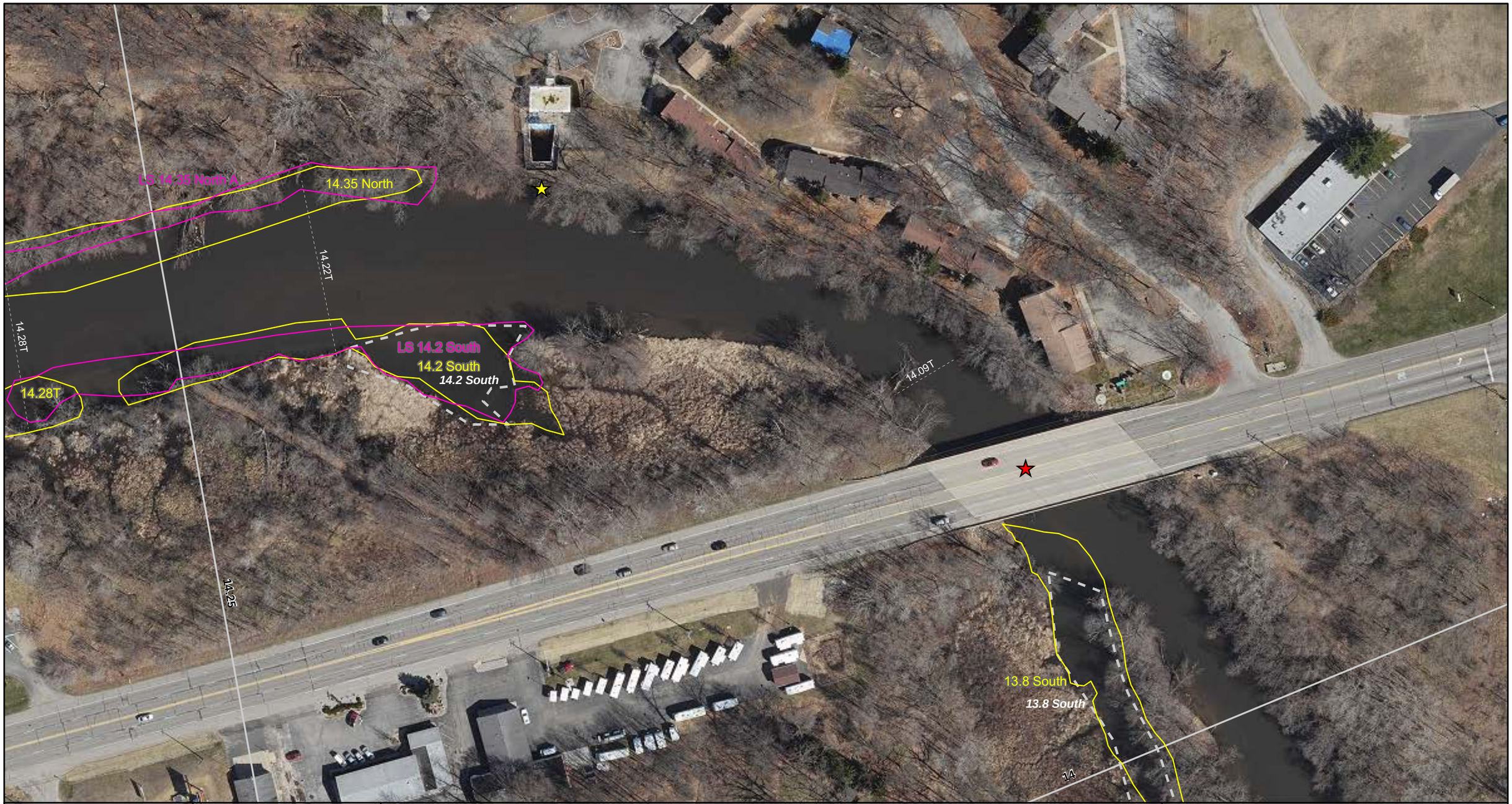
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 54 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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- Spring 2011 Delineation Area
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N

0 50 100 200

Scale in Feet

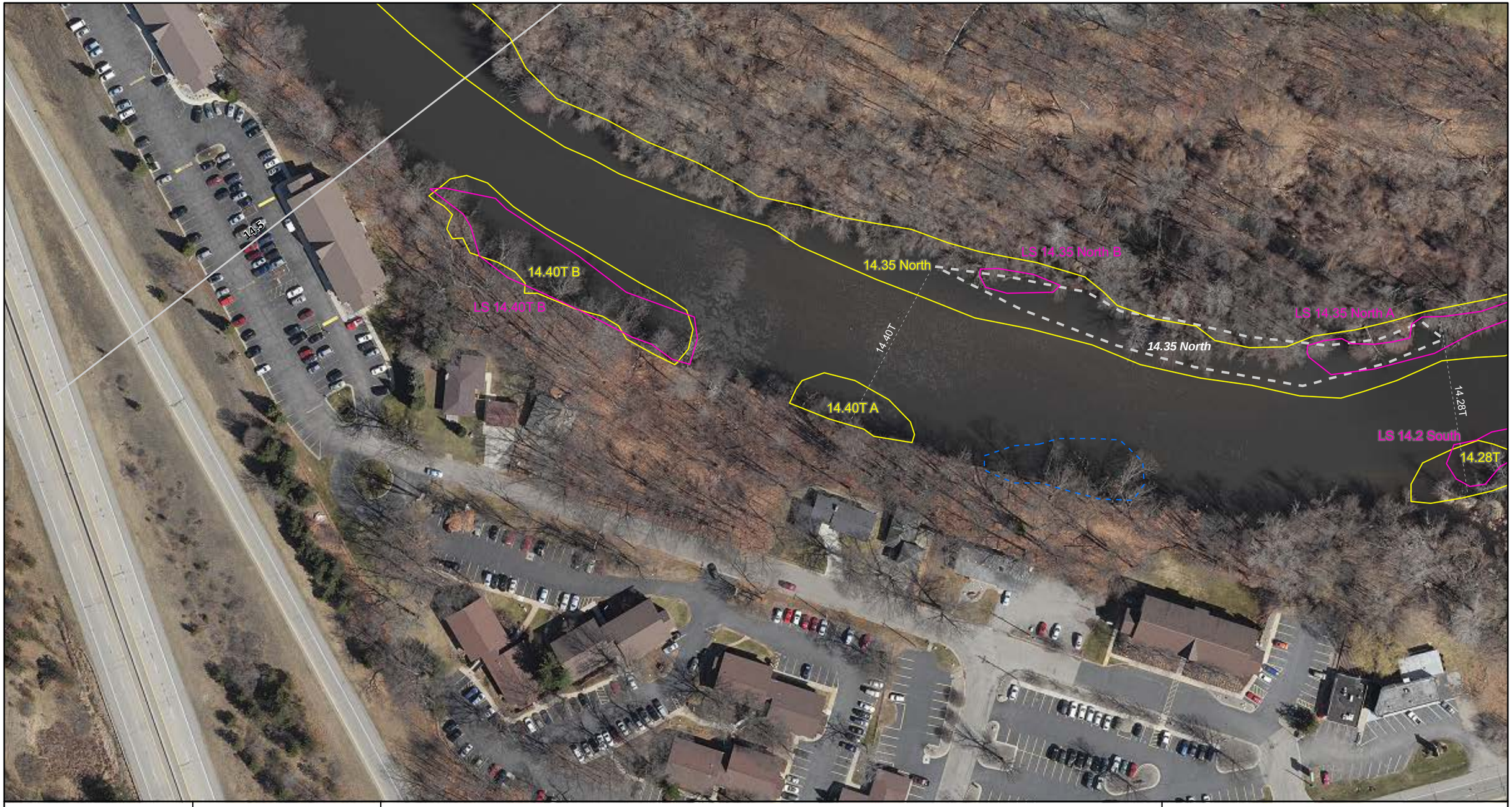
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 55 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



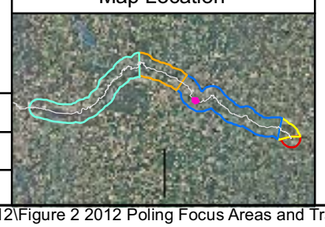
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



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N

0 50 100 200

Scale in Feet

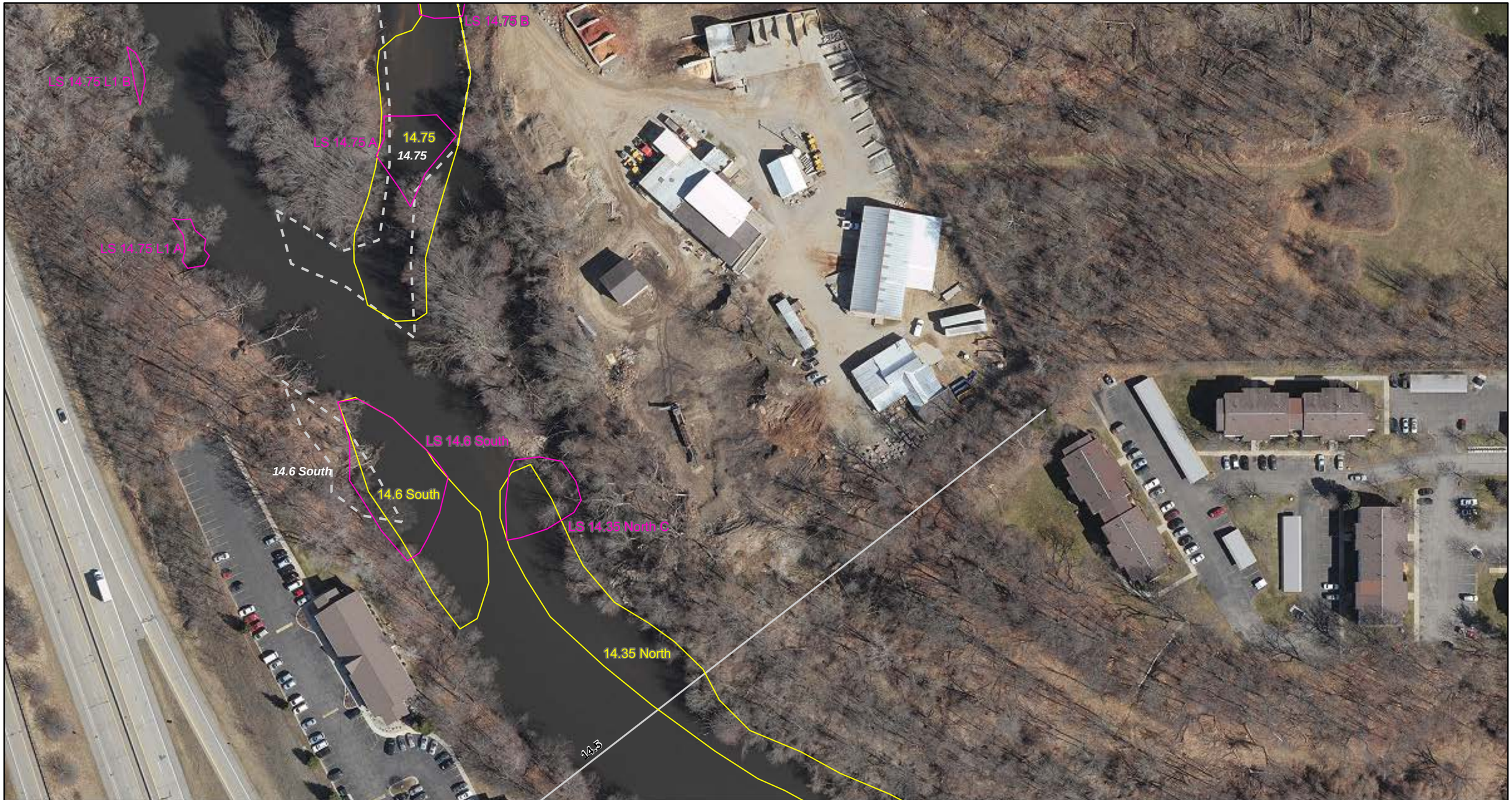
FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 56 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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0 50 100 200

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 57 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
Project #:	106-4186

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0 50 100 200
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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 58 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
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0 50 100 200
Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 59 OF 170

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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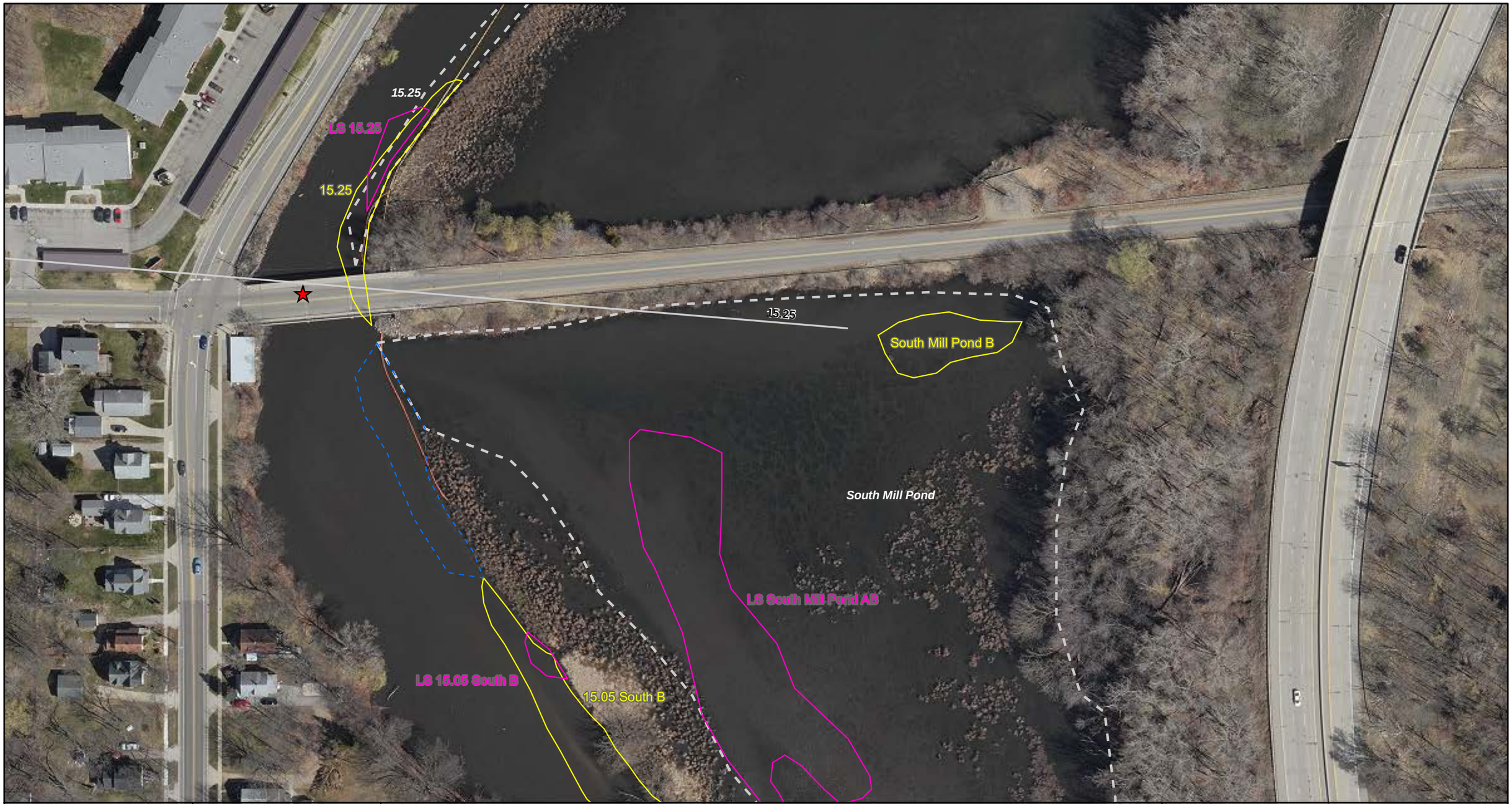

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 60 OF 170

ENBRIDGE LINE 6B MP 608
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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 61 OF 170

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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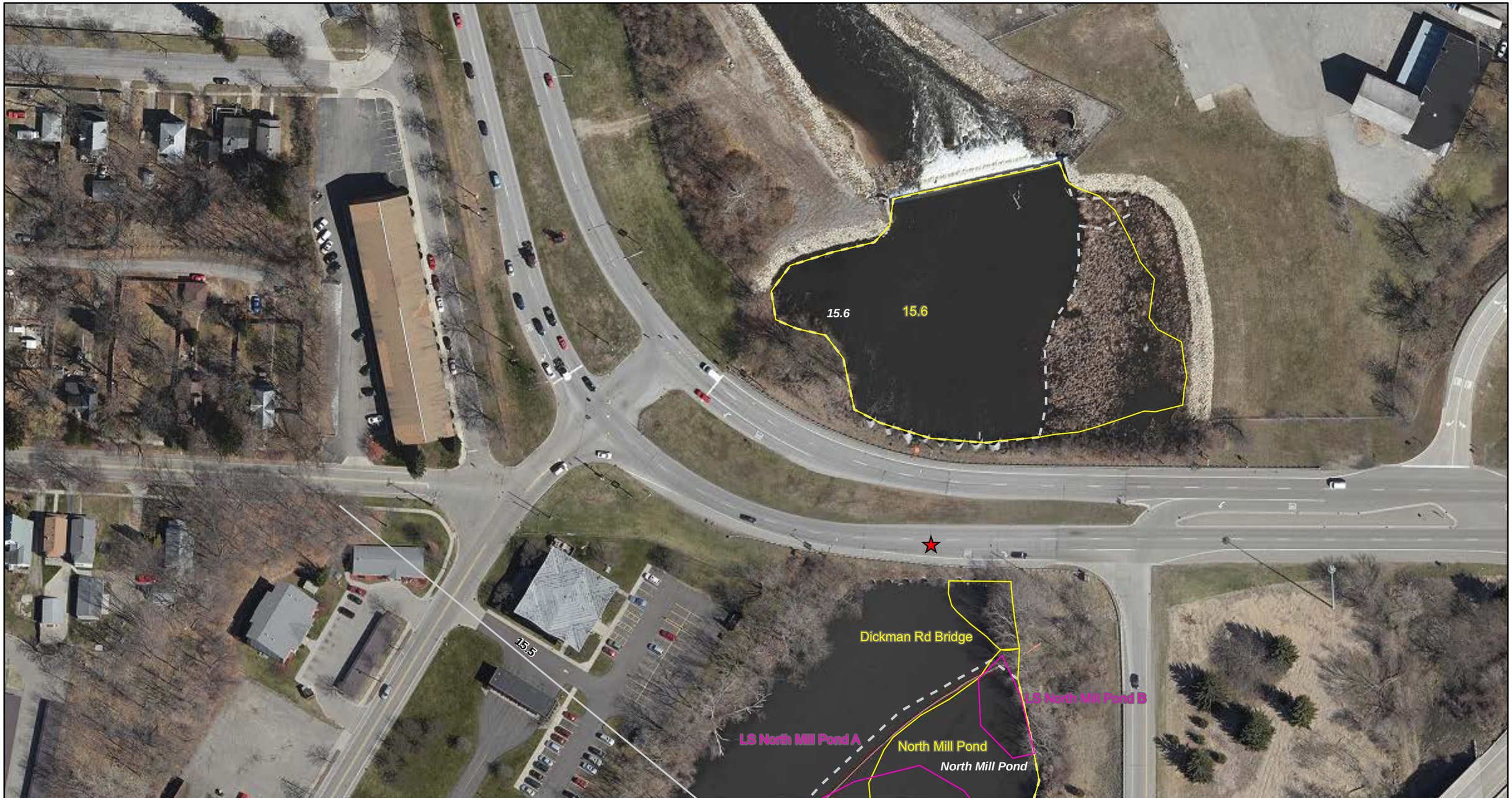

ENBRIDGE

Drawn: JLH 12/21/2011

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Project #: 106-4186

Map Location

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 62 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

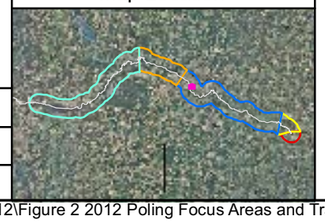
ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location



Legend

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 63 OF 170

ENBRIDGE LINE 6B MP 608
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ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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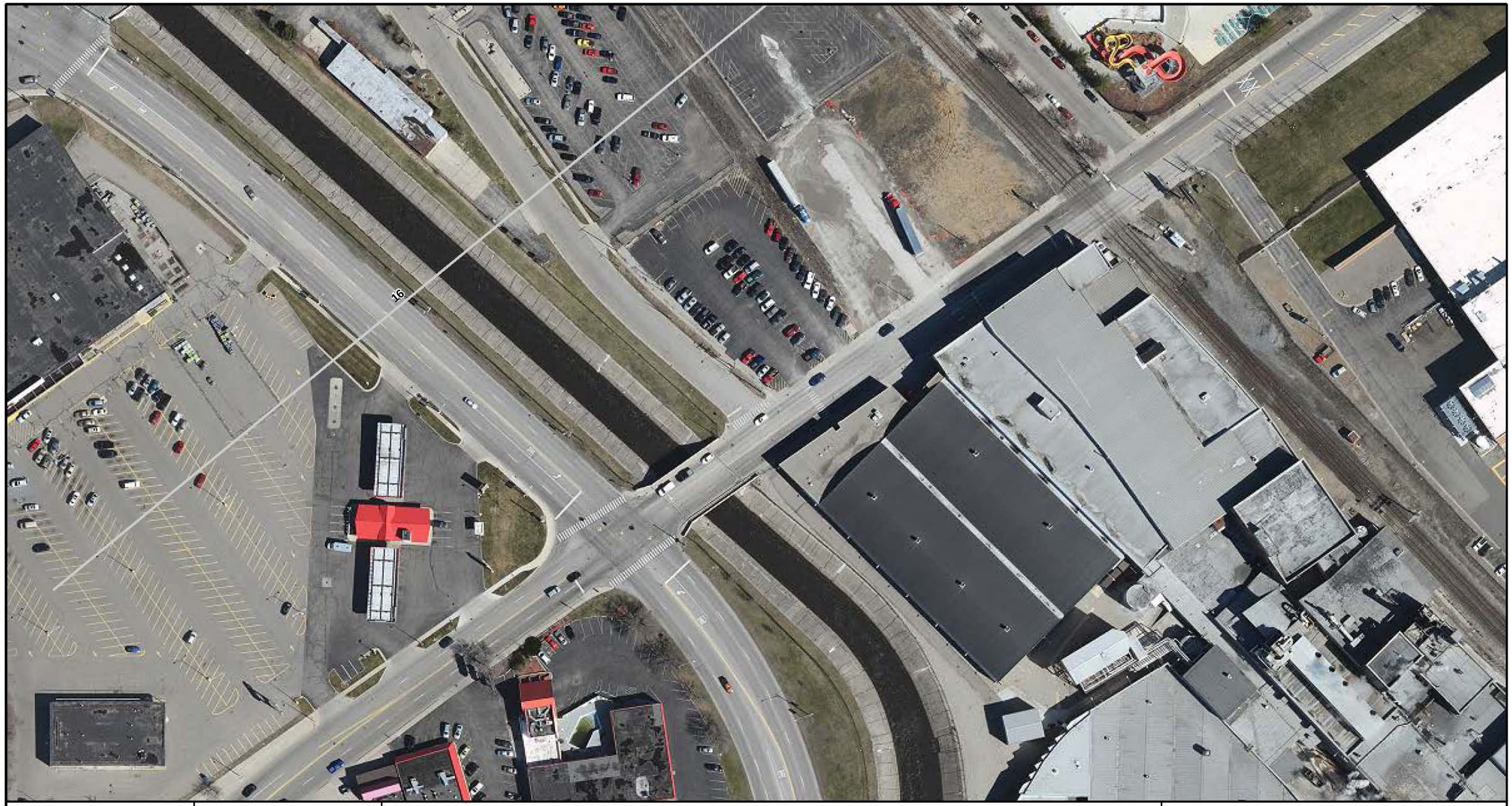

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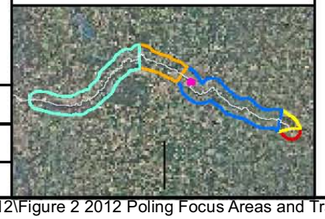

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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 64 OF 170

ENBRIDGE LINE 6B MP 608
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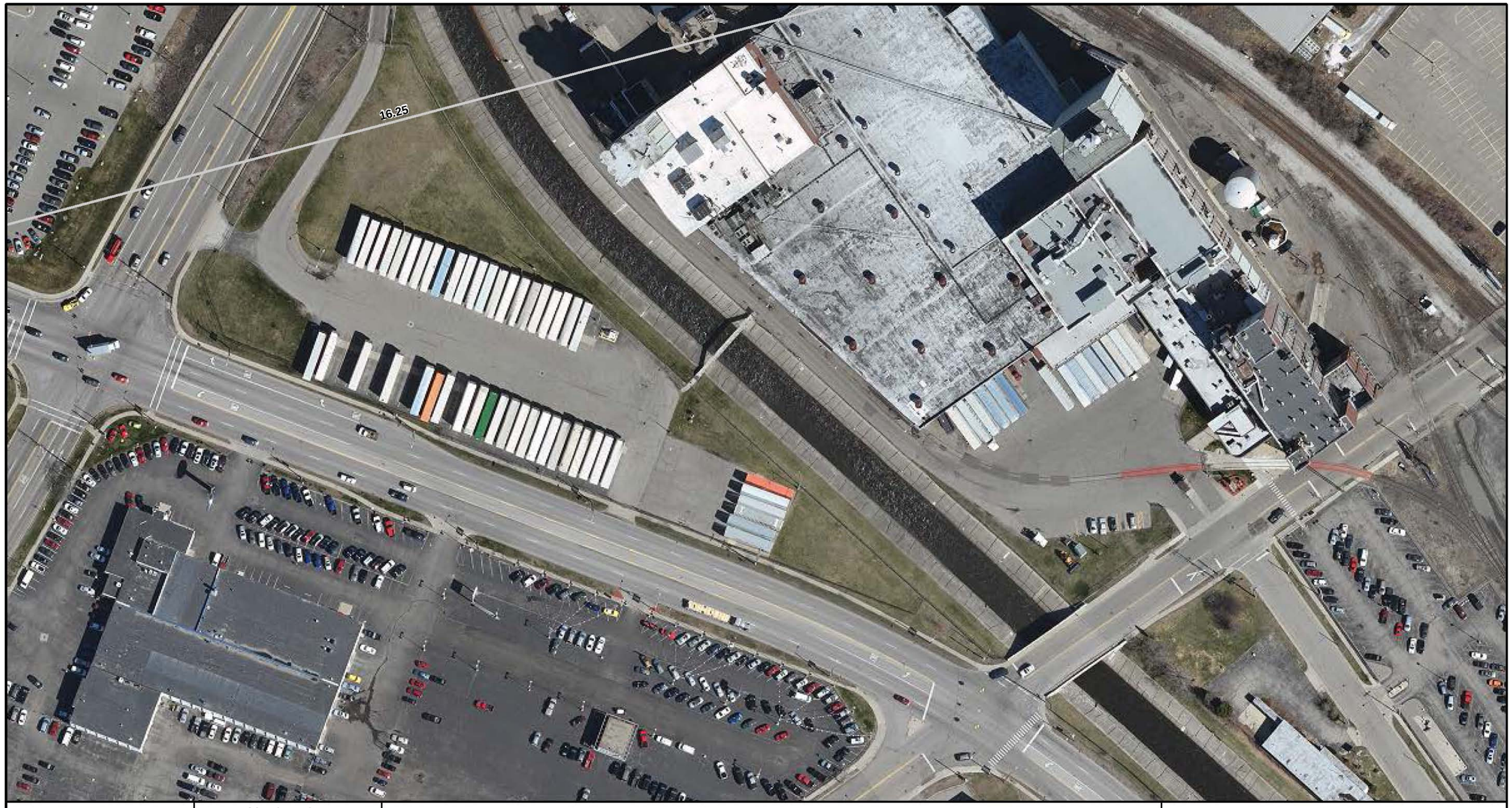

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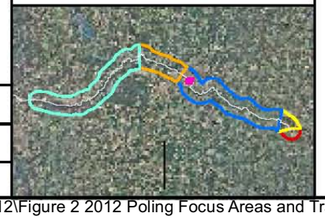

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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 65 OF 170

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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 66 OF 170

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 67 OF 170

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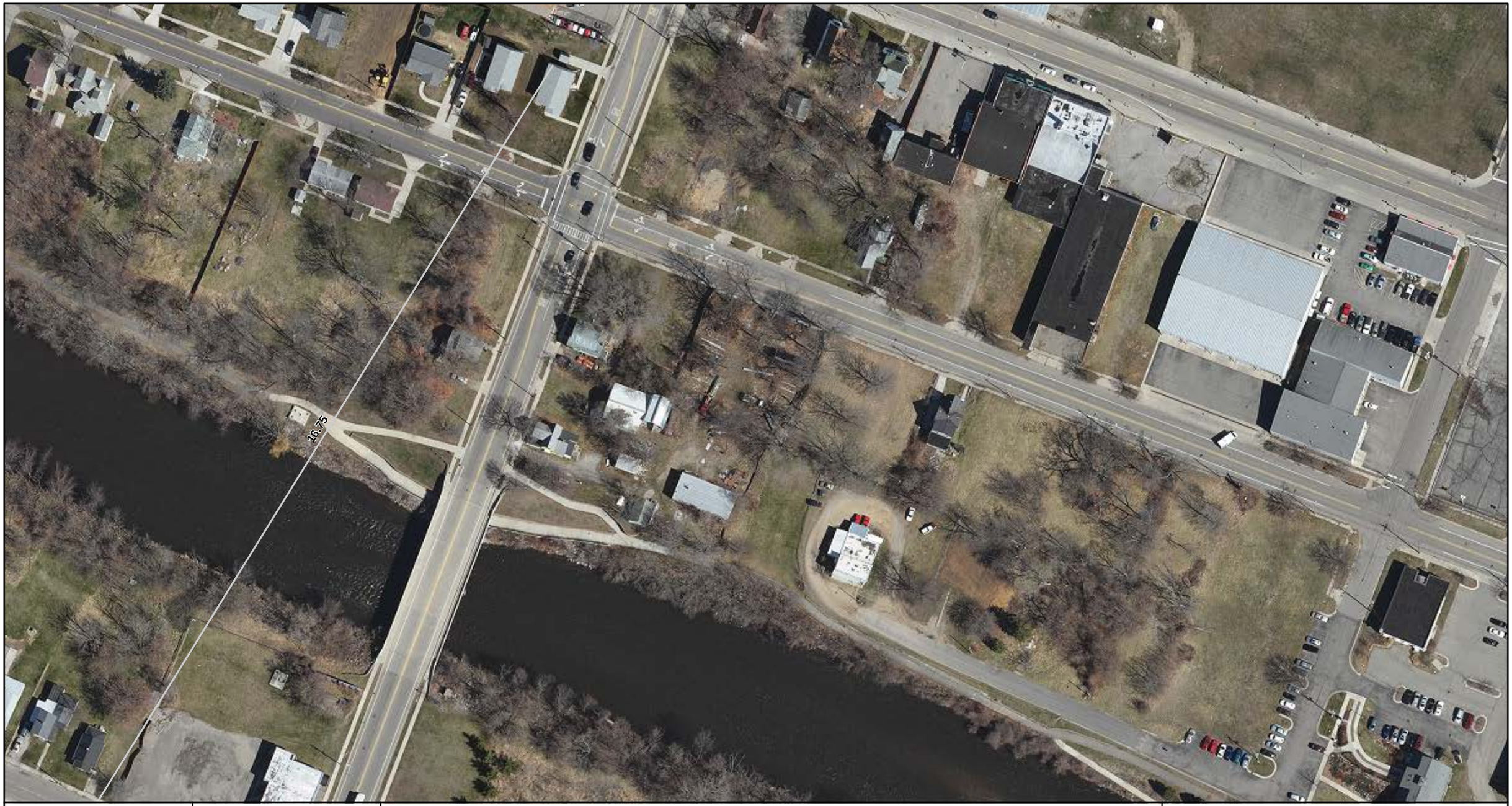

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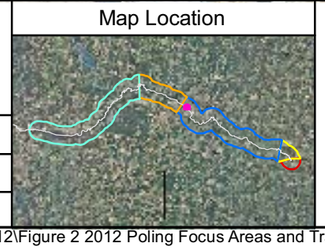

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 68 OF 170

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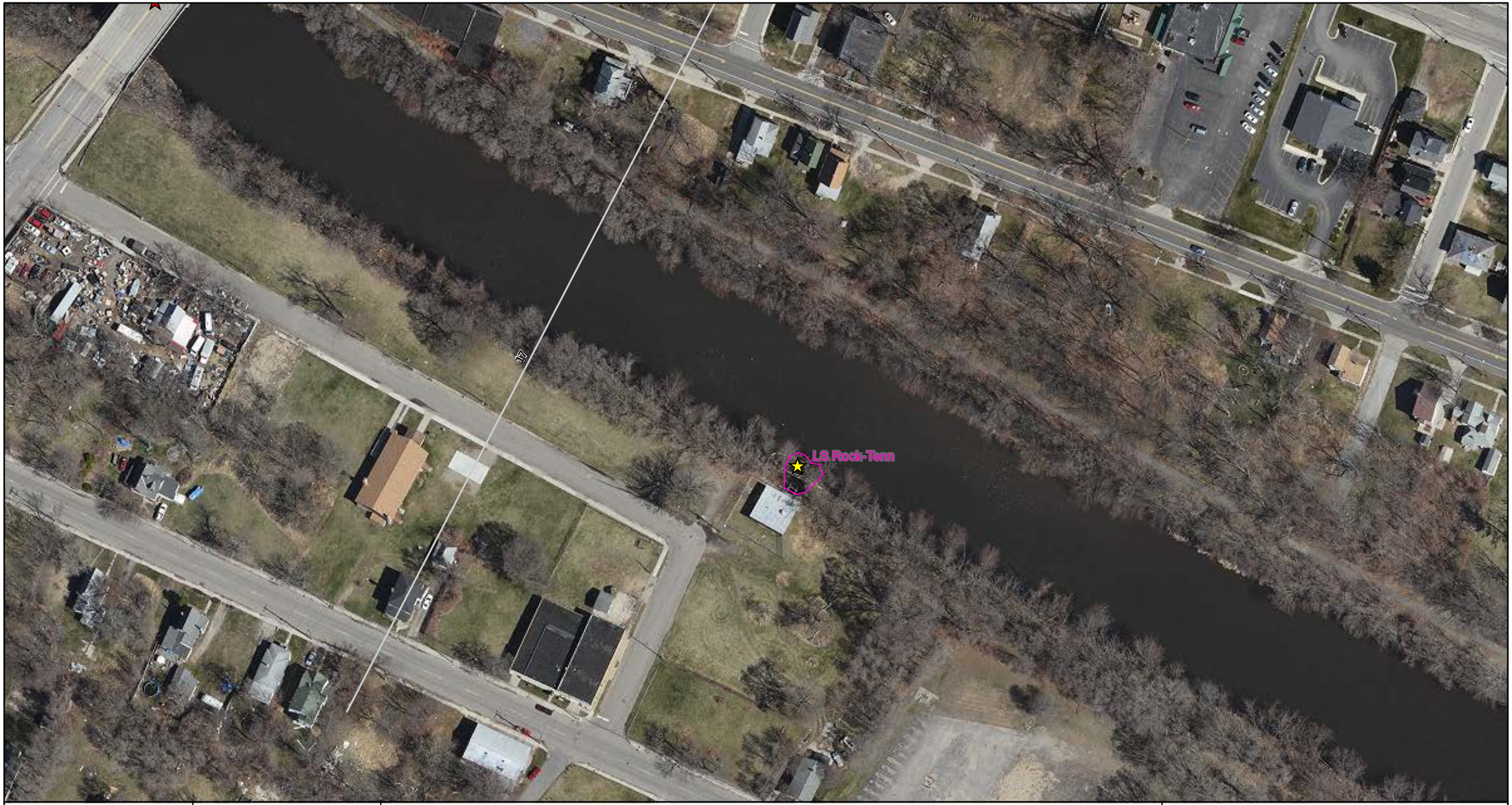

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Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 69 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 70 OF 170

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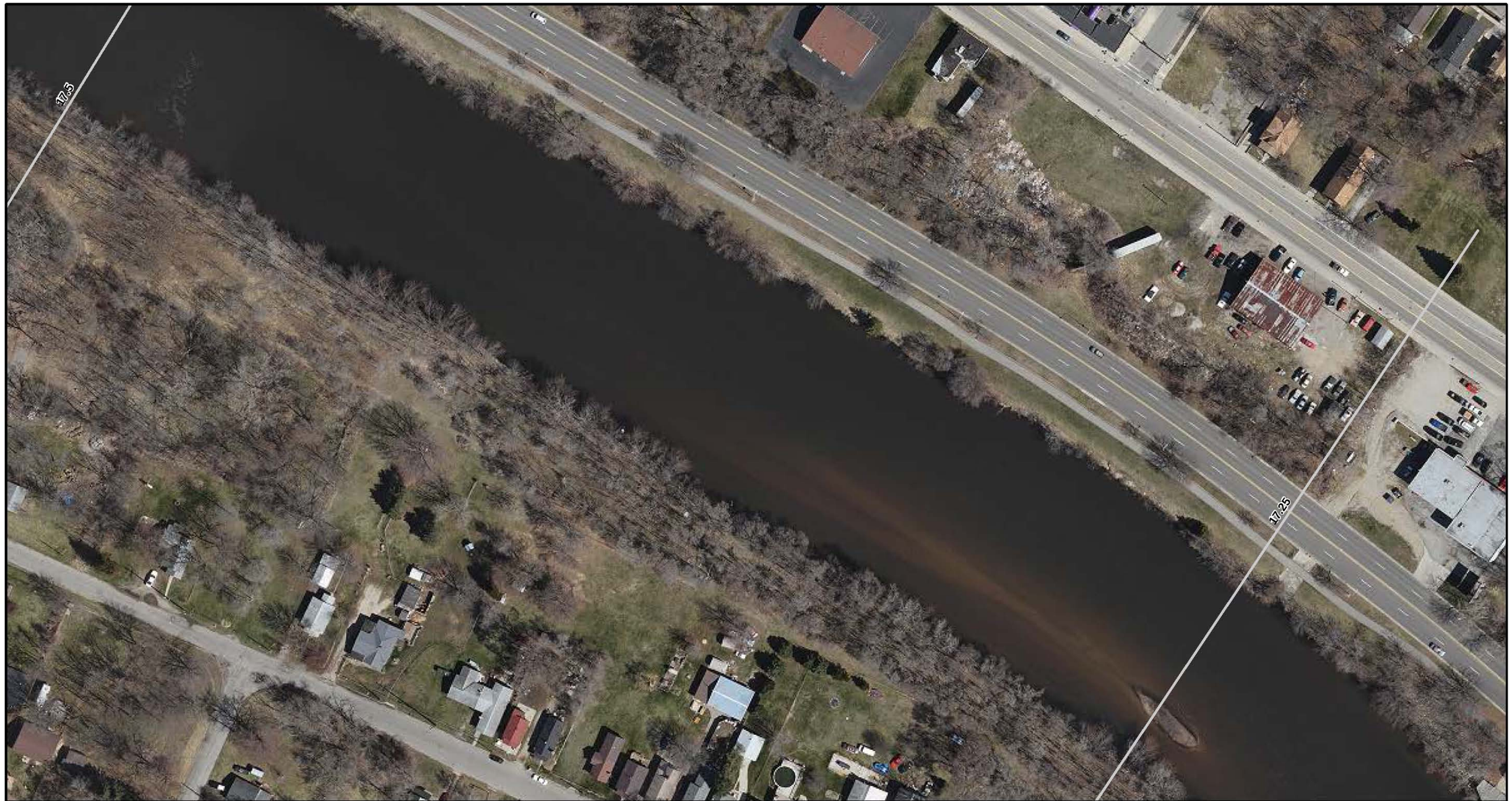

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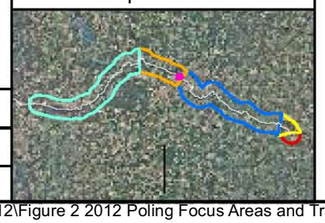

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2012 POLING FOCUS AREAS & TRANSECTS

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2012 POLING FOCUS AREAS & TRANSECTS

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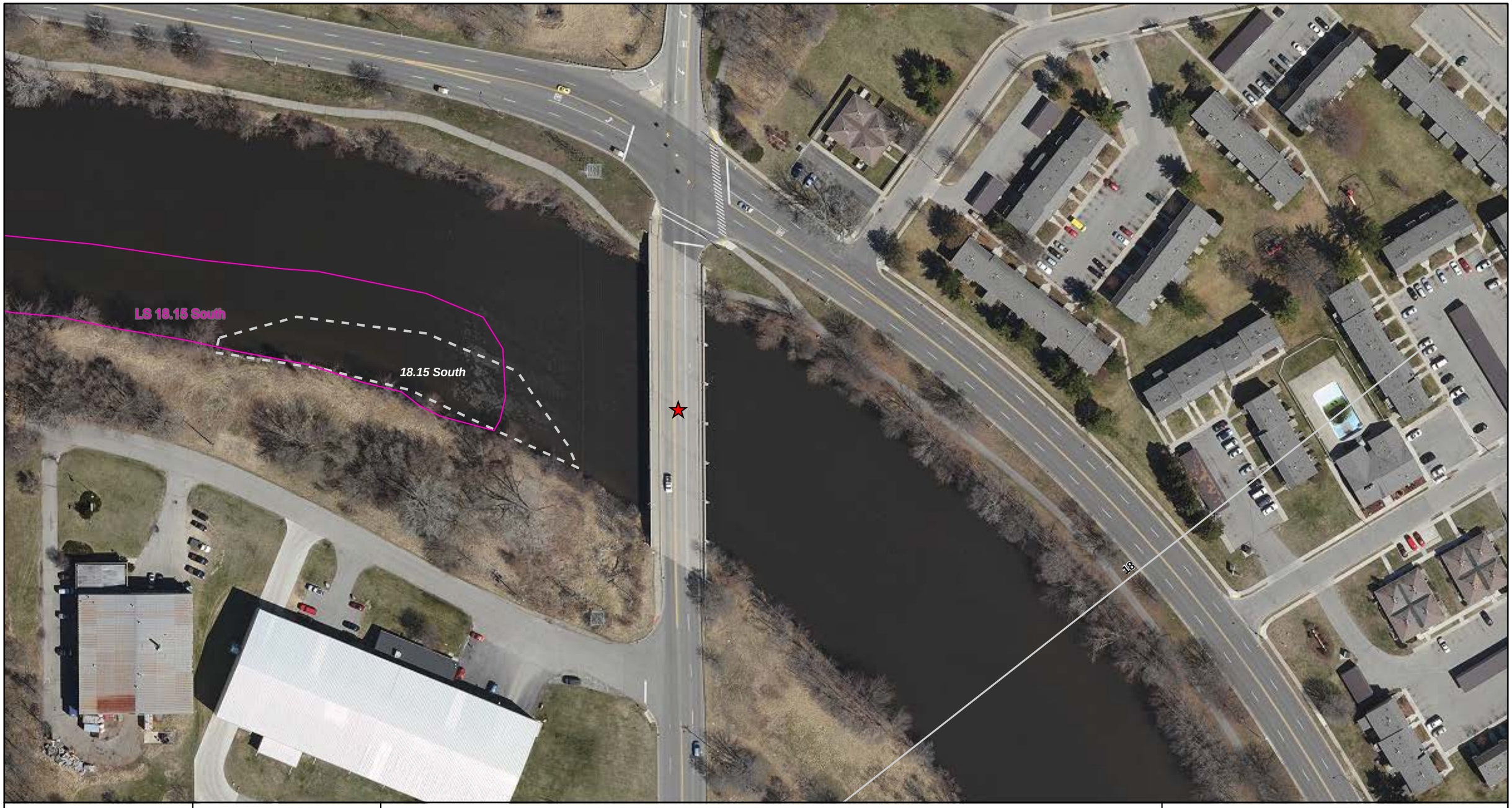

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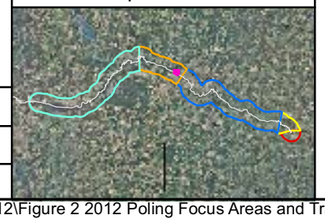

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2012 POLING FOCUS AREAS & TRANSECTS

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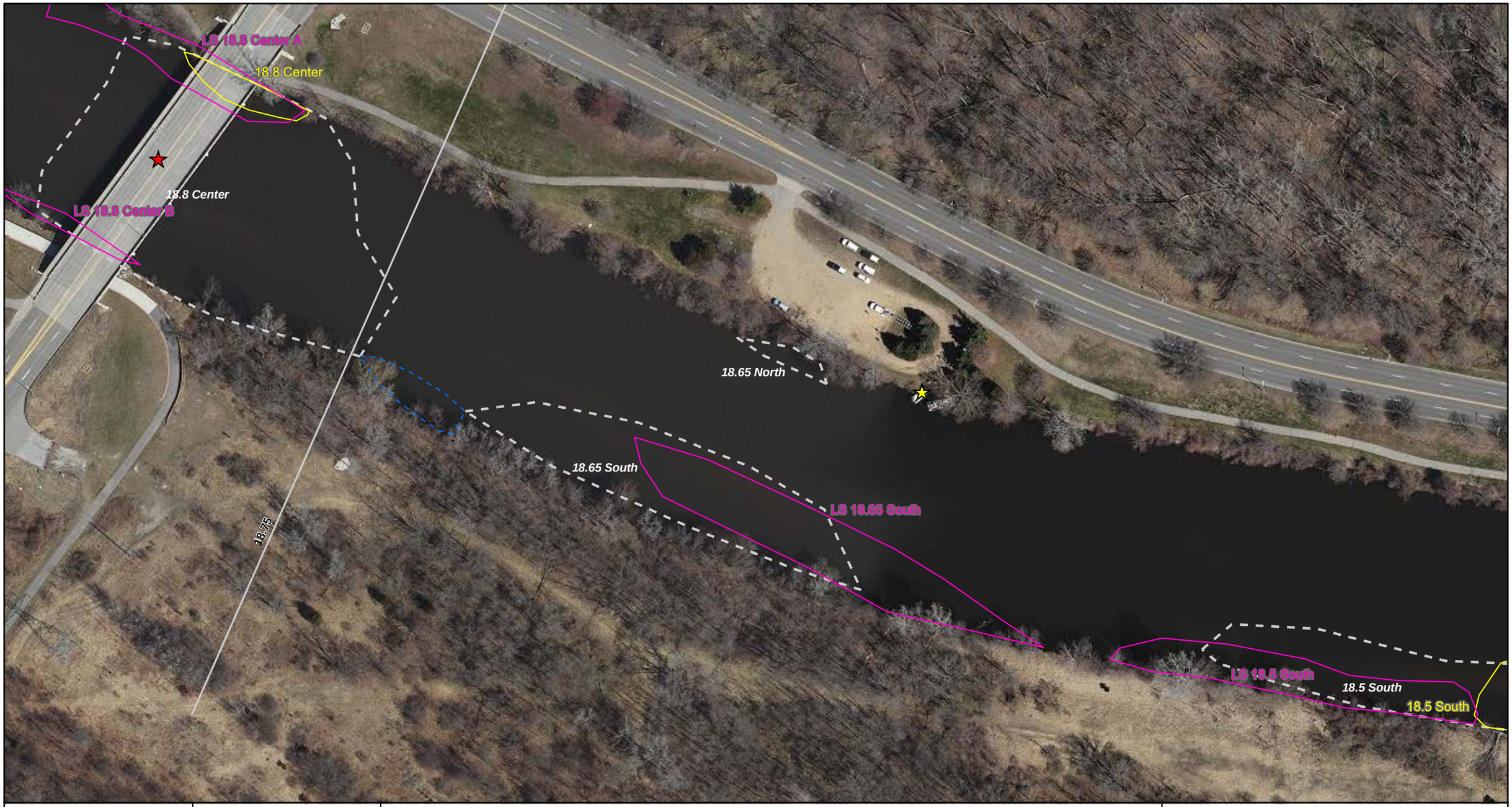

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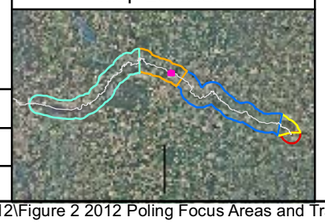

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2012 POLING FOCUS AREAS & TRANSECTS

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2012 POLING FOCUS AREAS & TRANSECTS

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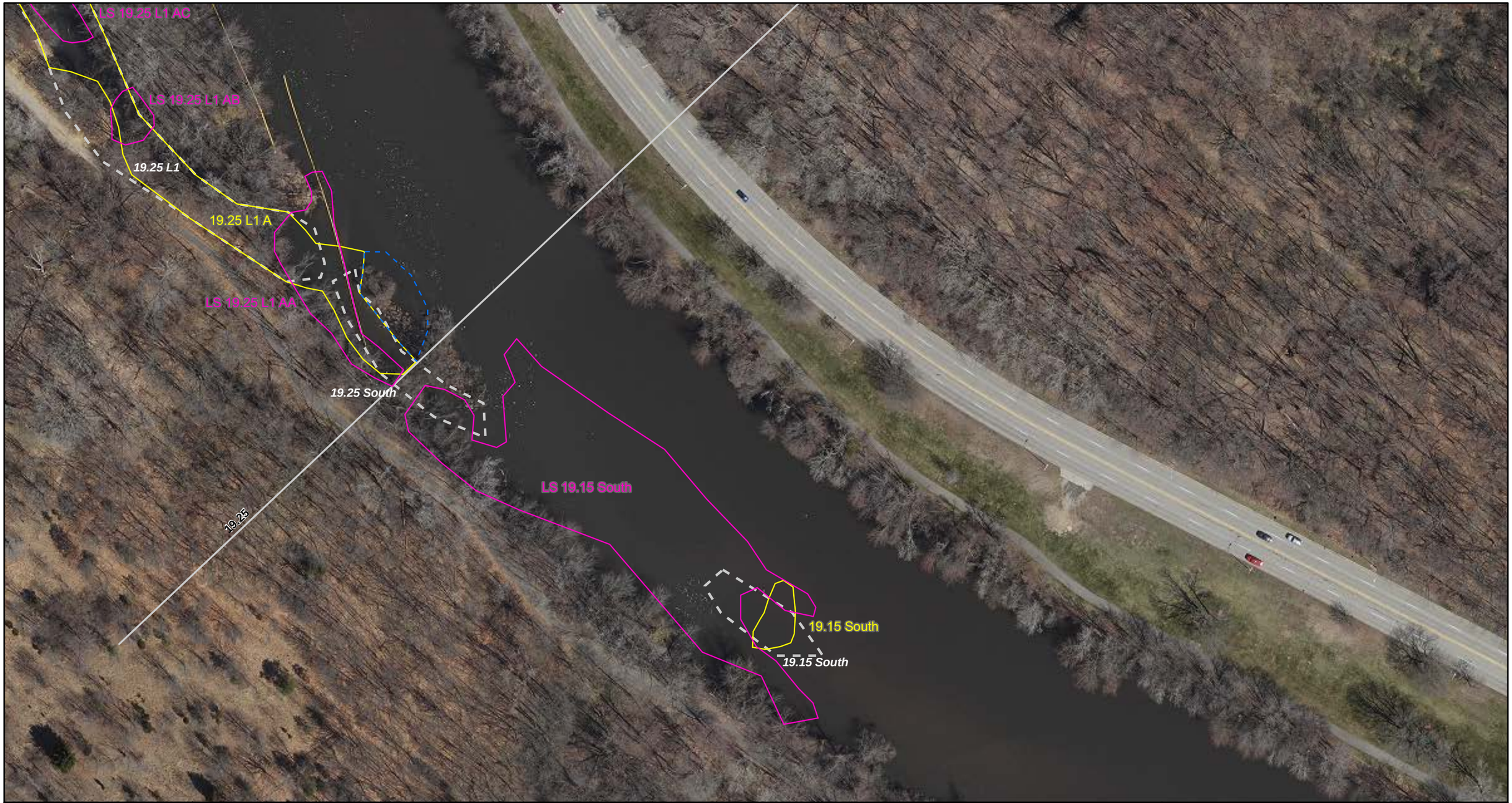

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2012 POLING FOCUS AREAS & TRANSECTS

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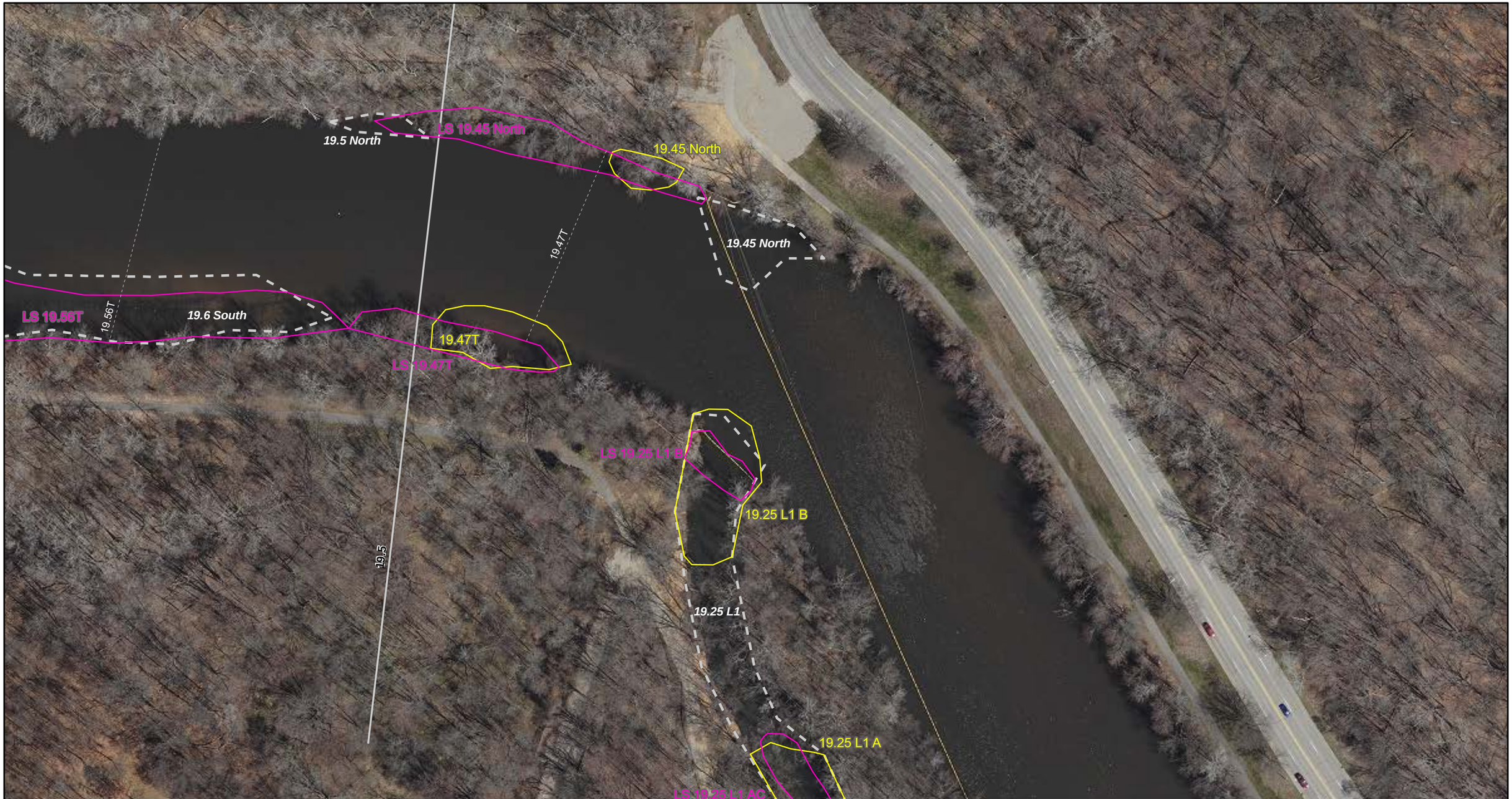

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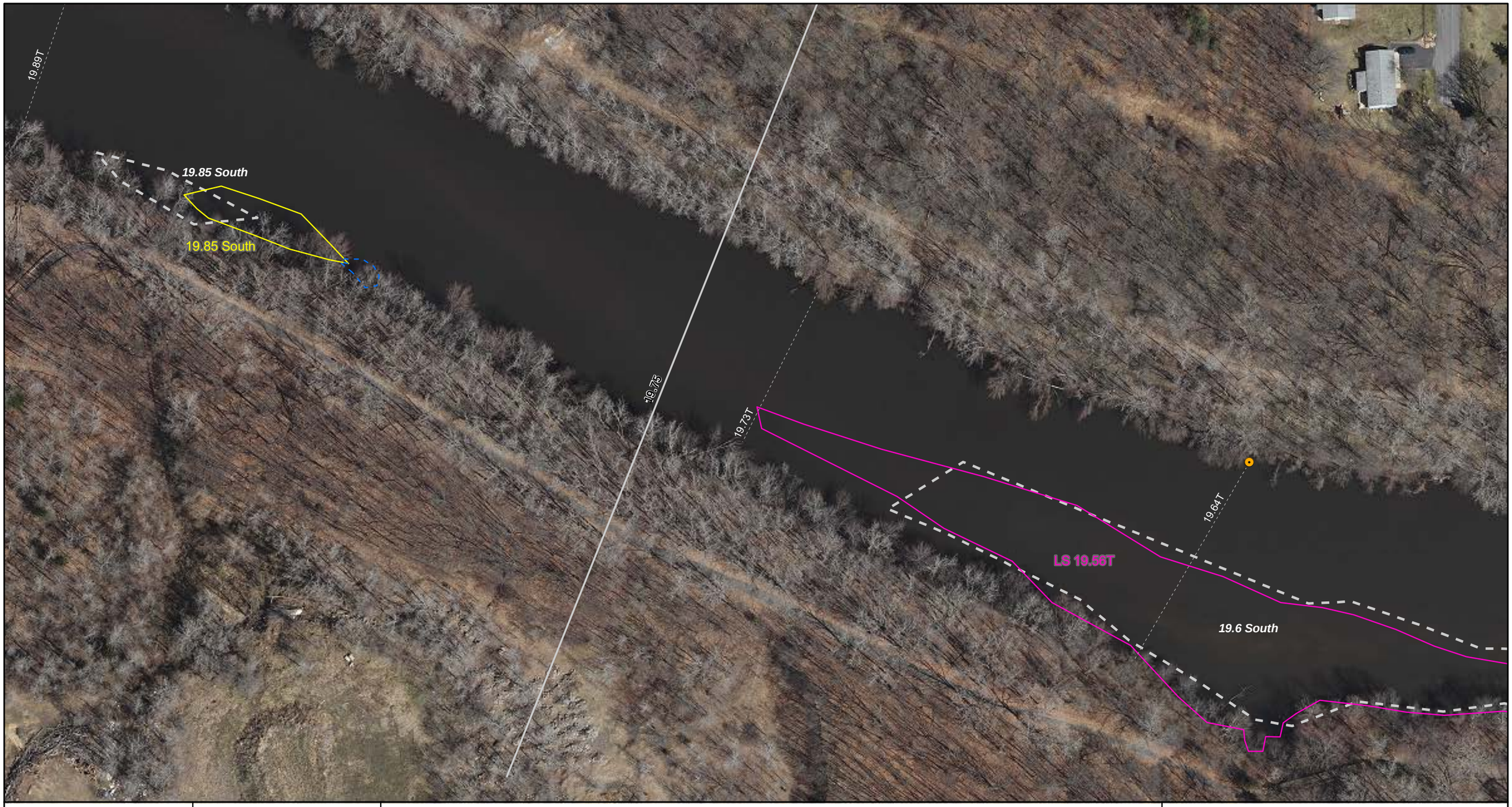

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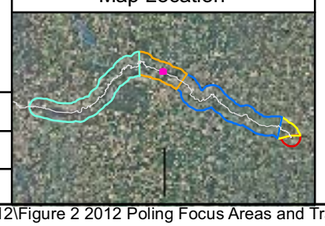

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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 80 OF 170

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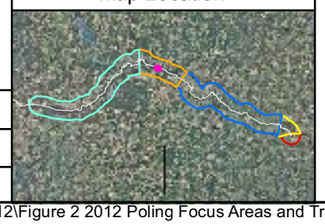

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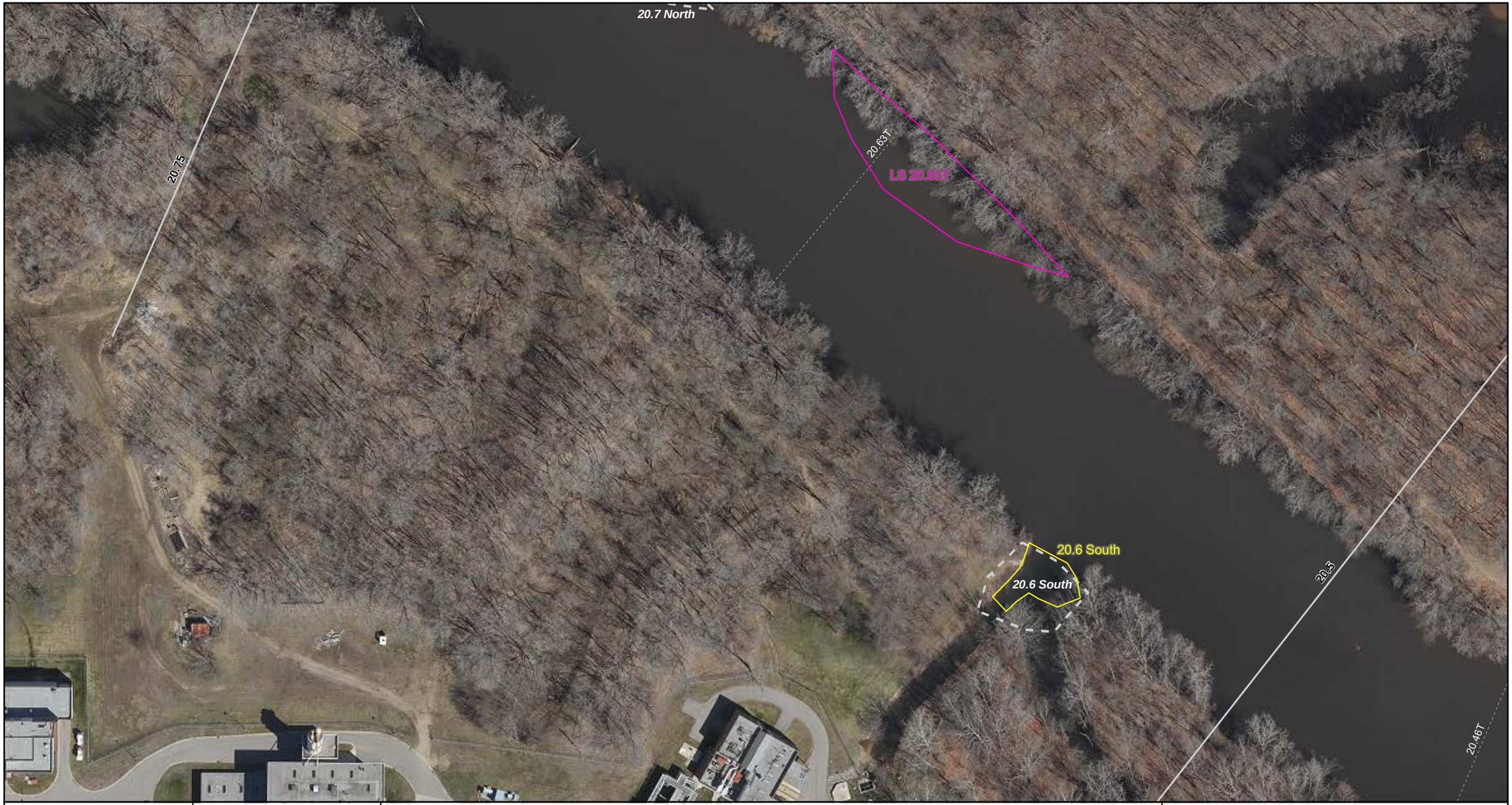

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

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2012 POLING FOCUS AREAS & TRANSECTS

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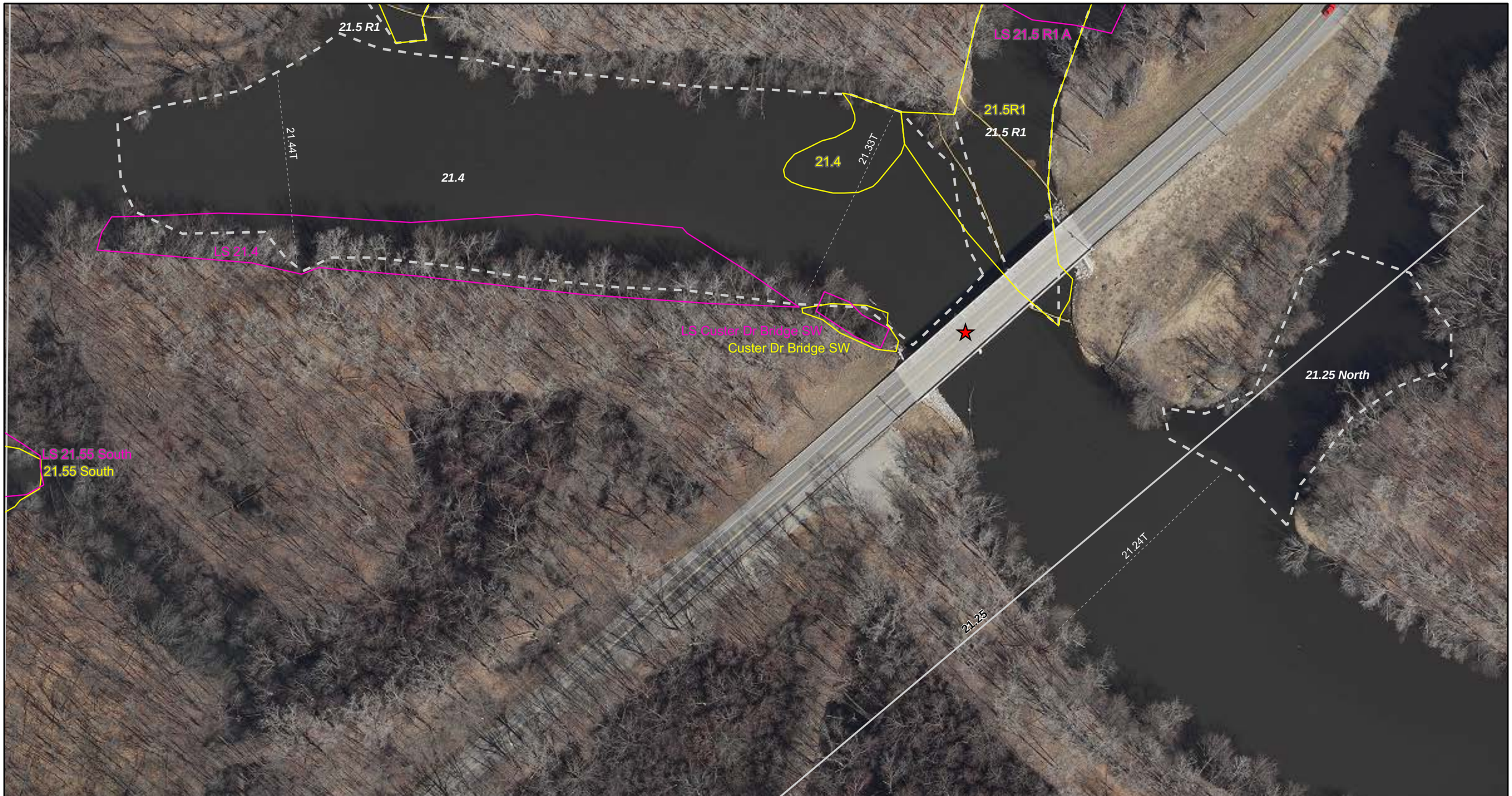

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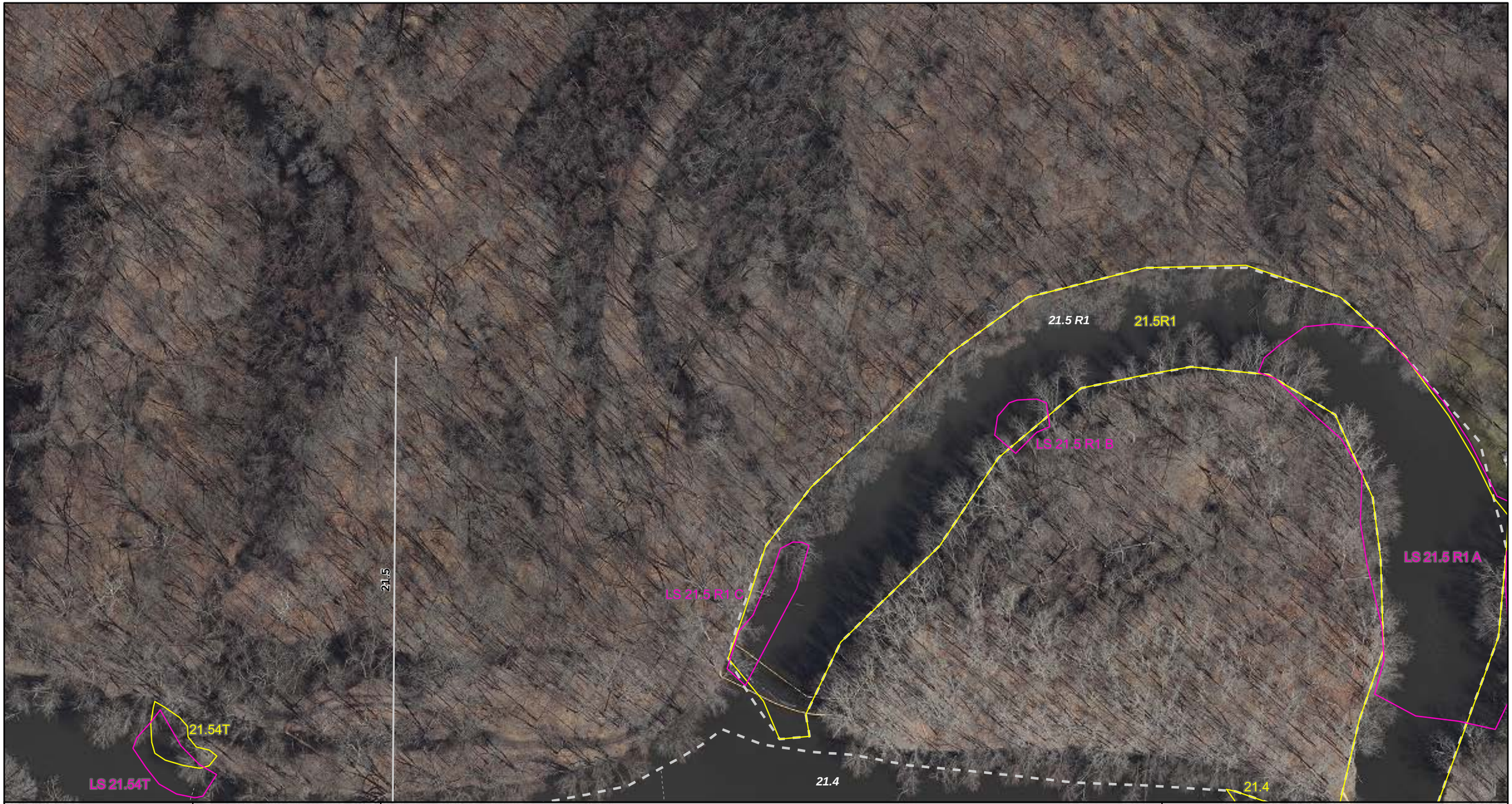

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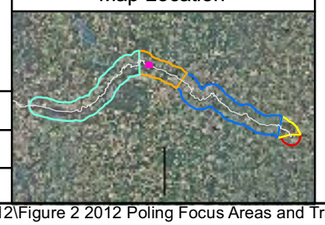

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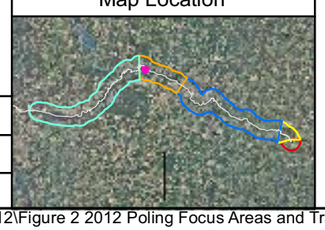

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N

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Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 89 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

22.33T
22.25 North
22.25
22.2 North
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LS 22.25T
22.2 North
22.17T
22.15 South
22.15 South

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Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

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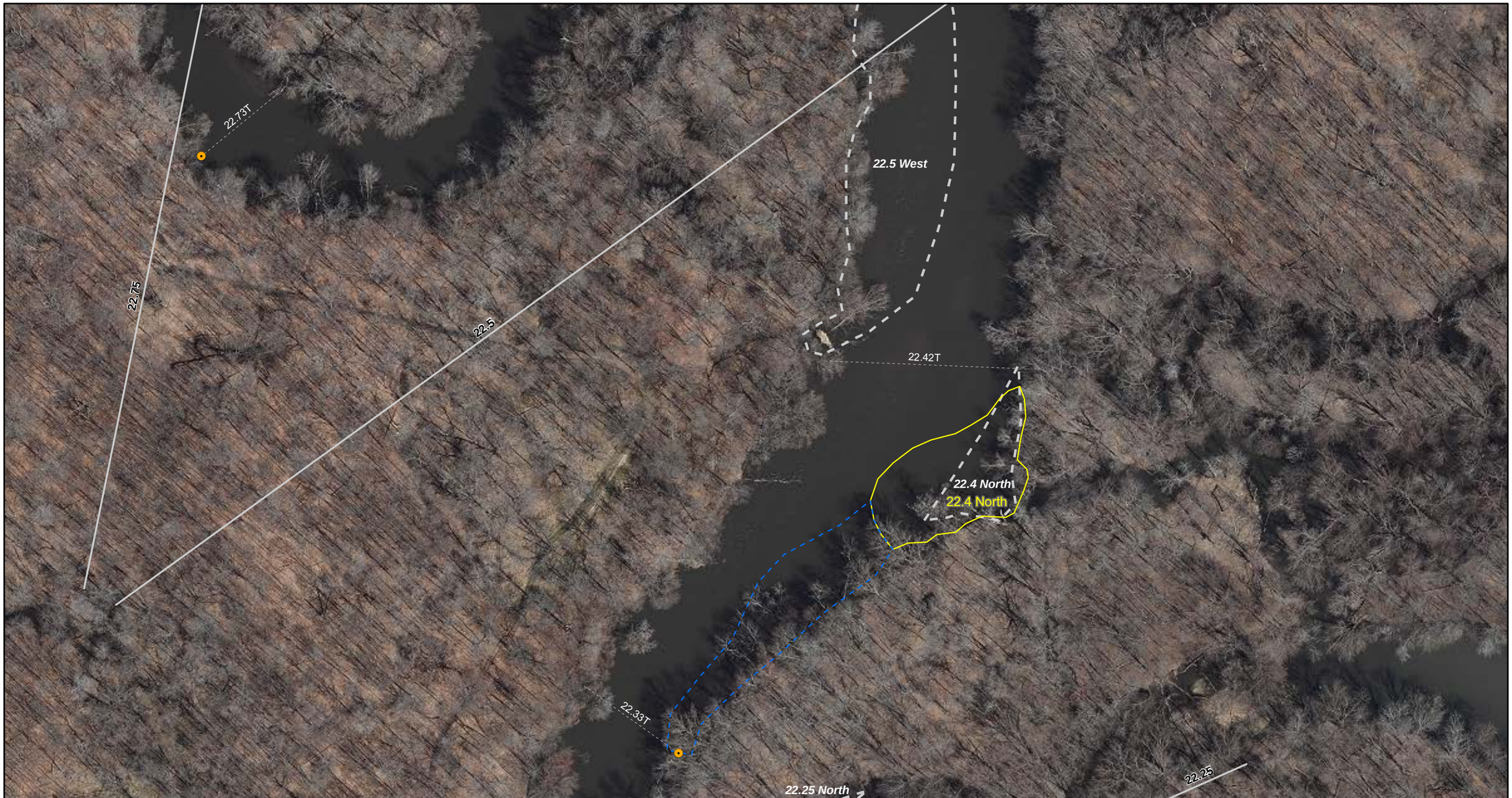

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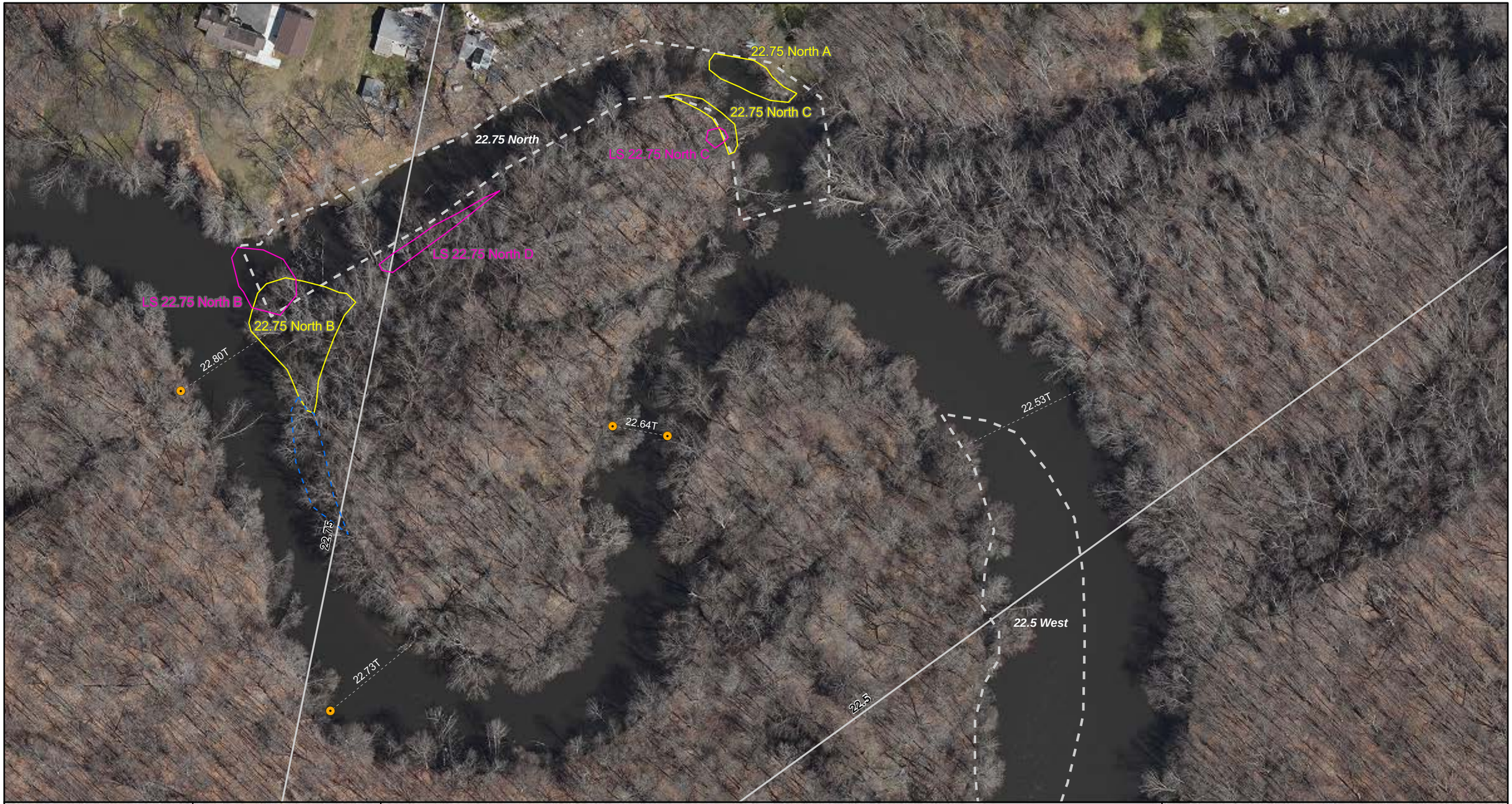

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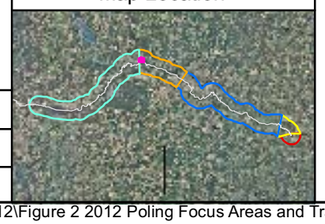

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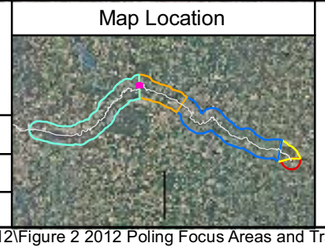

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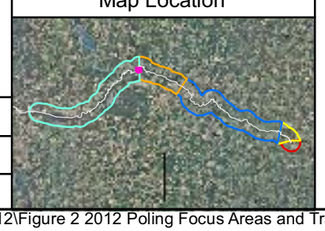

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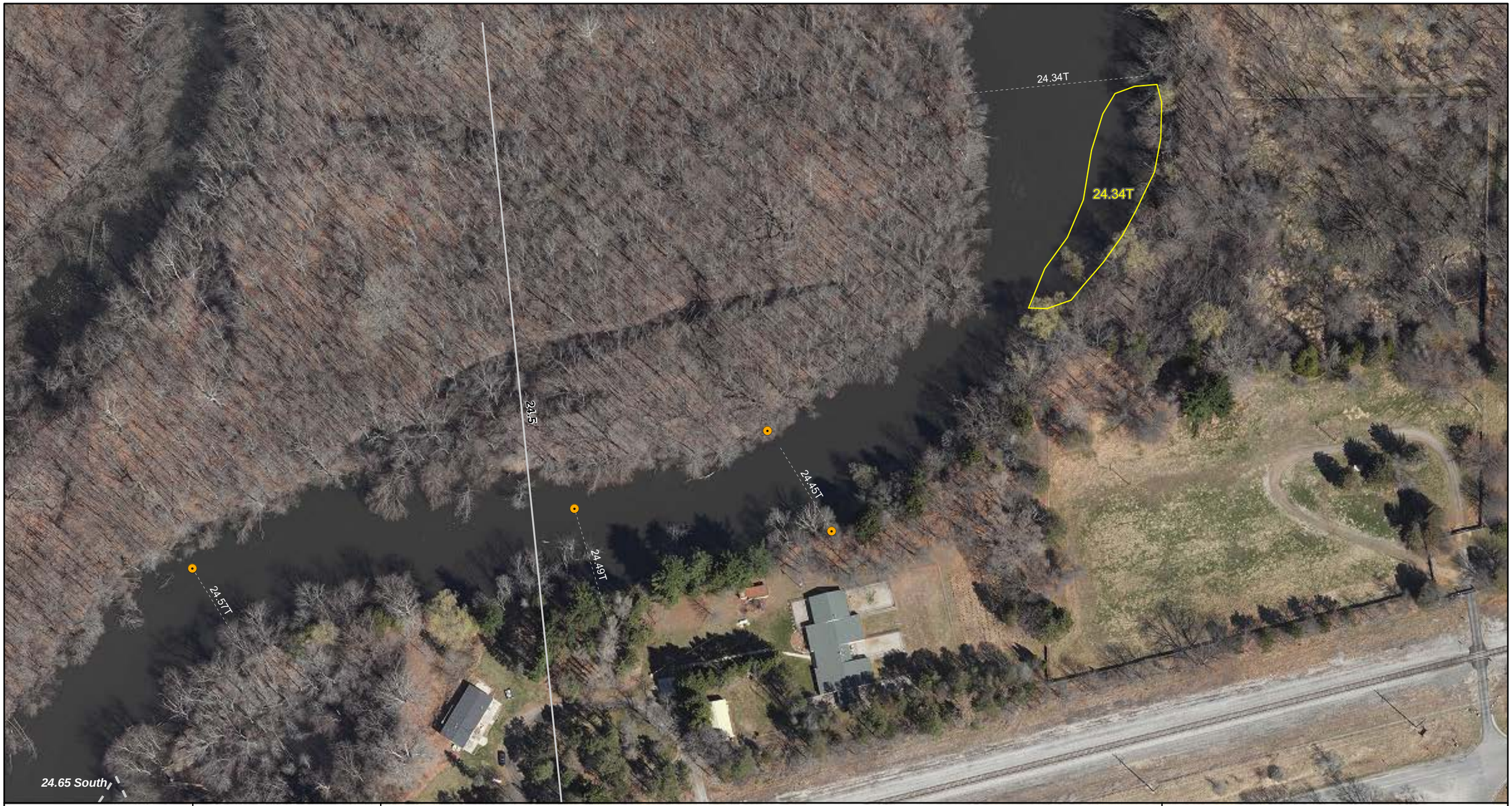

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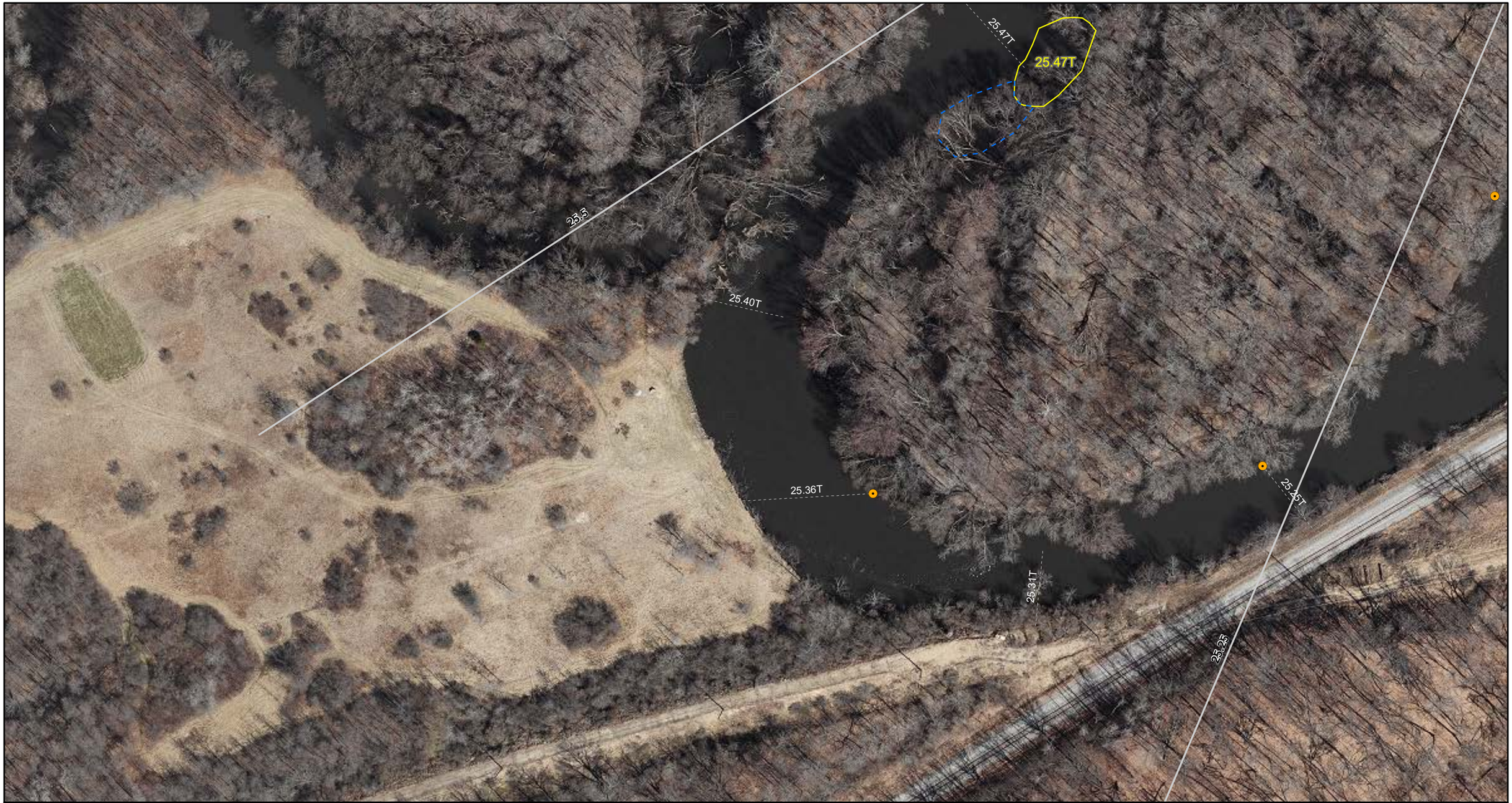

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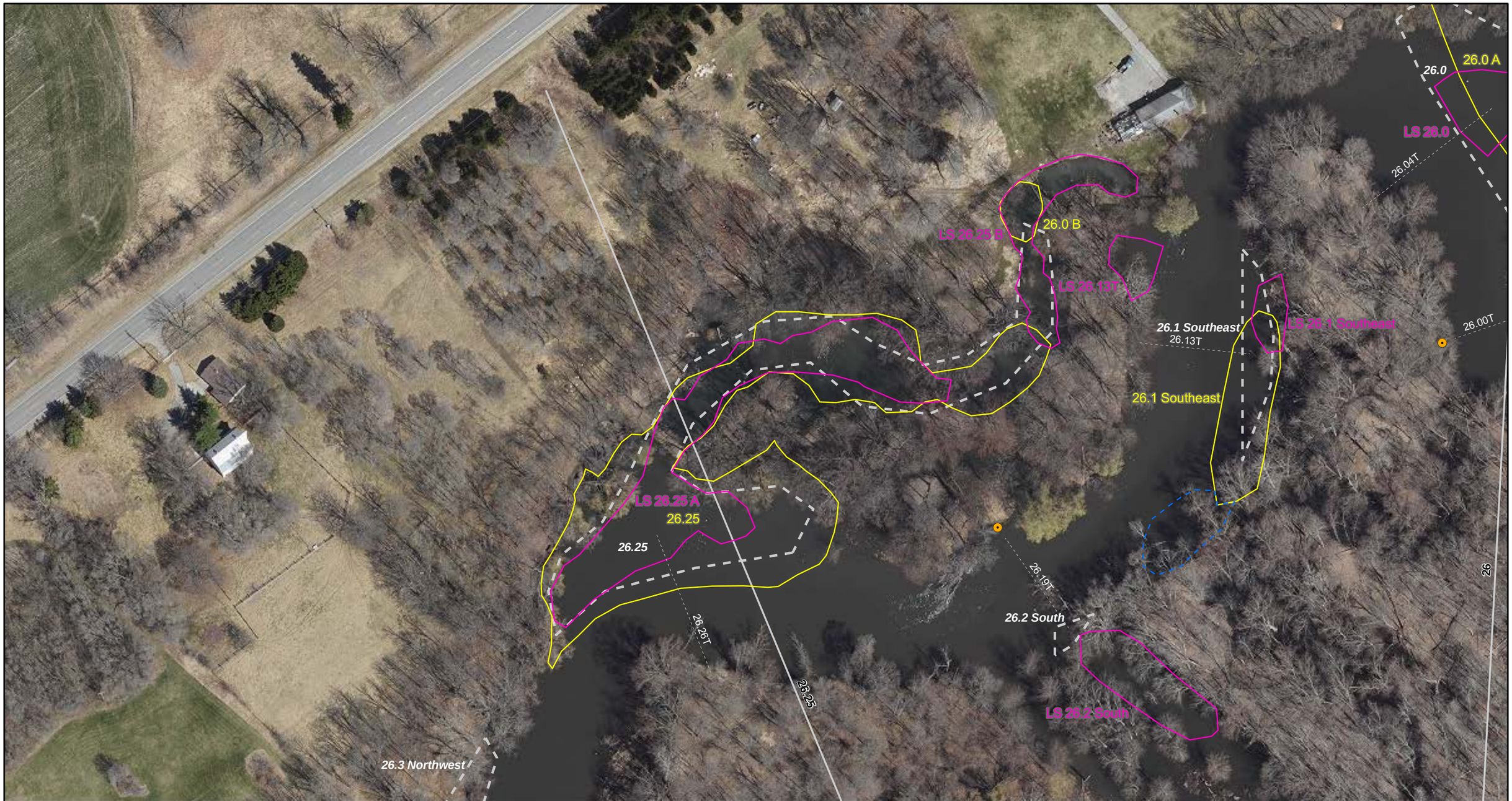

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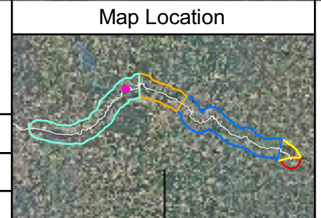

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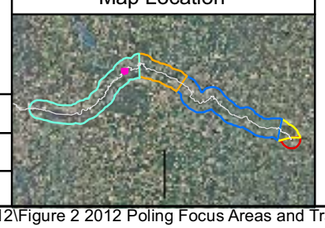

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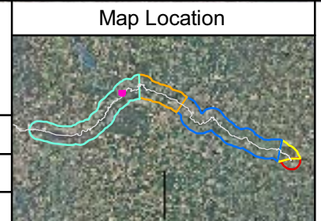

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X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

Legend

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 110 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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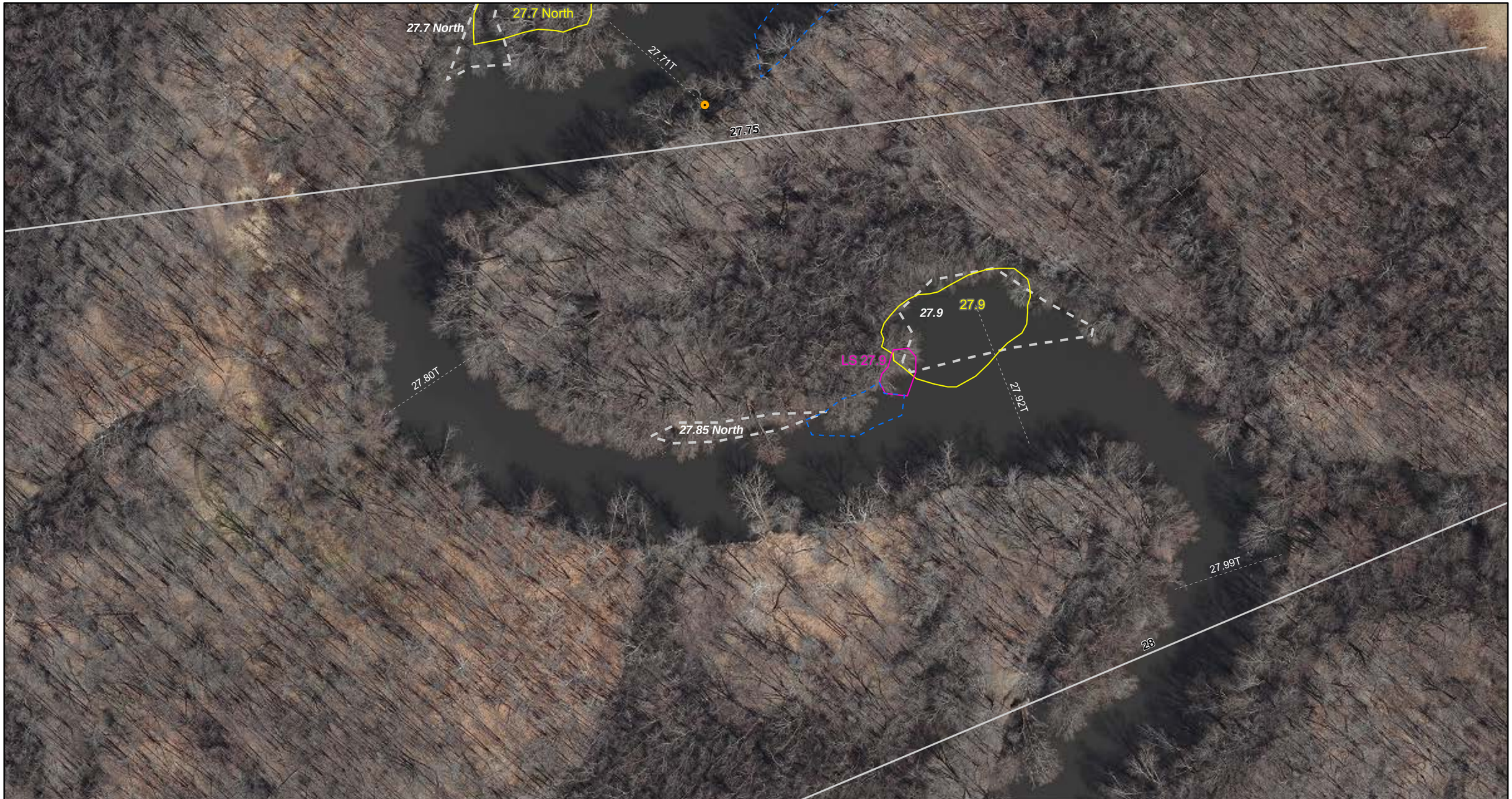

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Drawn: JLH 12/21/2011

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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 111 OF 170

ENBRIDGE LINE 6B MP 608
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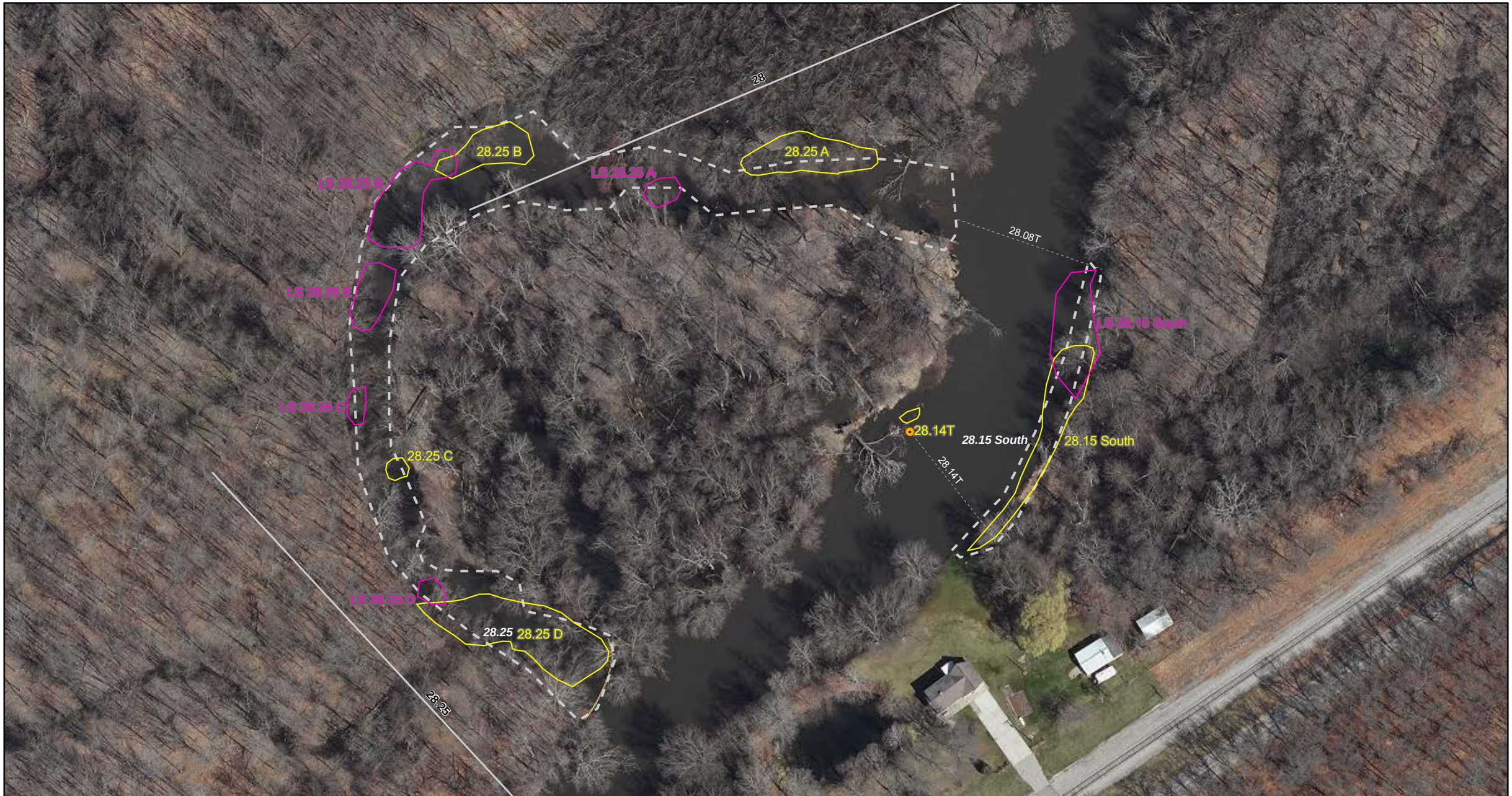

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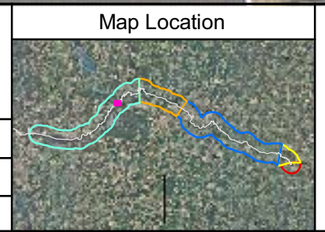

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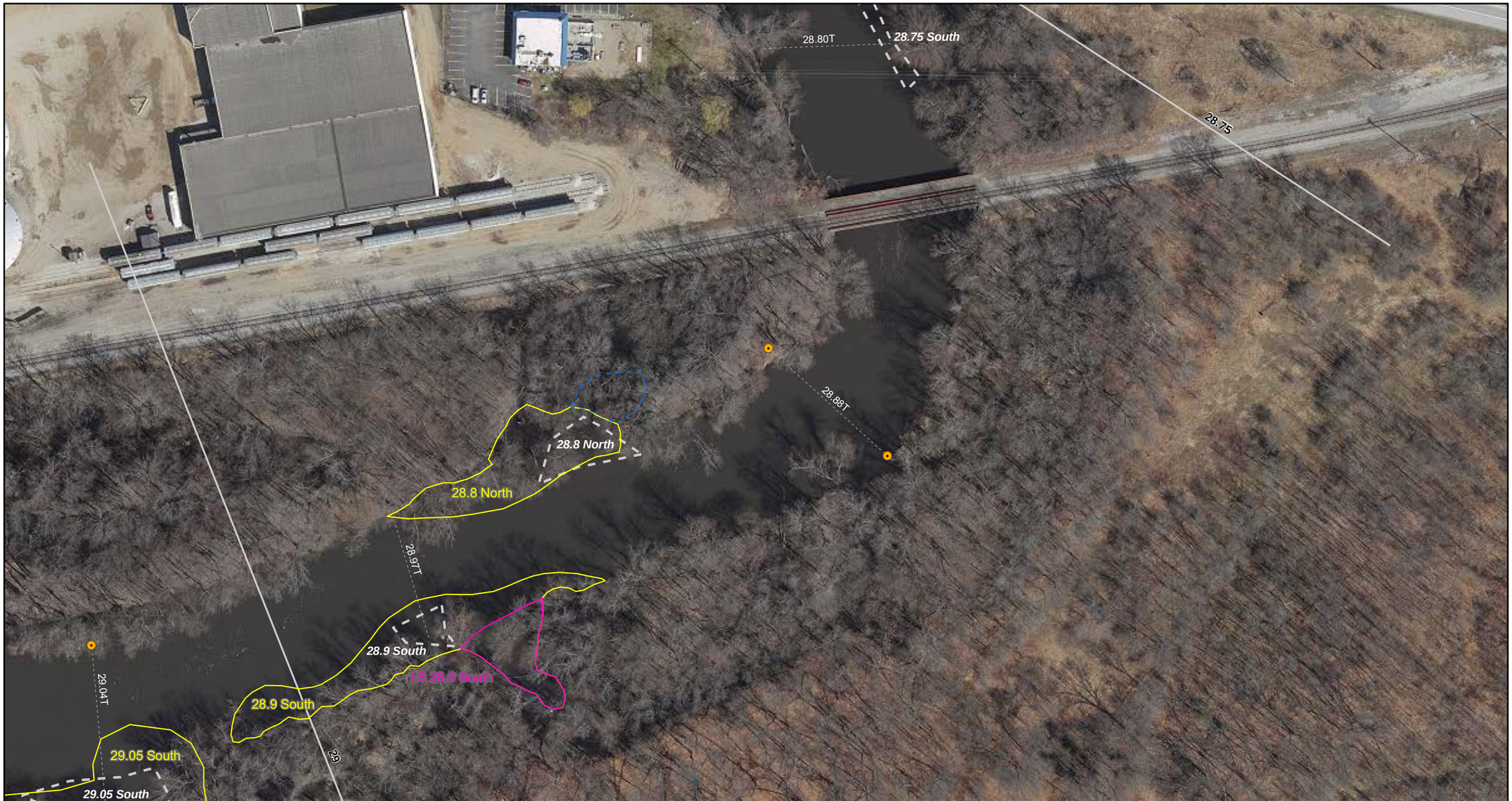

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 120 OF 170

ENBRIDGE LINE 6B MP 608
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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 121 OF 170

ENBRIDGE LINE 6B MP 608
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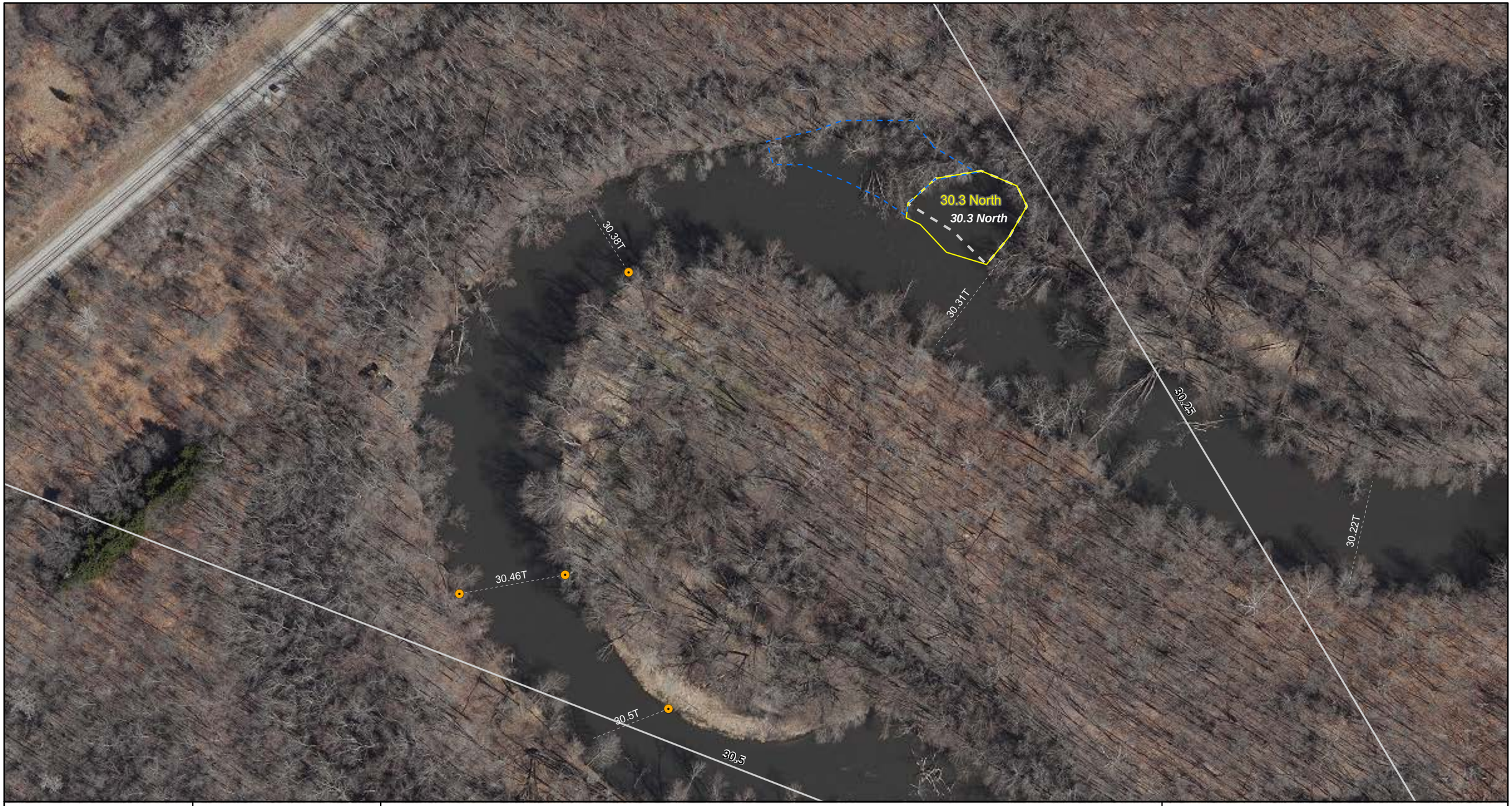

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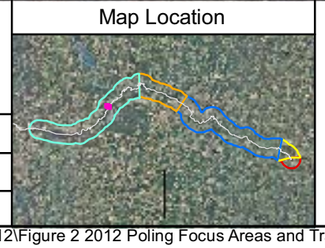

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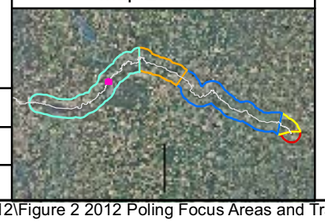

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

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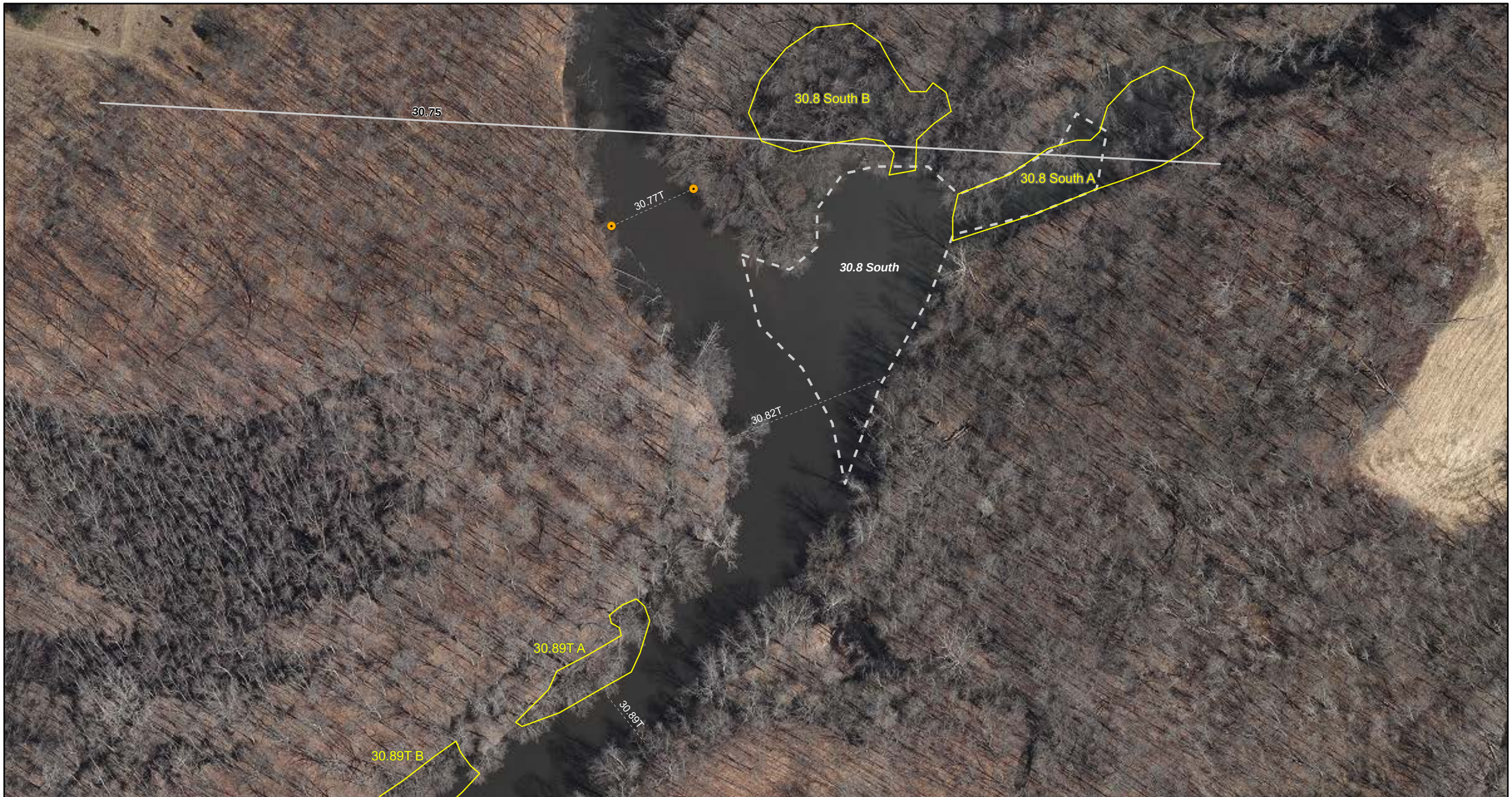

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

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FIGURE 2
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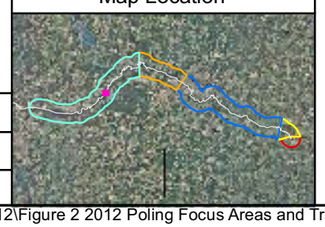

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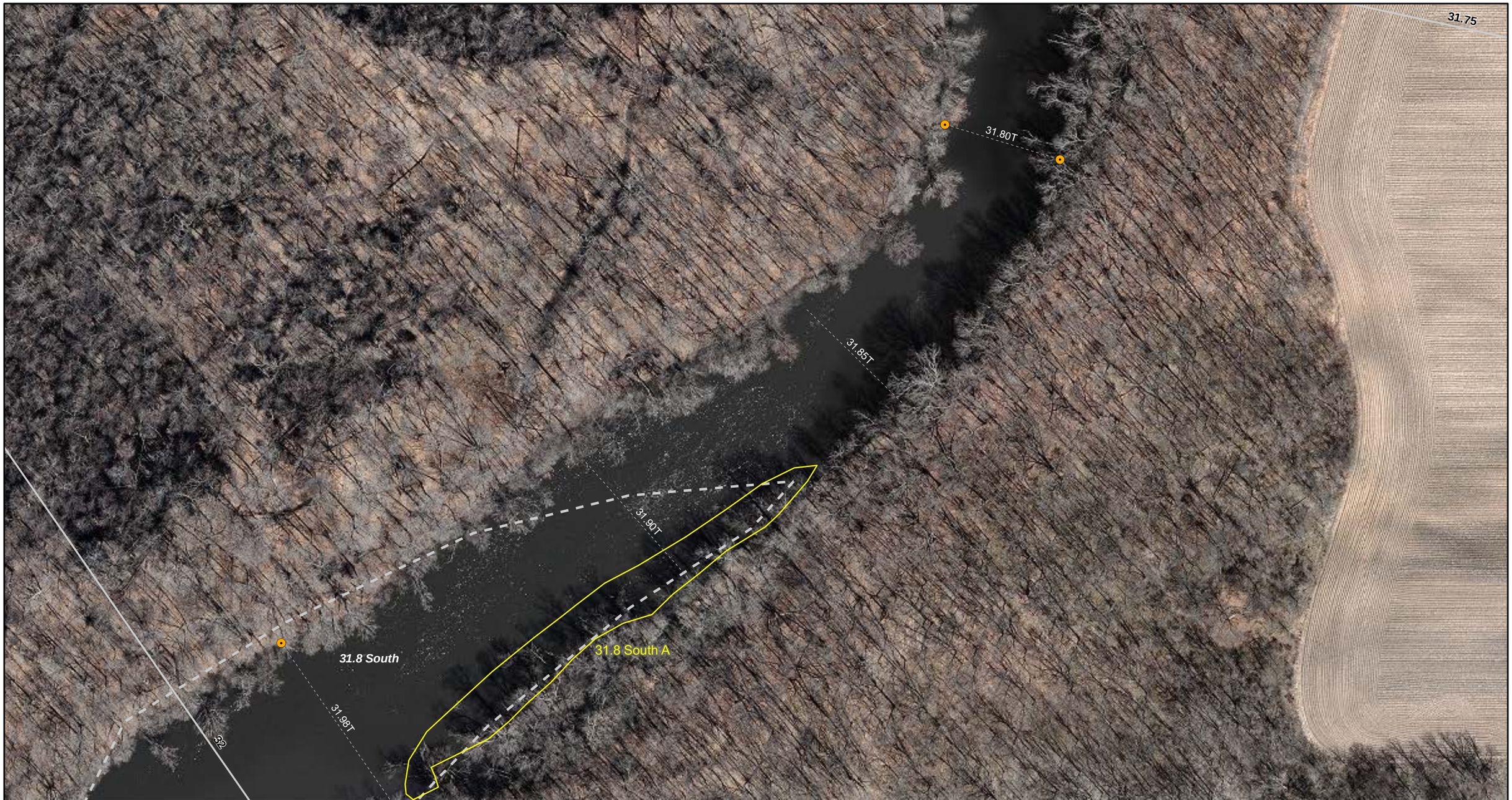

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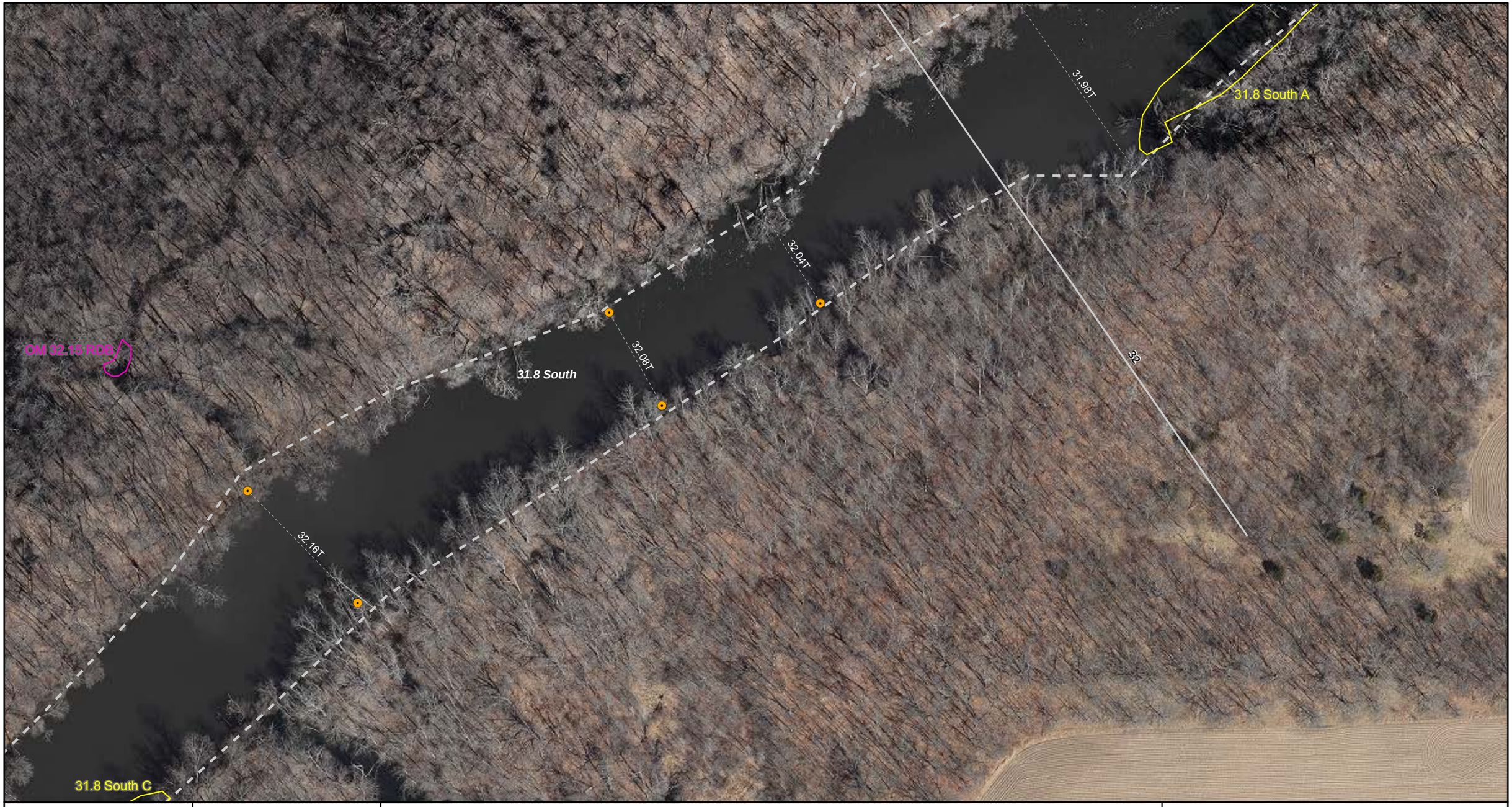

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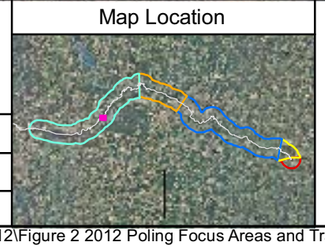

Legend

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 131 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	JLH 12/21/2011
Approved:	DBR 12/21/2011
Project #:	106-4186

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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 132 OF 170

ENBRIDGE LINE 6B MP 608
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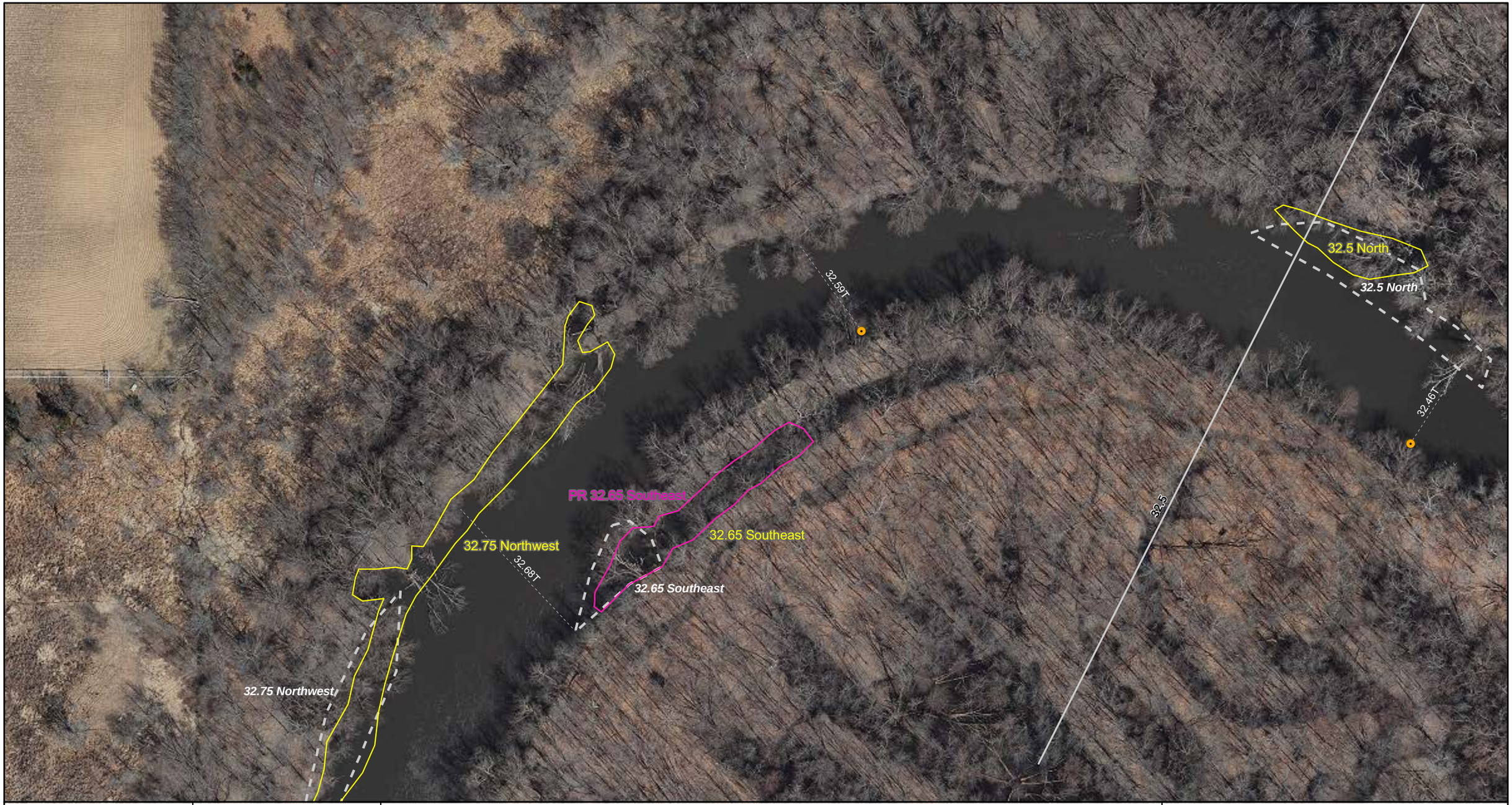

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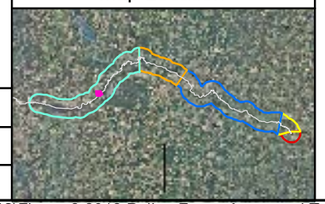

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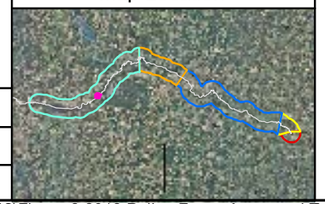

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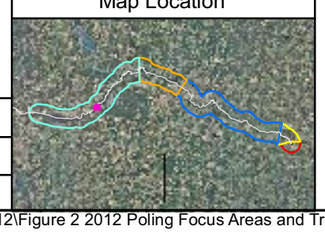

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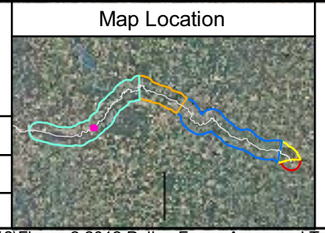

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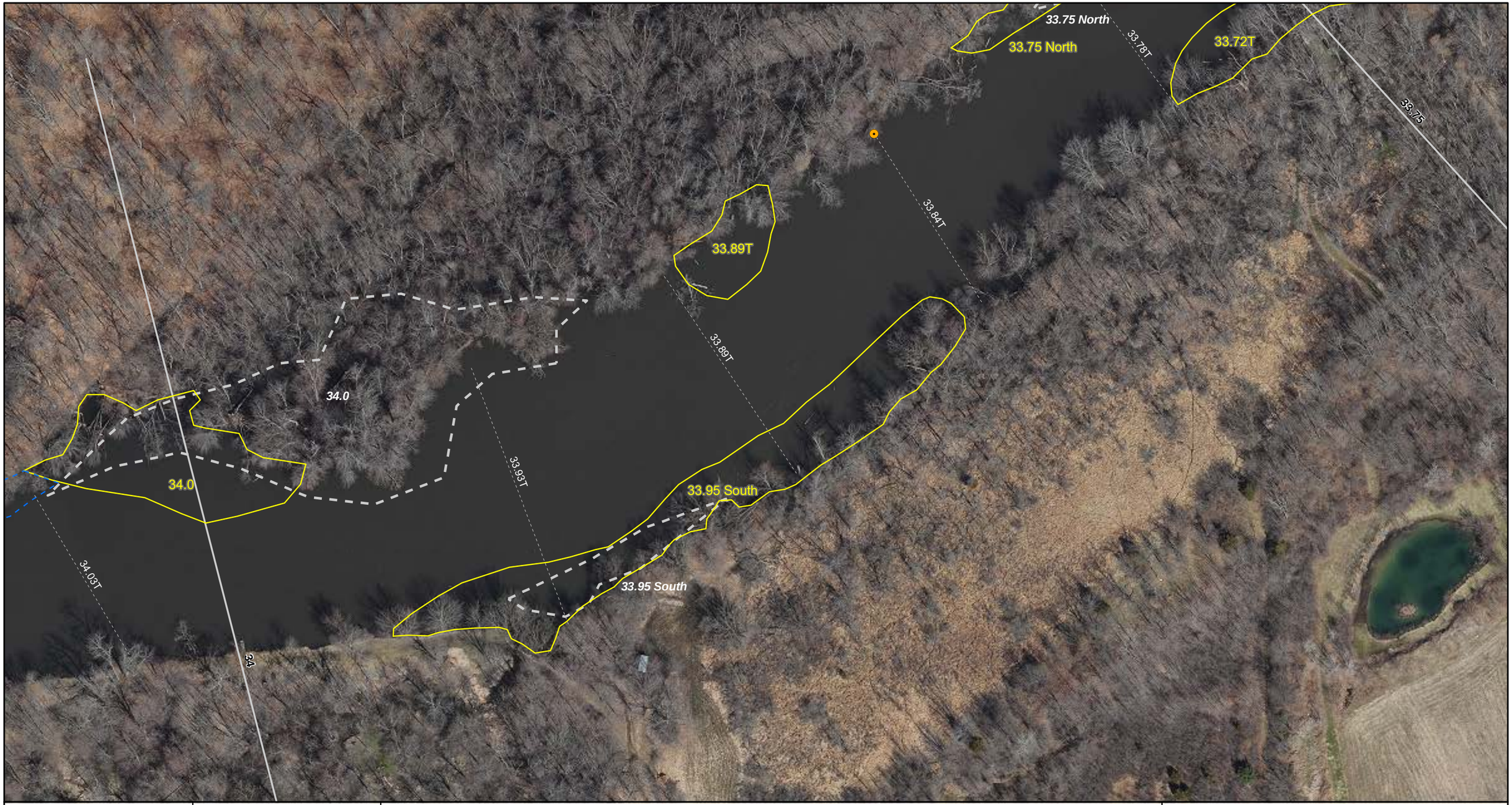

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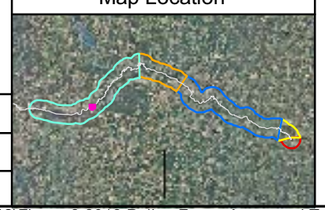

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 139 OF 170

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

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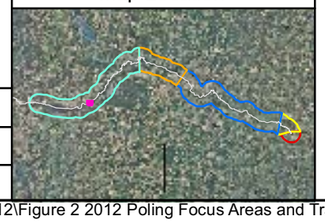

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 142 OF 170

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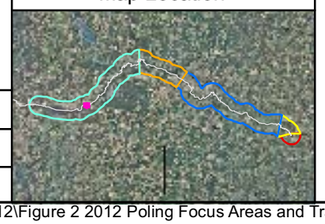

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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 144 OF 170

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2012 POLING FOCUS AREAS & TRANSECTS

SHEET 145 OF 170

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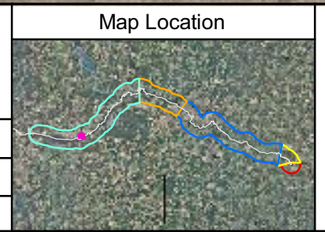

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Aerial Photography Date: April 2011

35.6 Southeast A

35.6 Southeast A

35.73T

35.75

35.77T

35.6 Southeast B

35.6 Southeast B

PR 35.84T A

35.8 Northwest

35.8 Northwest

35.84T

35.84T

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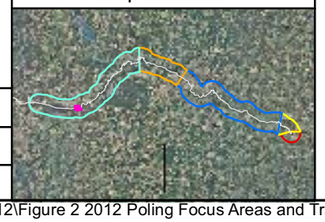

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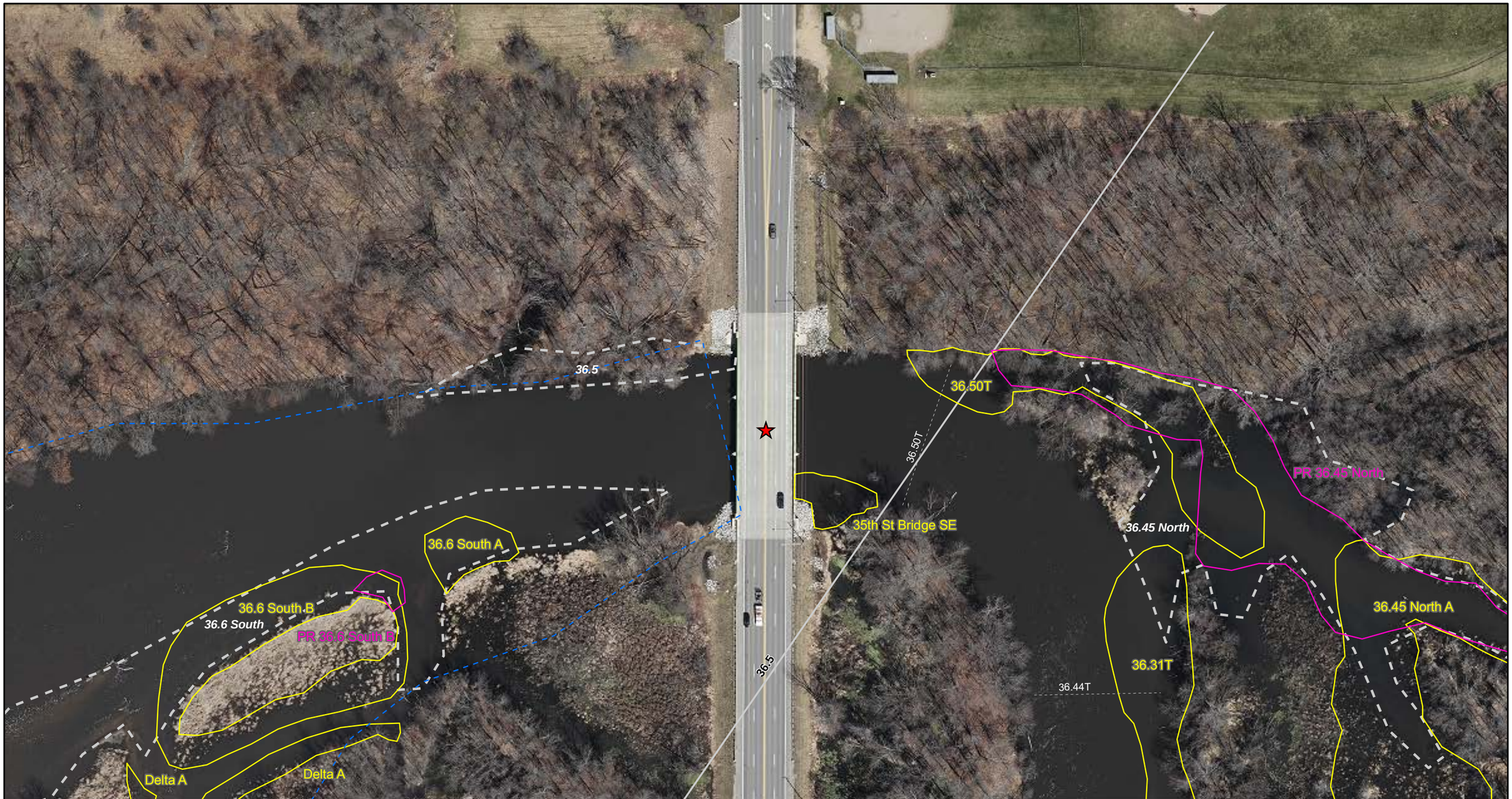

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N

0 50 100 200

Scale in Feet

FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 151 OF 170

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: JLH 12/21/2011

Approved: DBR 12/21/2011

Project #: 106-4186

Map Location

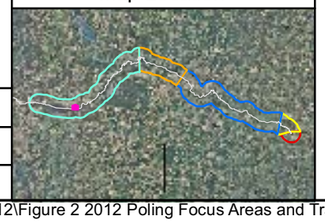

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FIGURE 2
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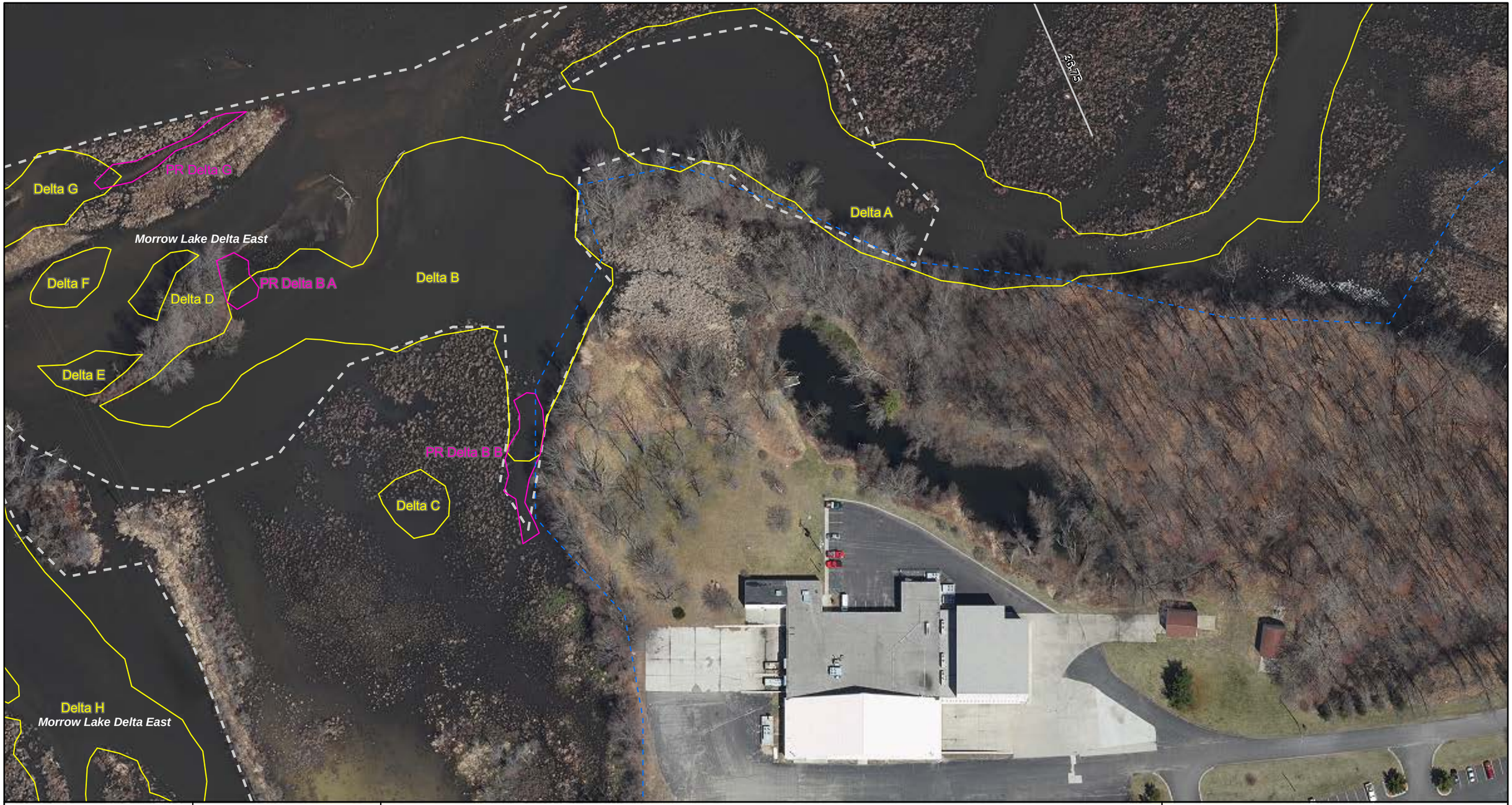

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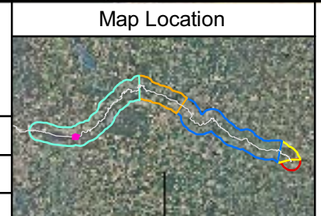

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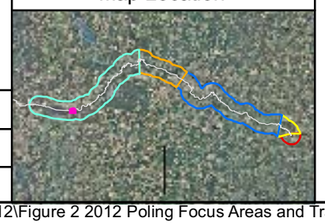

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Aerial Photography Date: April 2011

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Delta T
Delta S
Delta K
Delta J
Delta H
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Delta U
Delta R
Delta Q
PR Delta Q
Delta P
PR Delta P
Morrow Lake Delta East
Delta Y
Delta O
Delta Z

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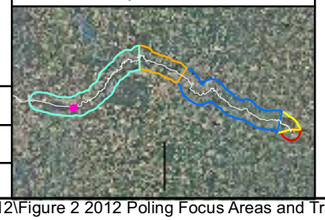

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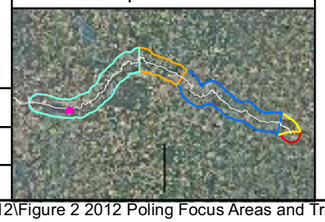

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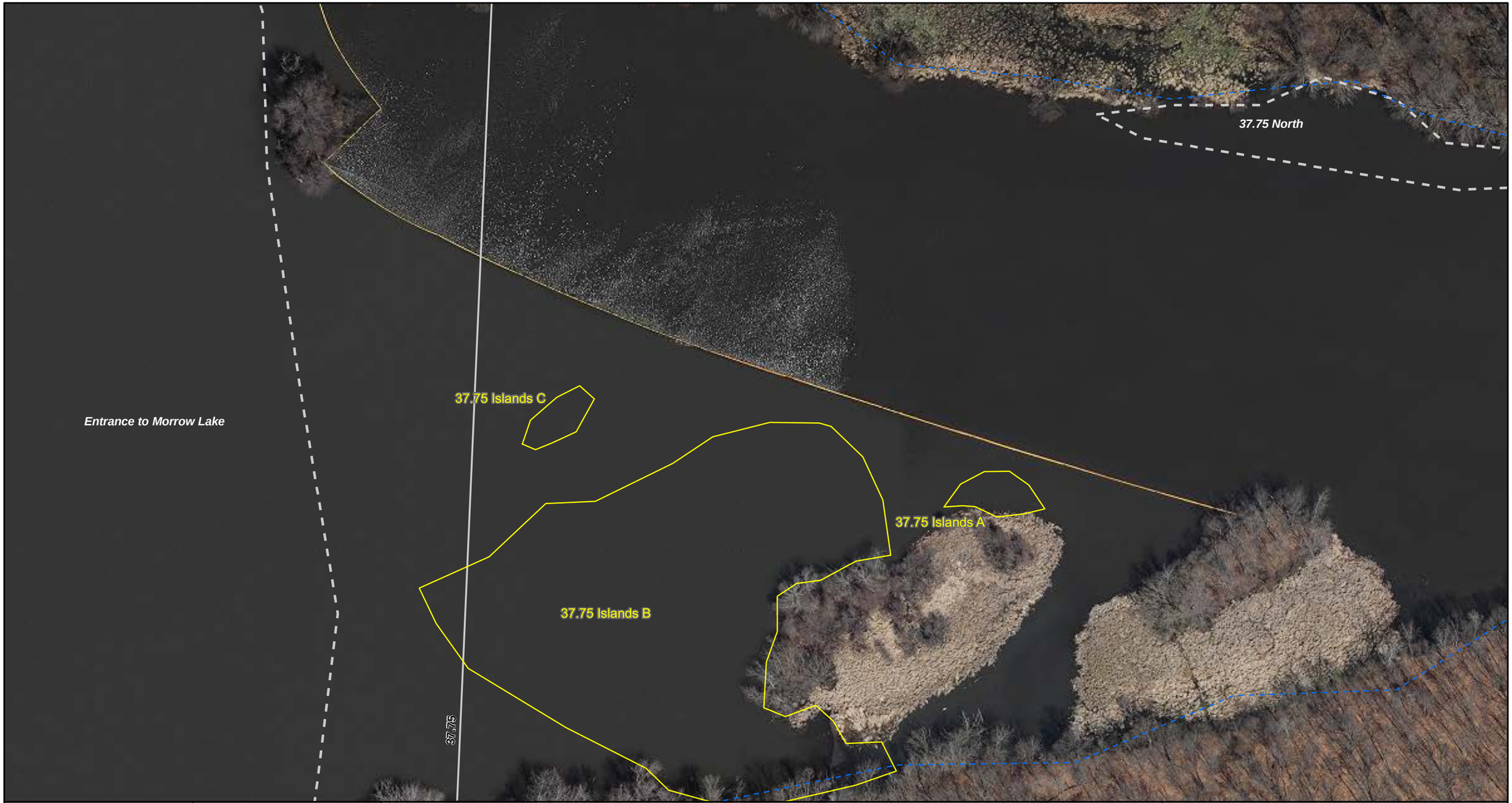

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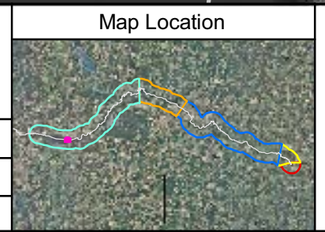

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SHEET 160 OF 170

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FIGURE 2
2012 POLING FOCUS AREAS & TRANSECTS

SHEET 162 OF 170

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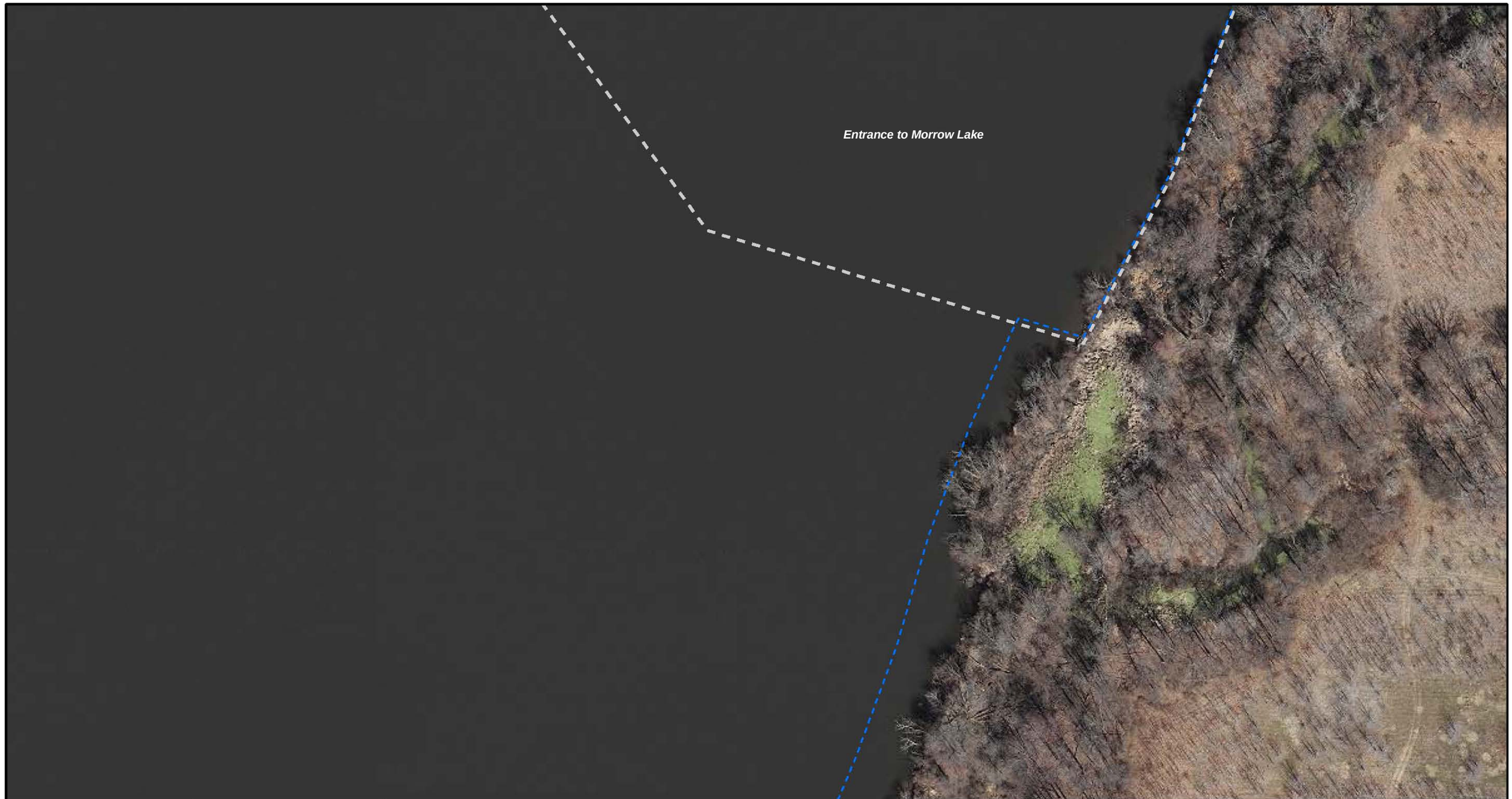

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SHEET 163 OF 170

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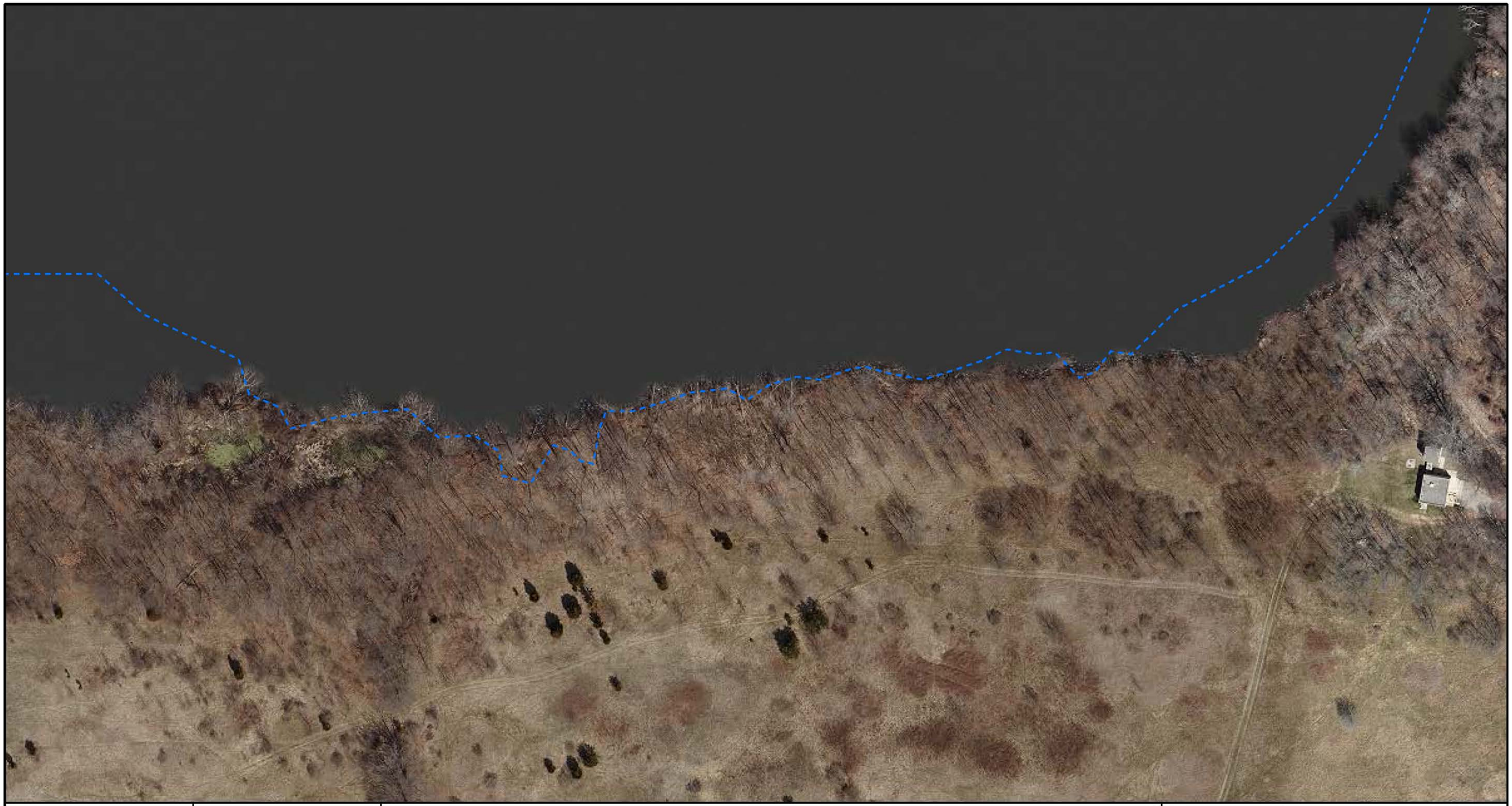

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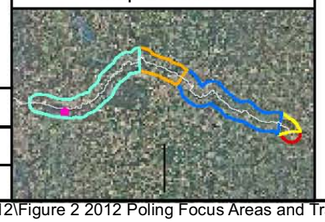

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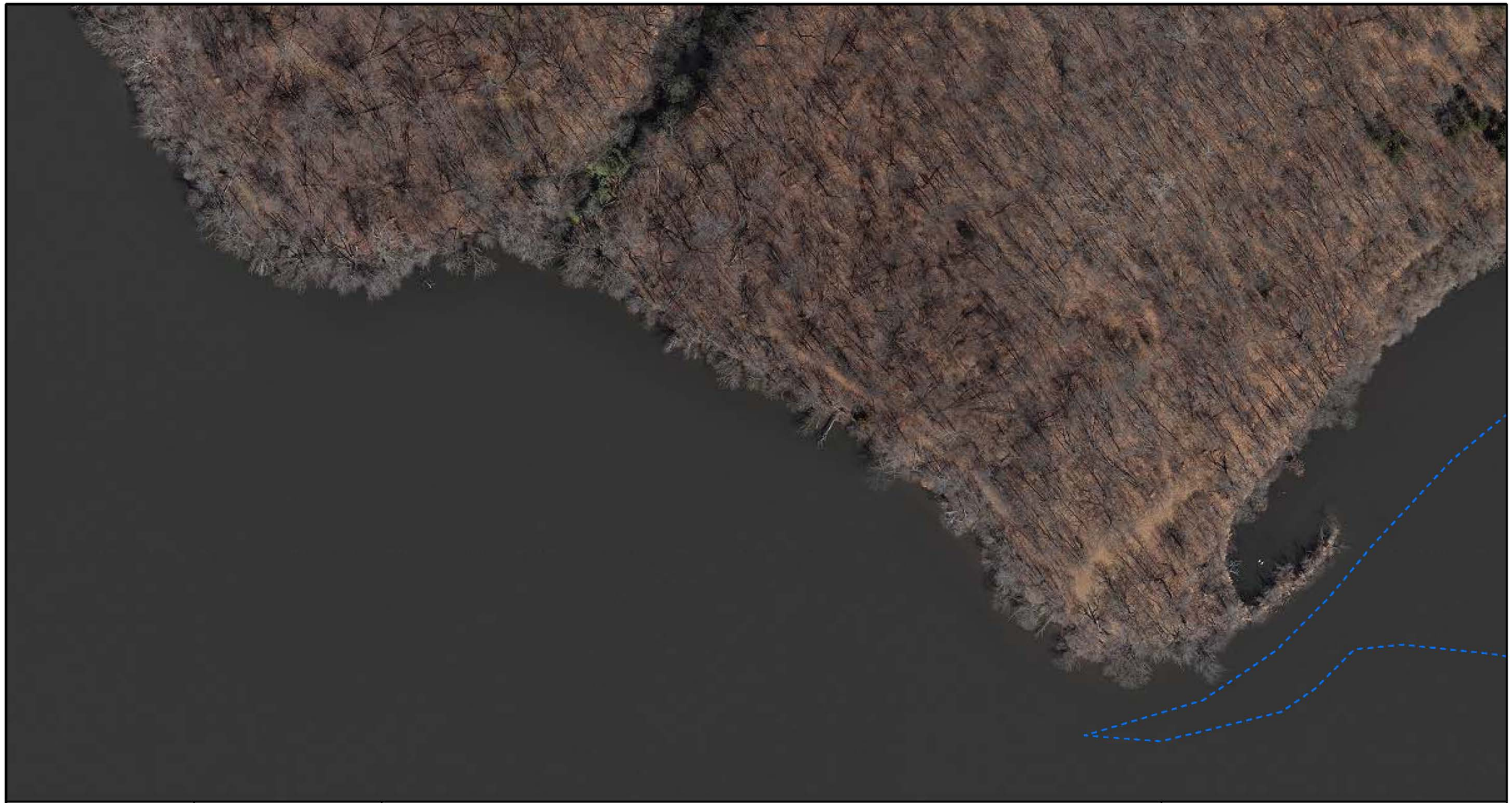

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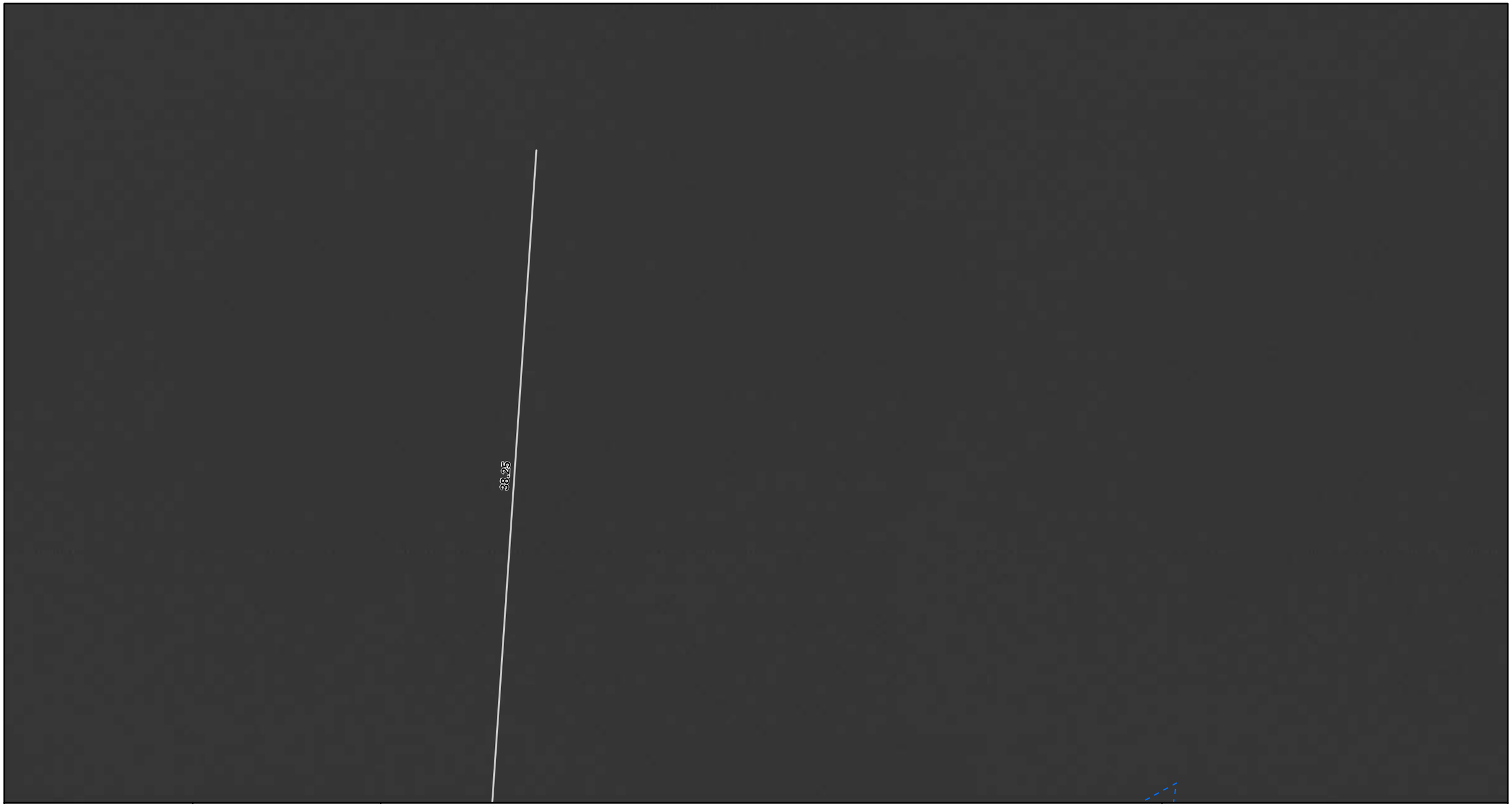

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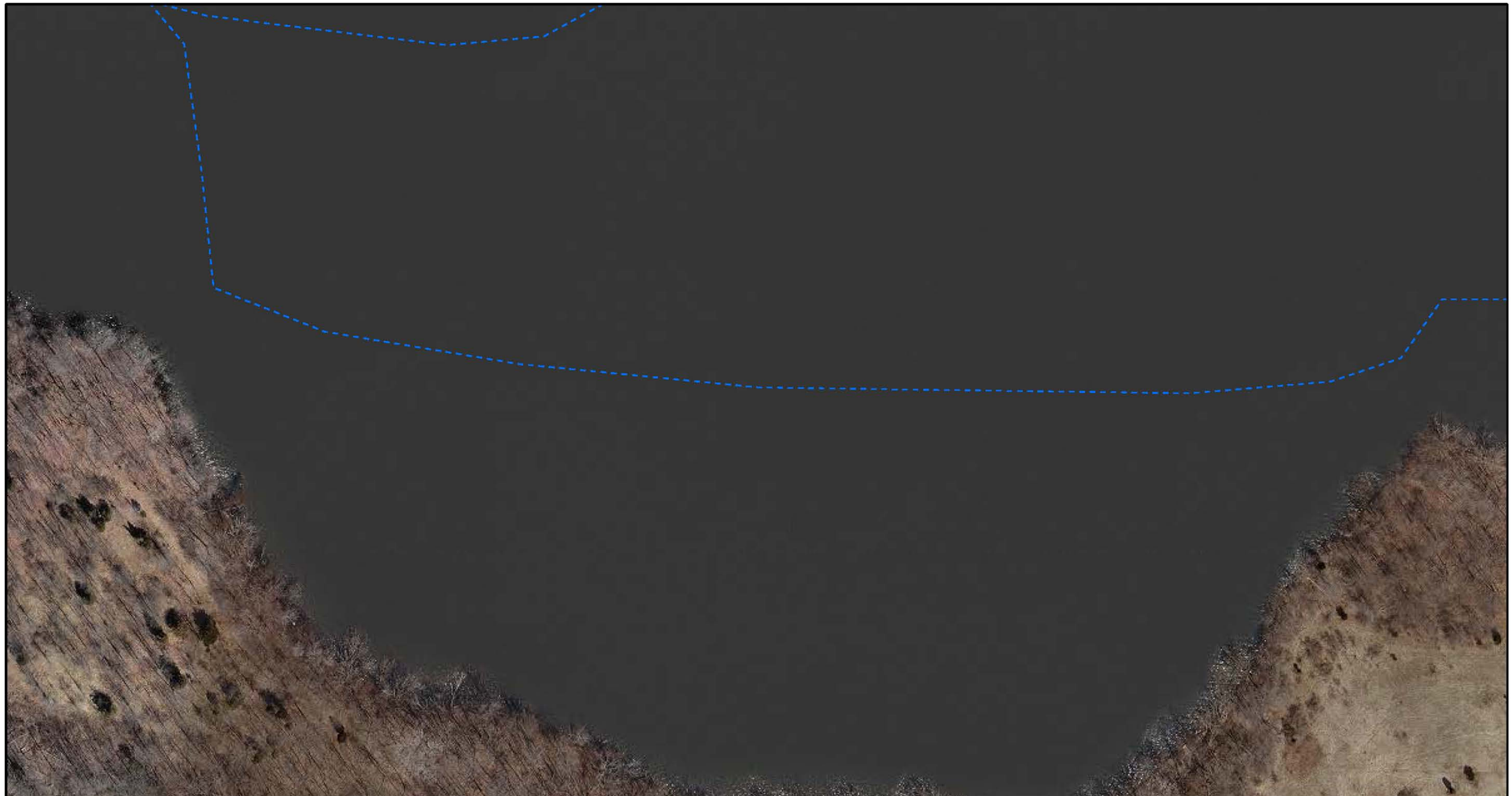

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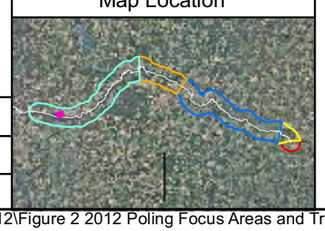

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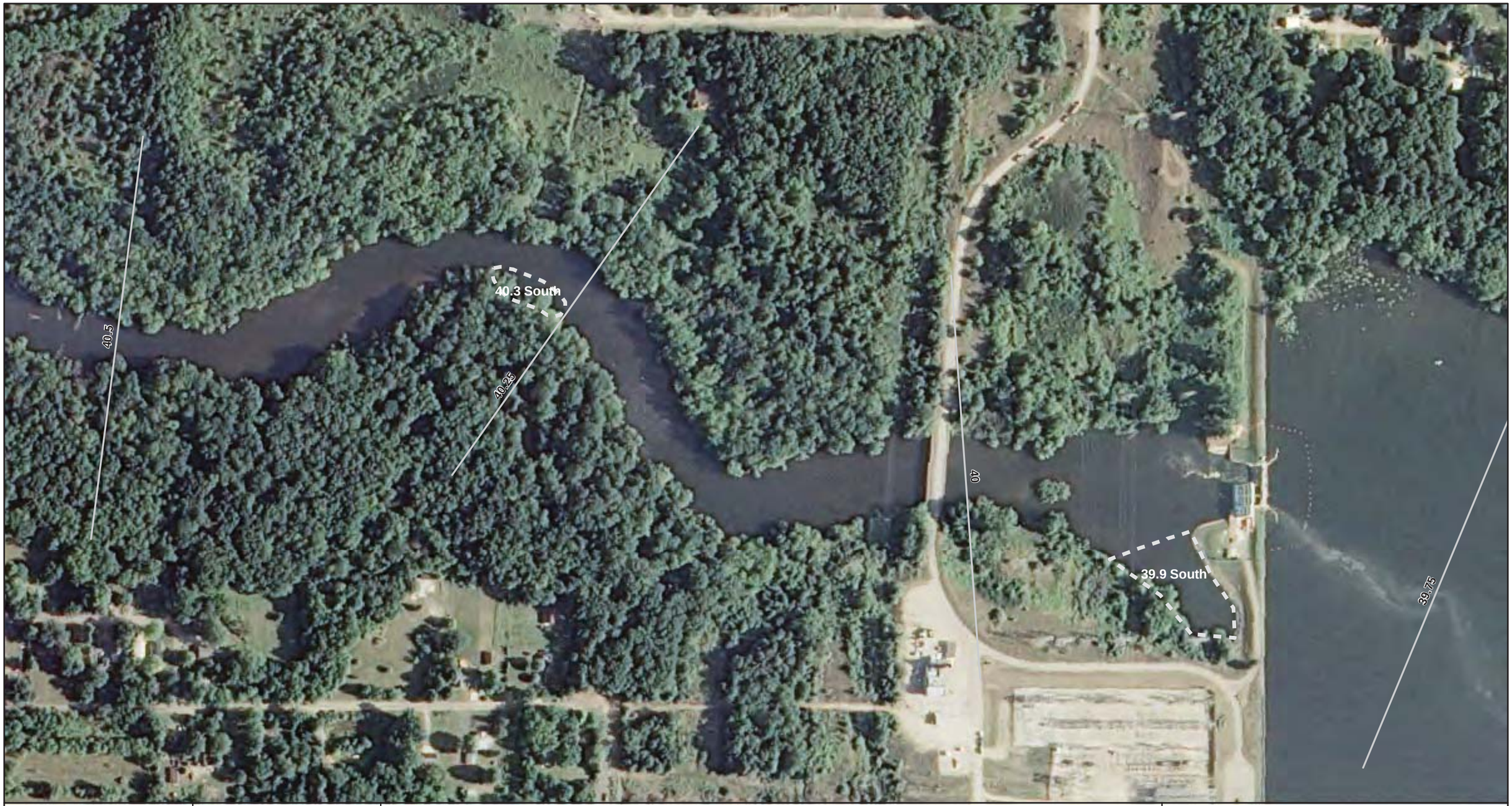
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 2012 Poling Focus Areas and Transects.mxd

Aerial Photography Date: April 2011

Attachment C

Hydrodynamic Assessment



ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

Proposed Poling Focus Areas

Quarter Mile Grid Segment

N

0 200 400 800

Scale in Feet

FIGURE 1
PROPOSED POLING AREAS
DOWNSTREAM OF MORROW LAKE DAM

SHEET 1 OF 2

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

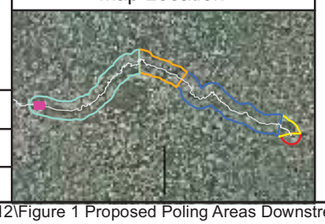
X:\ArcMap Project Files\Work Plan 2012\Figure 1 Proposed Poling Areas Downstream of Morrow Lake Dam.mxd

Aerial Photography: July and August 2009

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location



Legend

Proposed Poling Focus Areas

Quarter Mile Grid Segment

N

0 200 400 800

Scale in Feet

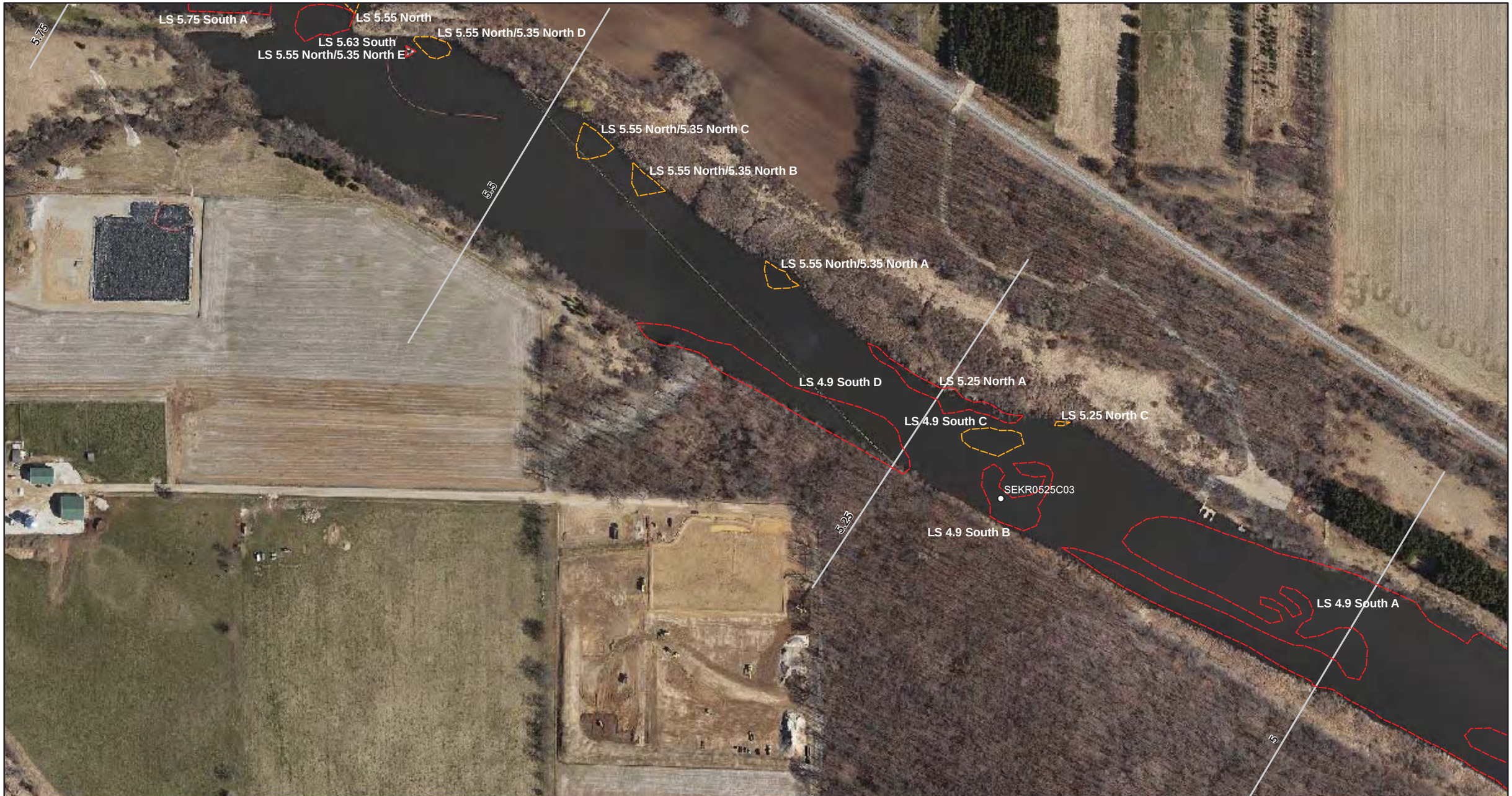
FIGURE 1
PROPOSED POLING AREAS
DOWNSTREAM OF MORROW LAKE DAM

SHEET 2 OF 2

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 1 Proposed Poling Areas Downstream of Morrow Lake Dam.mxd

Aerial Photography: July and August 2009



ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 1 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

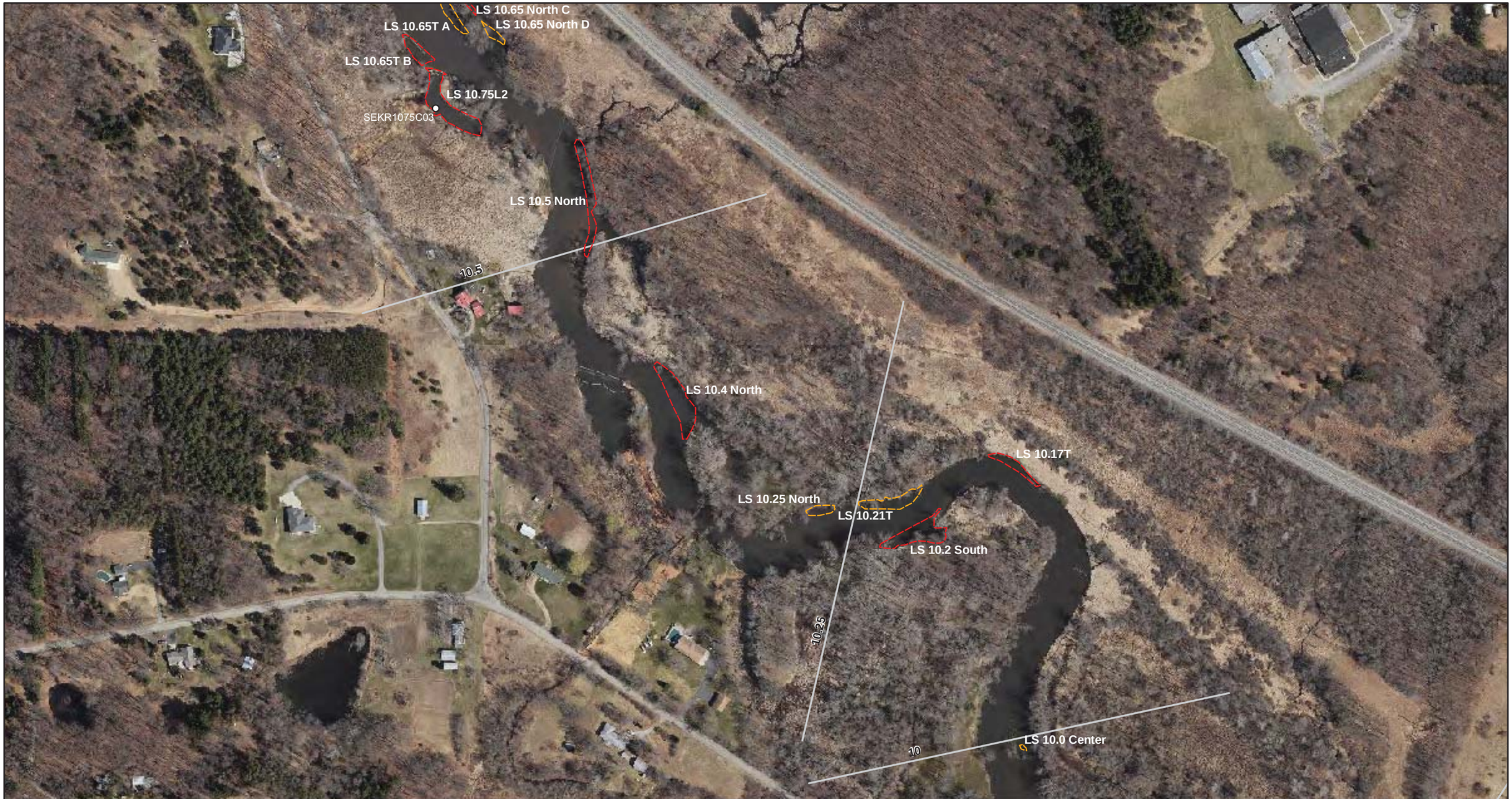
FIGURE 2
JET TEST LOCATIONS

SHEET 2 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

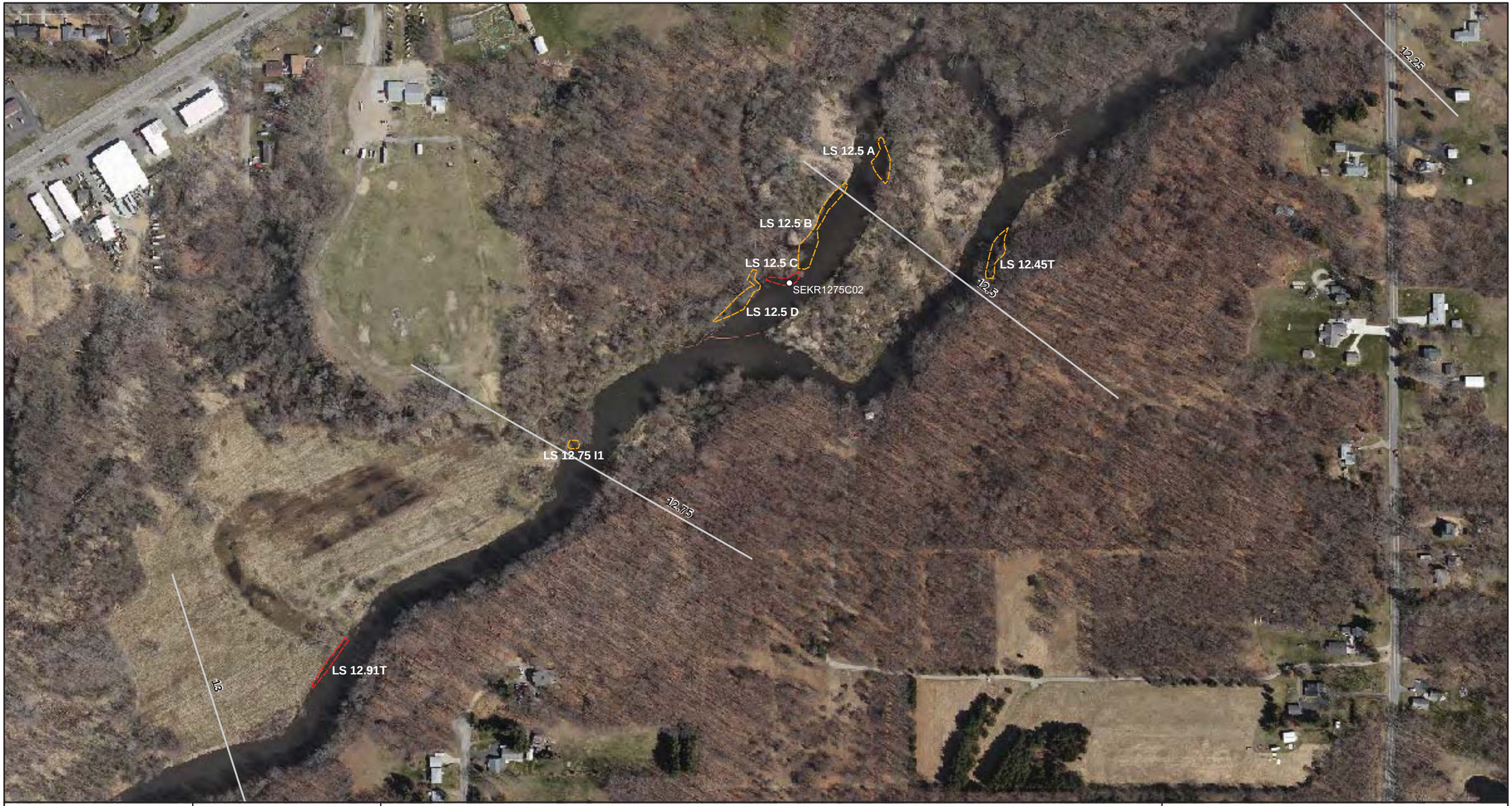
FIGURE 2
JET TEST LOCATIONS

SHEET 3 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

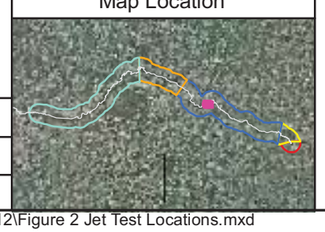
Aerial Photography Date: April 2011



ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location



Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 4 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

LS 14.75 C
LS 14.8 South
14.75
LS 14.75 B
LS 14.75 L1 B
SEKR1475C01
LS 14.75 A
LS 14.75 L1 A
LS 14.6 South
LS 14.35 North C
14.3
LS 14.35 North B
LS 14.40T B
SEKR1450C02
LS 14.35 North A
LS 14.2 South
14.25
14

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Jet Test Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 5 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 6 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 7 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 8 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

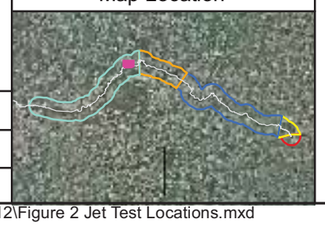
X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location



Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 9 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

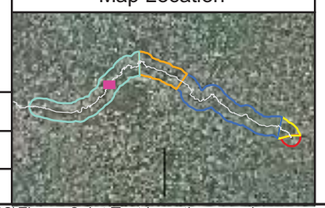
X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location



Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 10 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

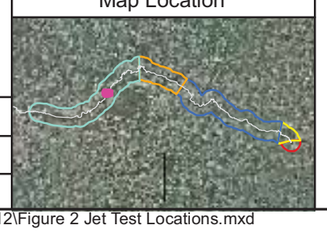
X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location



Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 11 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 12 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

PR 36.75 North
PR 37.1 North
PR Delta G
PR Delta M
PR Delta B A
PR Delta I
PR Delta B B
PR Delta N
37.5
37.25
13
SEKR3700C03
PR Delta Q
PR Delta P
PR Delta FF
PR Delta GG
SEKR3725C06
PR Delta HH

ENBRIDGE

Drawn:	BRS	12/2/2011
Approved:	DBR	12/2/2011
Project #:	106-4186	

Map Location

Legend

- Jet Test Location
- November 2011 Delineation Areas
  - Heavy
  - Moderate
- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 2
JET TEST LOCATIONS

SHEET 13 OF 13

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 2 Jet Test Locations.mxd

Aerial Photography Date: April 2011

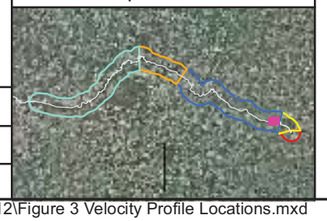
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 1 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

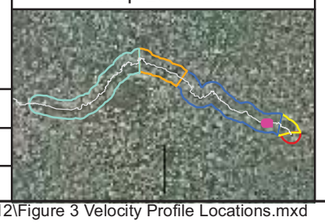
X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 2 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 3 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 4 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 5 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

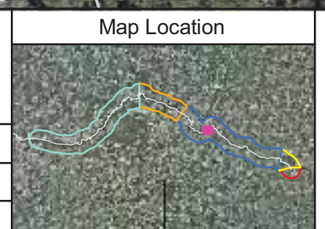
X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 6 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 7 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

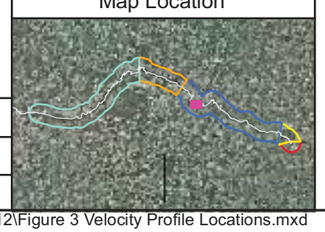
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 8 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 9 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 10 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

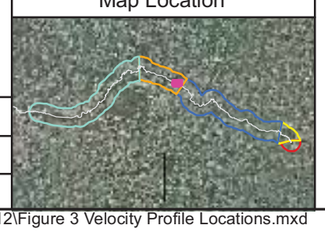
X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 11 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 12 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 13 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 14 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 15 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 16 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

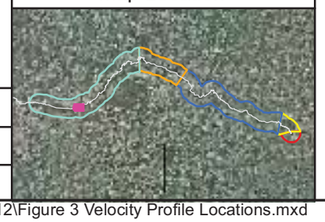
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 17 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

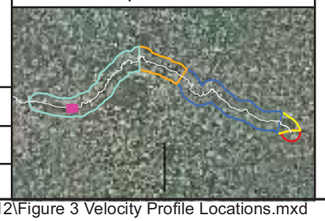
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 18 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

- Proposed Velocity Profiling Locations
- Velocity Moving Transects

November 2011 Delineation Areas

- Heavy
- Moderate

- Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 19 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

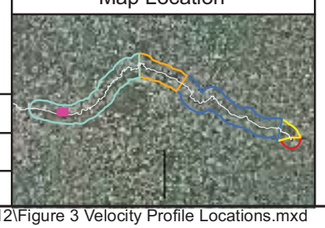
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 20 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

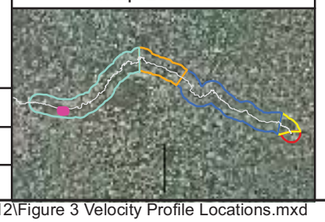
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 21 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 22 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

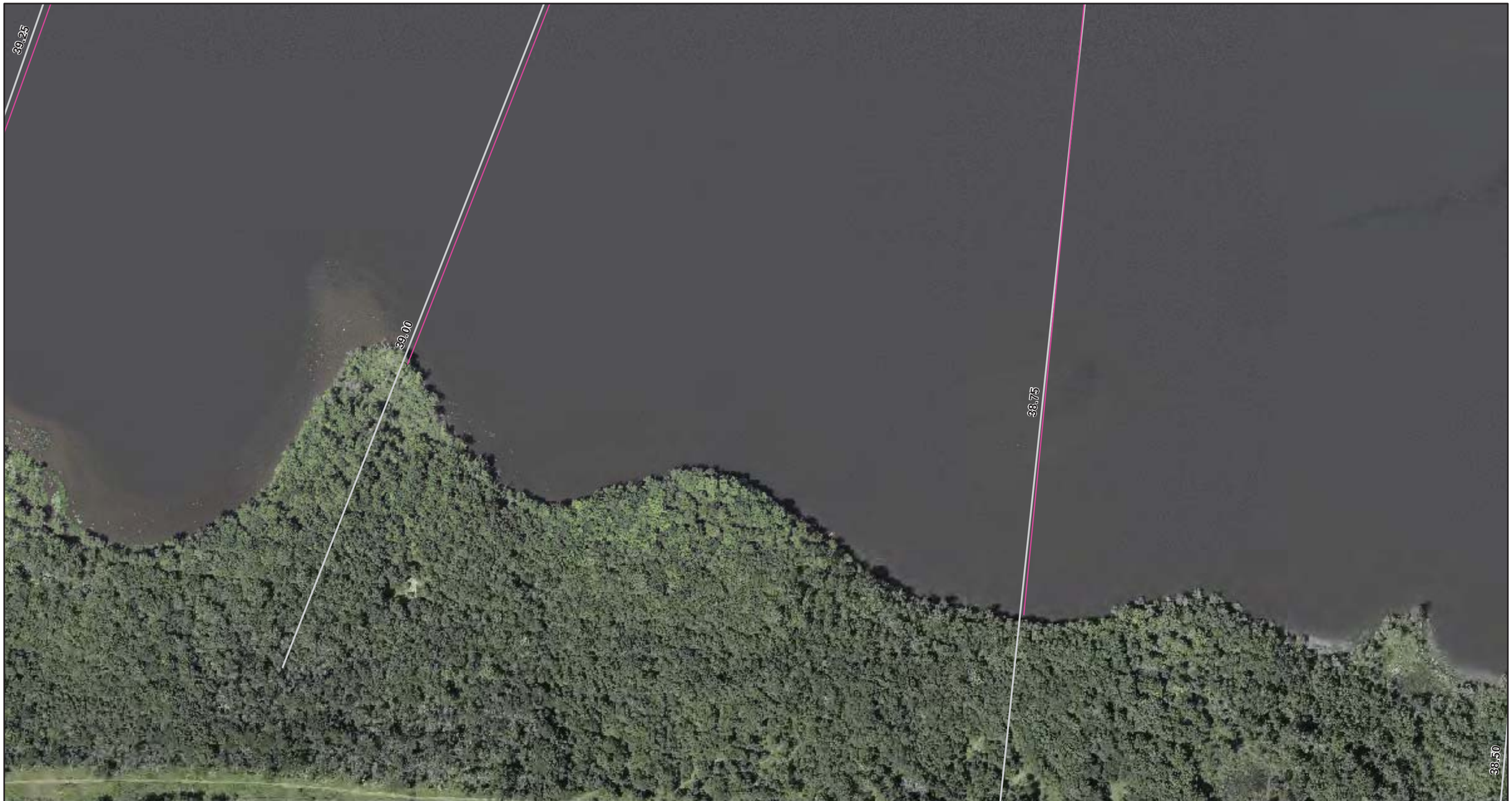
FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 23 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 24 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

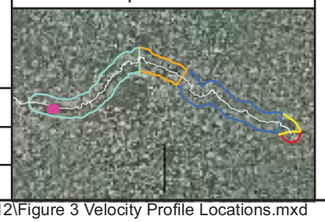
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 25 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Velocity Profiling Locations

Velocity Moving Transects

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 3
VELOCITY PROFILE LOCATIONS

SHEET 26 OF 26

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 3 Velocity Profile Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 1 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

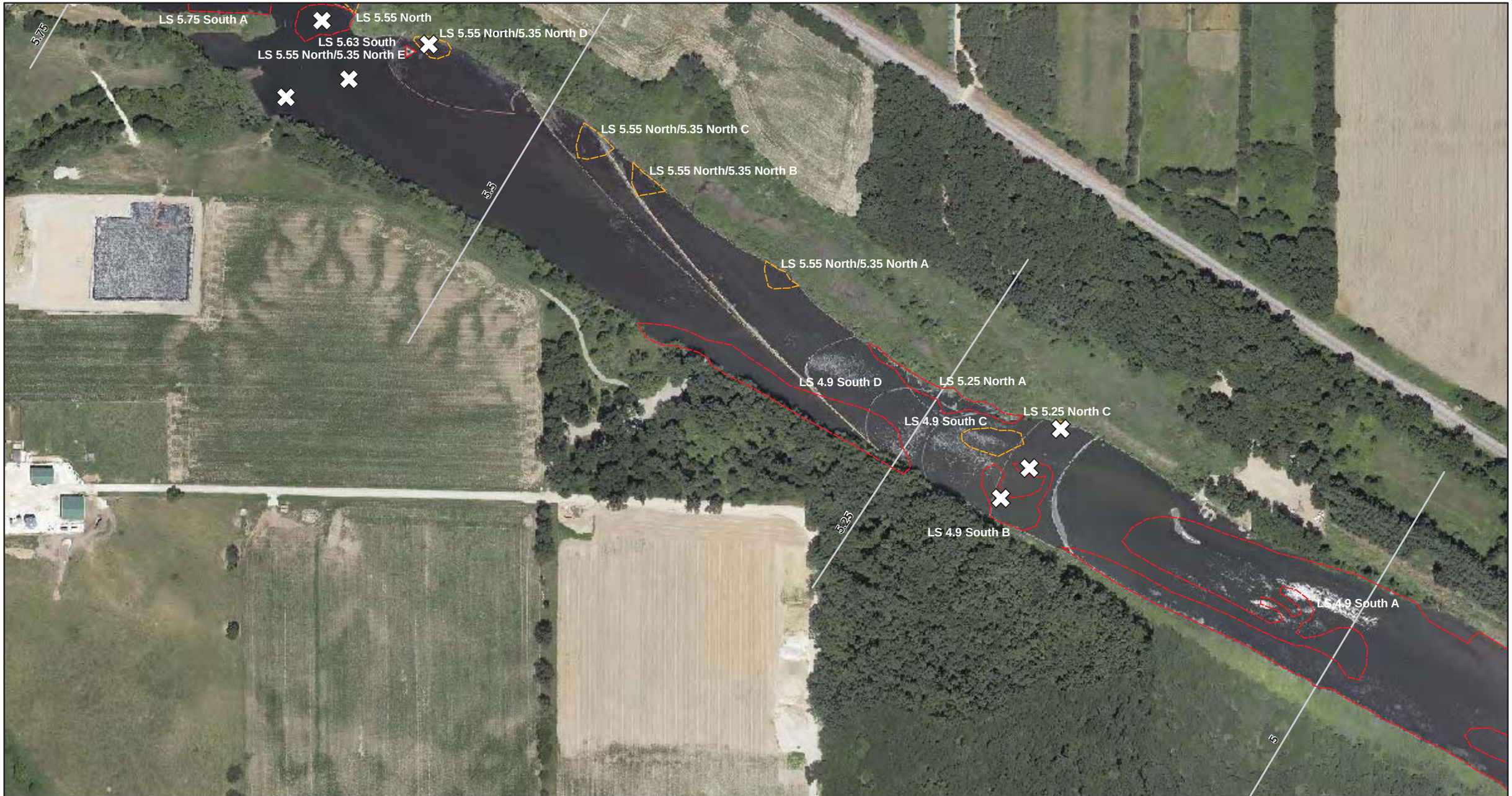
FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 2 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 3 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

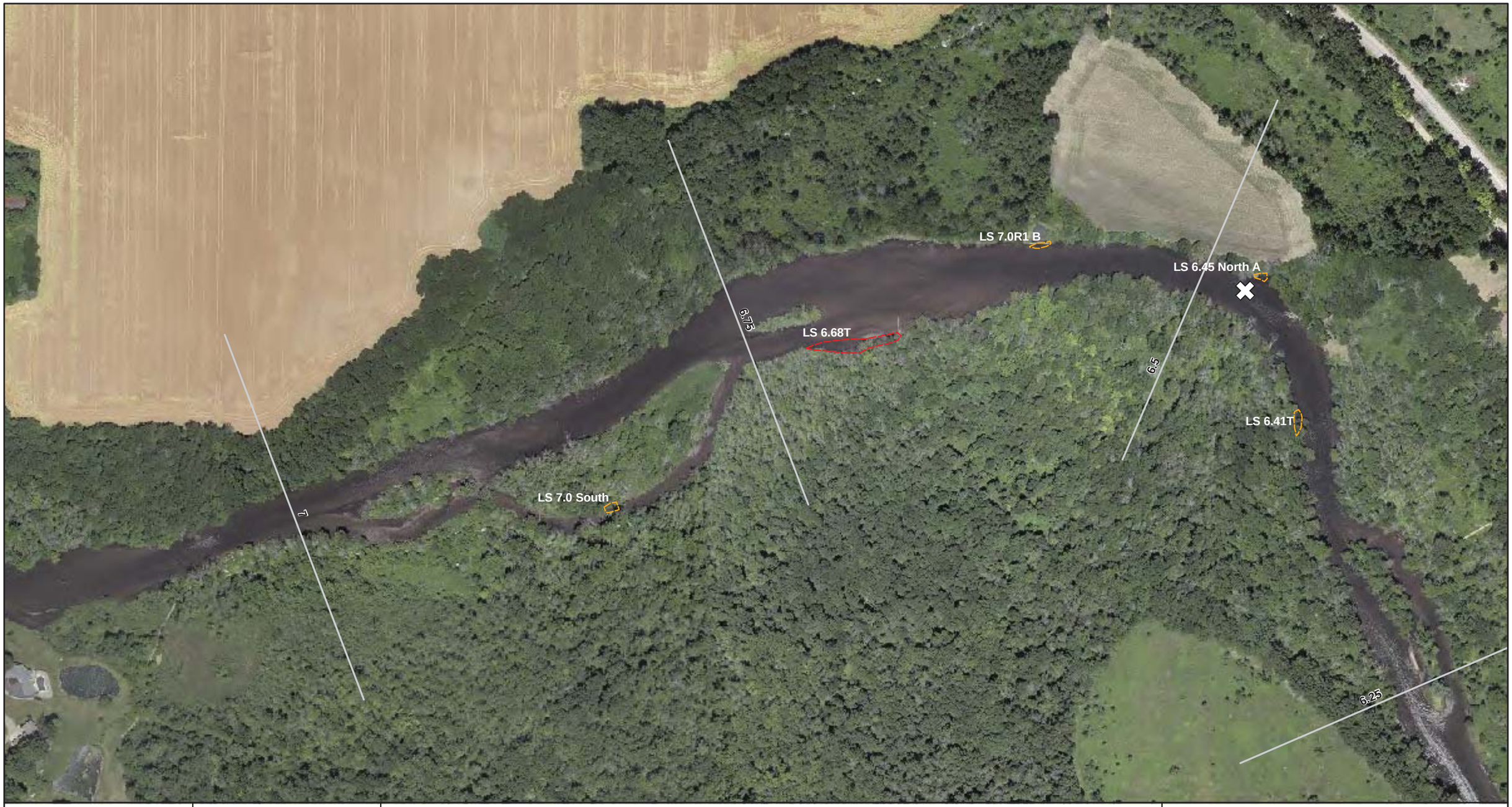
FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 4 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011



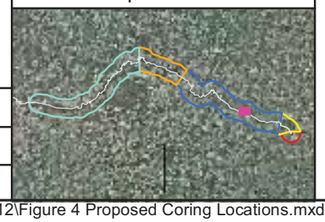
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 5 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

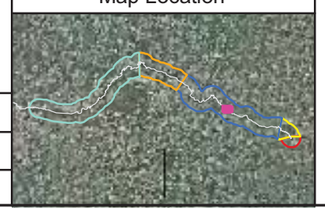
X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 6 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 7 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 8 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

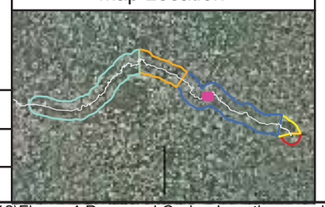
X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 9 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

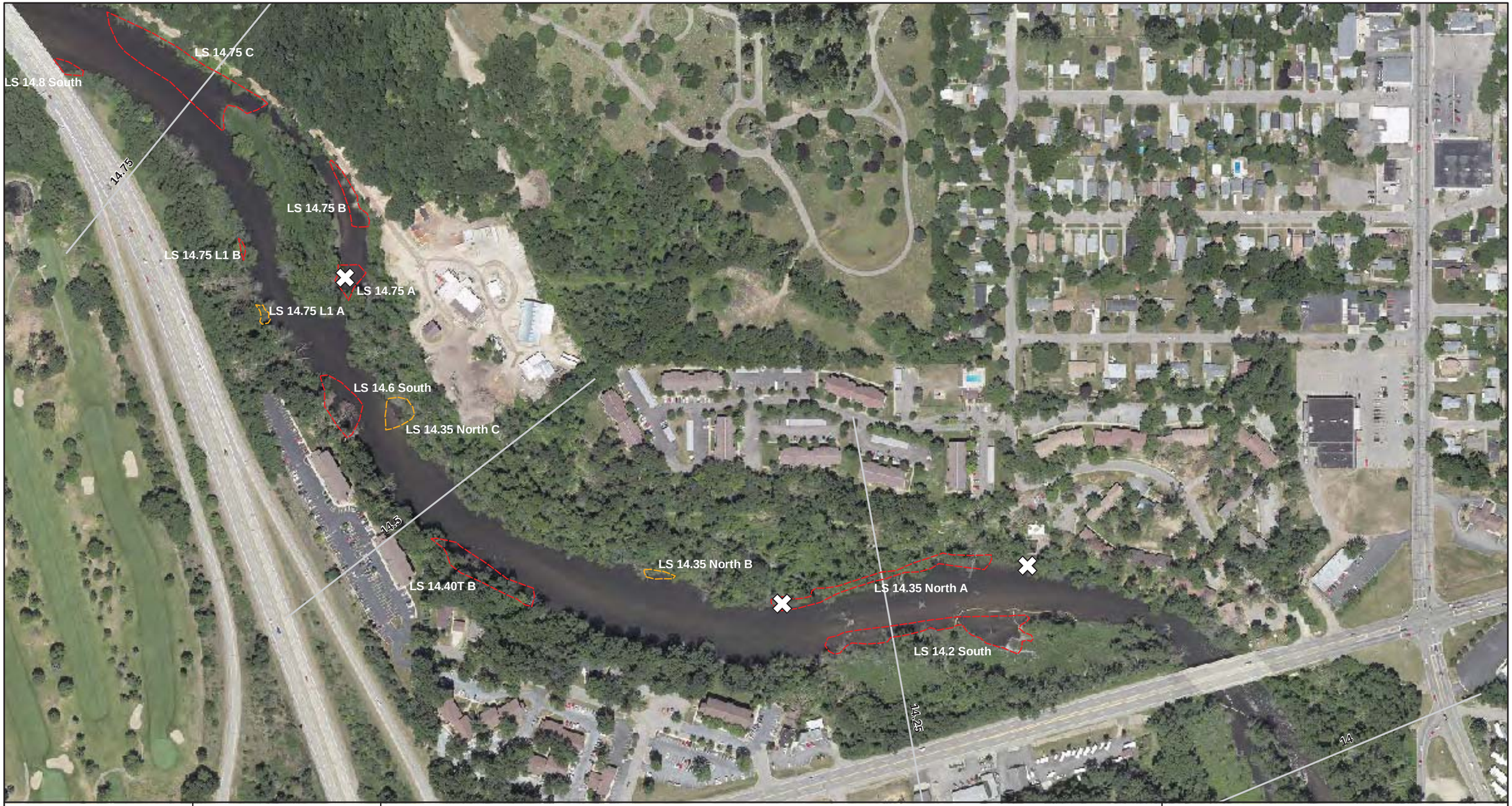
FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 10 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

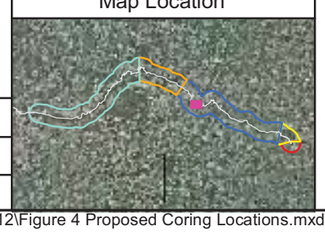
Aerial Photography Date: April 2011



ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 11 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 12 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

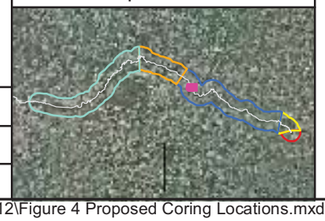
X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 13 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 14 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

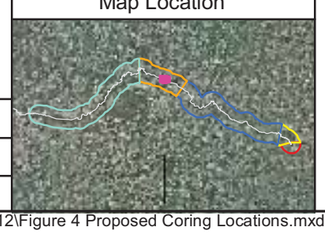
X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 15 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 16 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 17 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 18 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 19 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 20 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

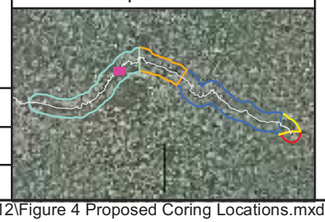
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 21 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 22 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

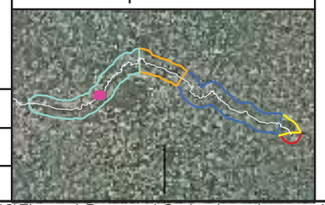
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 23 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

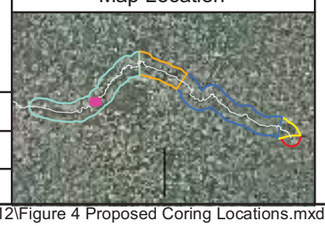
X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 24 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

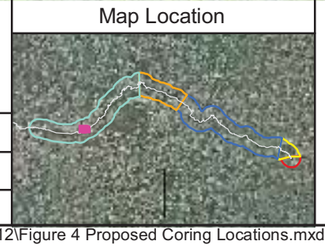
X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 25 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

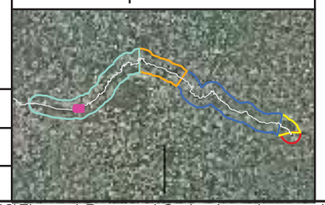
X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 26 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

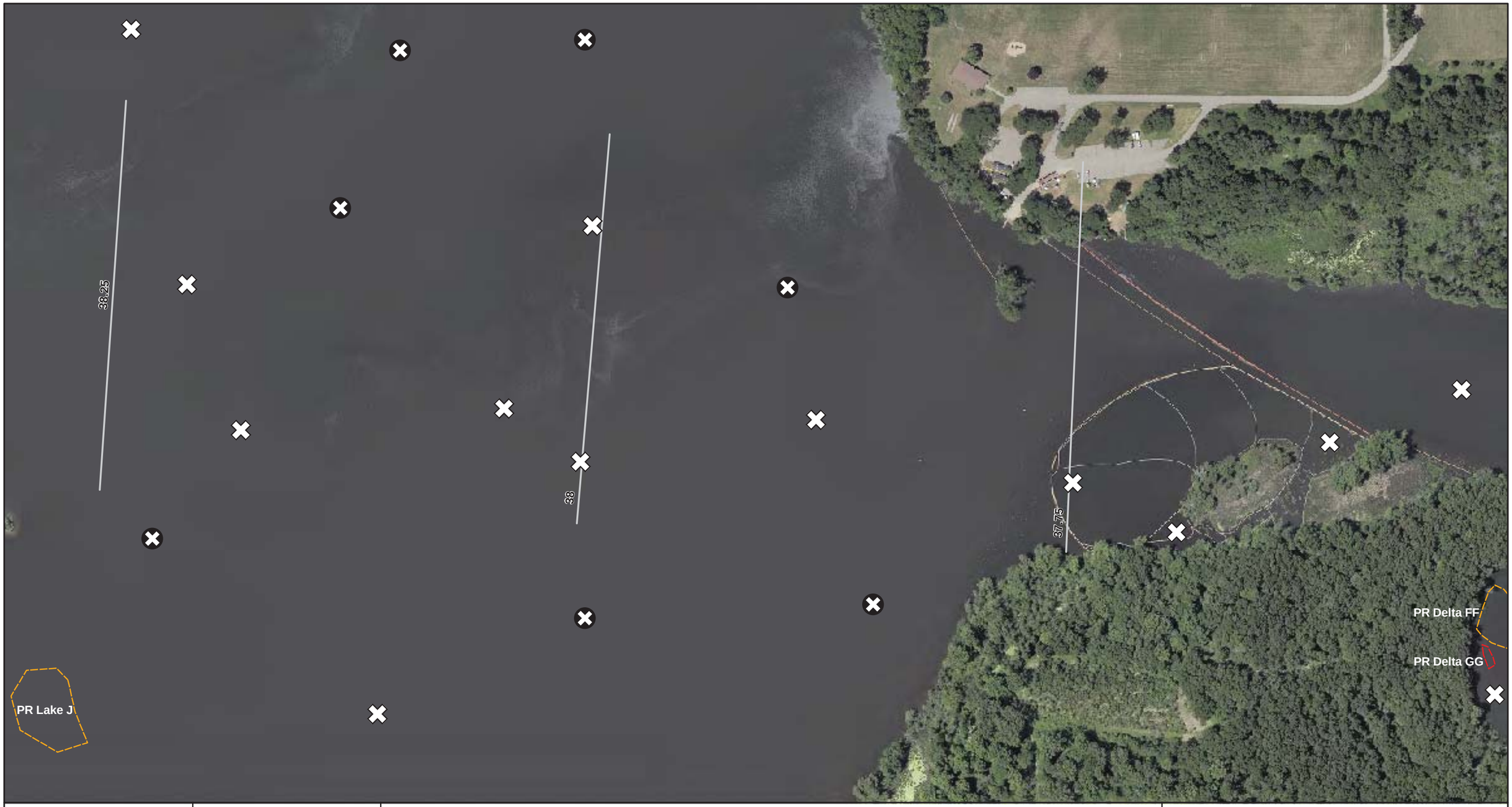
FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 27 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

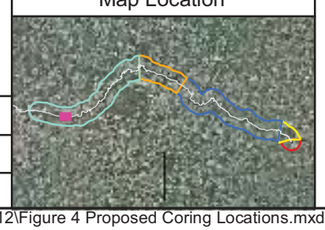
Aerial Photography Date: April 2011



ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 28 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

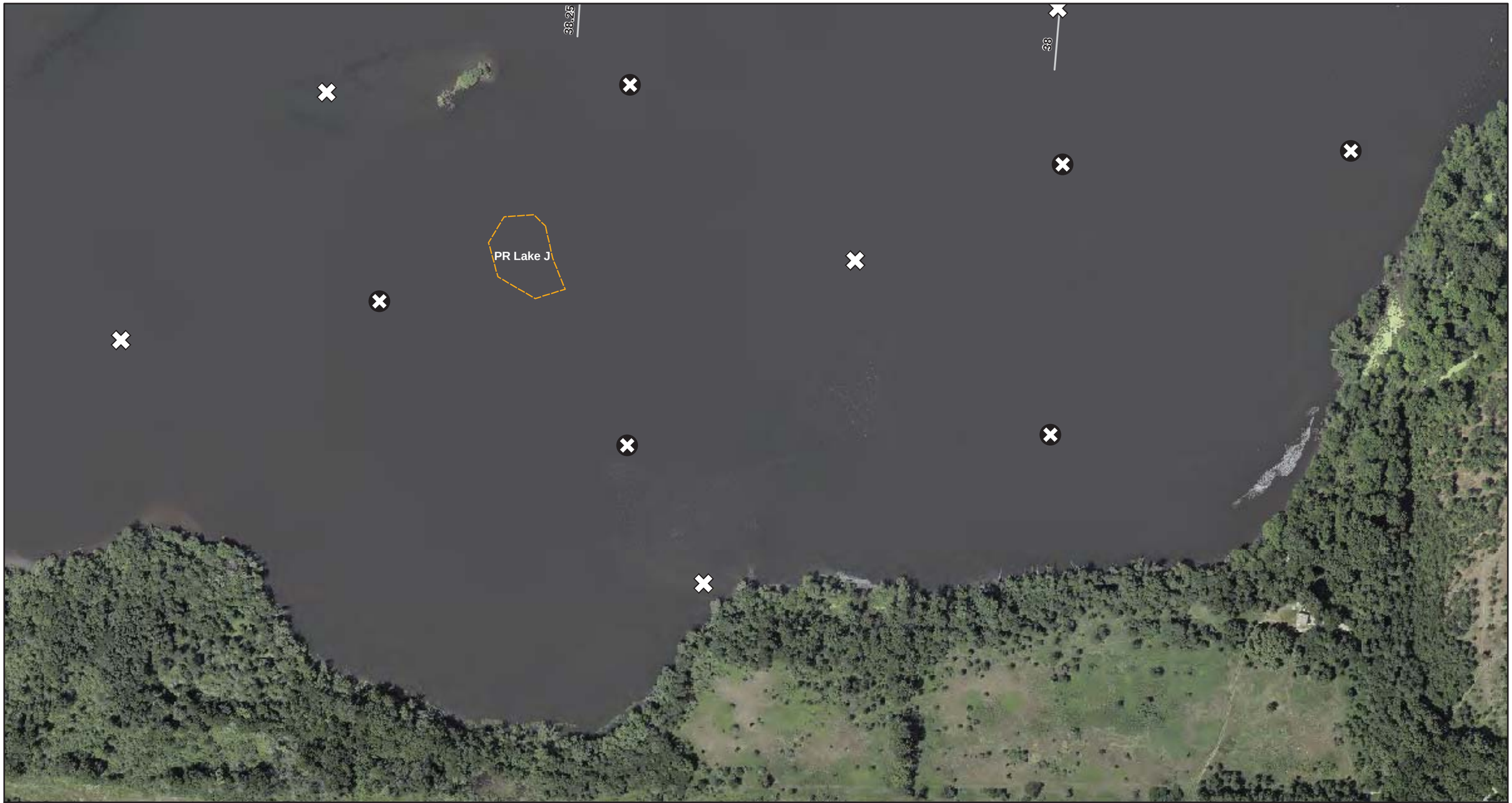
FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 29 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011



ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 30 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Proposed Core Locations

New Core Location

Previous Core Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 4
PROPOSED CORING LOCATIONS

SHEET 31 OF 31

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 4 Proposed Coring Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Walling Suspended Sediment Location

November 2011 Delineation Areas
Heavy
Moderate

Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 5
PROPOSED WALLING SUSPENDED
SEDIMENT LOCATIONS

SHEET 1 OF 7

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 5 Proposed Walling Suspended Sediment Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Walling Suspended Sediment Location

November 2011 Delineation Areas
- Heavy
- Moderate

Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 5
PROPOSED WALLING SUSPENDED SEDIMENT LOCATIONS

SHEET 2 OF 7

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 5 Proposed Walling Suspended Sediment Locations.mxd

Aerial Photography Date: April 2011

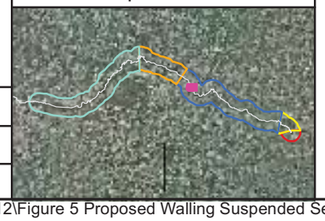
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Walling Suspended Sediment Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 5
PROPOSED WALLING SUSPENDED
SEDIMENT LOCATIONS

SHEET 3 OF 7

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 5 Proposed Walling Suspended Sediment Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location

Legend

Walling Suspended Sediment Location

November 2011 Delineation Areas
- Heavy
- Moderate

Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 5
PROPOSED WALLING SUSPENDED SEDIMENT LOCATIONS

SHEET 4 OF 7

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

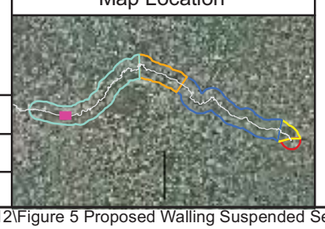
X:\ArcMap Project Files\Work Plan 2012\Figure 5 Proposed Walling Suspended Sediment Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	BRS 12/2/2011
Approved:	DBR 12/2/2011
Project #:	106-4186

Map Location



Legend

Walling Suspended Sediment Location

November 2011 Delineation Areas
- Heavy
- Moderate

Quarter Mile Grid Segment

N

0 125 250 500
Scale in Feet

FIGURE 5
PROPOSED WALLING SUSPENDED SEDIMENT LOCATIONS

SHEET 5 OF 7

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 5 Proposed Walling Suspended Sediment Locations.mxd

Aerial Photography Date: April 2011

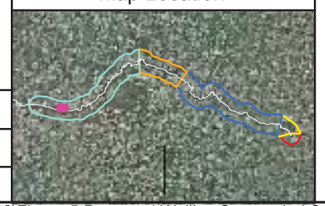
ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location



Legend

Walling Suspended Sediment Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 5
PROPOSED WALLING SUSPENDED SEDIMENT LOCATIONS

SHEET 6 OF 7

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 5 Proposed Walling Suspended Sediment Locations.mxd

Aerial Photography Date: April 2011

ENBRIDGE

Drawn: BRS 12/2/2011

Approved: DBR 12/2/2011

Project #: 106-4186

Map Location

Legend

Walling Suspended Sediment Location

November 2011 Delineation Areas

Heavy

Moderate

Quarter Mile Grid Segment

N

0 125 250 500

Scale in Feet

FIGURE 5
PROPOSED WALLING SUSPENDED
SEDIMENT LOCATIONS

SHEET 7 OF 7

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Work Plan 2012\Figure 5 Proposed Walling Suspended Sediment Locations.mxd

Aerial Photography Date: April 2011

Attachment D

Temperature Effects on Submerged Oil

Table 1. Study Design Summary

Enbridge Line 6B MP 608 Marshall, MI Pipeline Release

Enbridge Energy, Limited Partnership

Target Water Bath Temperature, °F	Number of Sample Replicates
35	3
45	3
55	3
65	3
75	3
Final 75 °F agitation	All sample aliquots (15)

Table 2. Data Collection Parameters

Enbridge Line 6B MP 608 Marshall, MI Pipeline Release

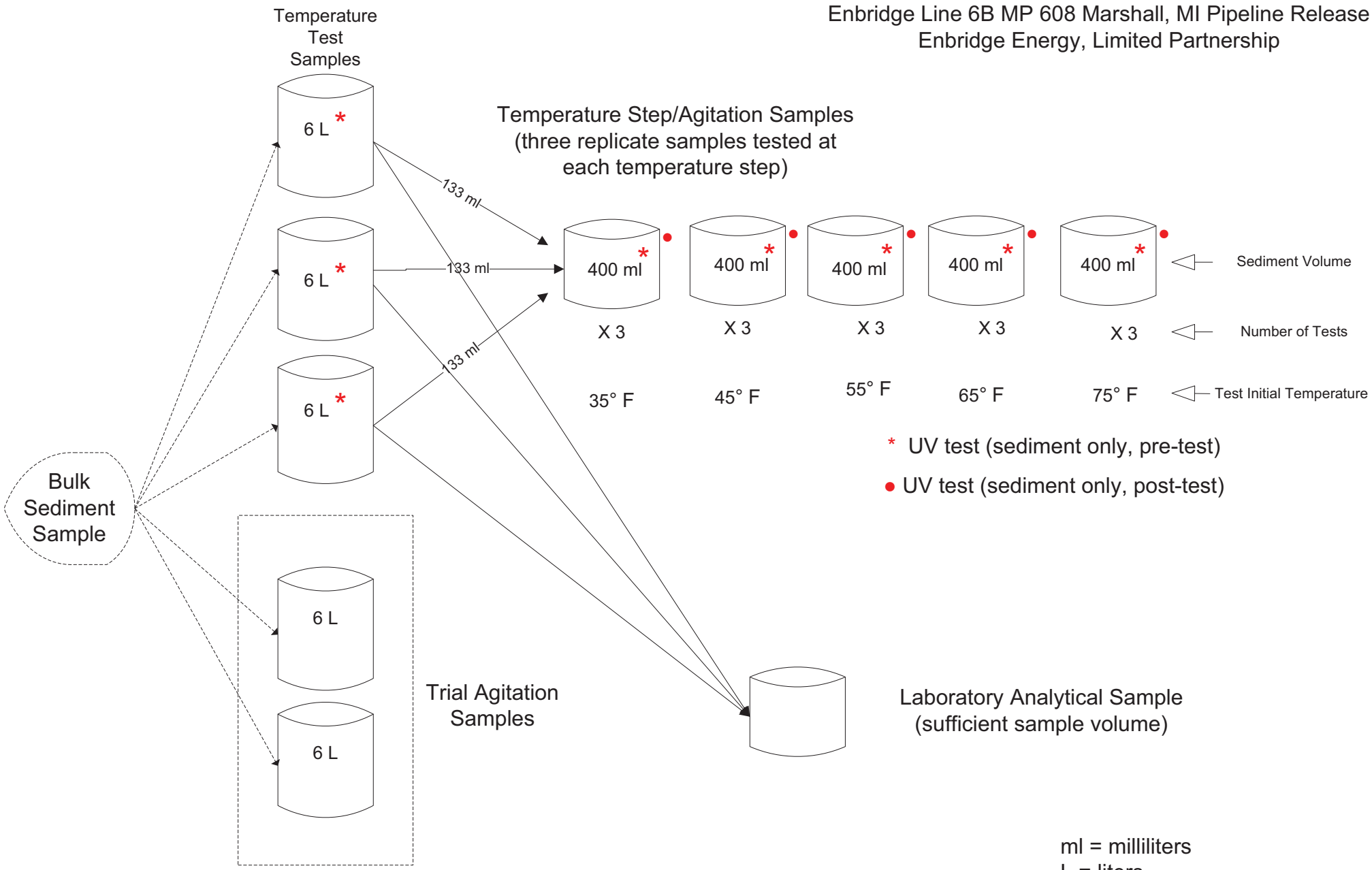
Enbridge Energy, Limited Partnership

Location	Observation period	Appearance and abundance of sheen and oil and photographs		Temperature		Laboratory Analysis	
		Natural Light	Ultraviolet Light	Sediment	Water	Analytical Parameters	Grain Size
Field	Prior to agitation	X	X	X	X	NA	X
	After agitation	X	X	NA	NA	NA	NA
Temperature controlled environment	Prior to agitation	X	X	X	X	X[1]	NA
	After 1 turn, each temperature range	X	X	NA	NA	NA	NA
	After 3 turns, each temperature range	X	X	X	X	NA	NA
Final Warm temperature agitation	Prior to agitation	X	X	X	X	NA	NA
	After 1 turn	X	X	NA	NA	NA	NA
	After 3 turns	X	X	X	X	NA	NA

NA = Not applicable.

[1] Split sample composited from the replicate samples. Analysis to include total petroleum hydrocarbons measured as diesel range organics and oil range organics, and for oil and grease and organic content.

Figure 1: Conceptual Sample Design
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership



Sheet 1 of 1

Attachment E

Overbank Oil Recovery Standard Operating Procedures

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Overbank Oil Recovery Standard Operating Procedures

Prepared for United States Environmental Protection Agency / Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: May 27, 2011

Approved: June 8, 2011

Approved

1.0 INTRODUCTION 1

2.0 SITE SELECTION 1

3.0 OVERBANK OIL RECOVERY PROCEDURES 2

3.1 Mechanical Removal 2

3.2 Vacuum Removal 3

3.3 Organic Sorbent Application 3

Approved

LIST OF ACRONYMS

Enbridge	Enbridge Energy, Limited Partnership
GPS	global positioning system
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MDEQ	Michigan Department of Environmental Quality
SCAT	Shoreline Cleanup Assessment Technique.
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
WTTD	Waste Treatment, Transportation and Disposal Plan

Approved

1.0 INTRODUCTION

The purpose of this Overbank Oil Recovery Standard Operating Procedure (SOP) is to provide general guidance to the ongoing recovery operations of overbank oil resulting from the July 2010 Enbridge Line 6B MP 608 pipeline release in Marshall, Michigan. This SOP addresses overbank oil recovery operations for the sites identified as requiring response activities by Enbridge Energy, Limited Partnership (Enbridge), the United States Environmental Protection Agency (U.S. EPA) and the Michigan Department of Environmental Quality (MDEQ).

This SOP expands upon the approved National Oceanic and Atmospheric Administration (NOAA) Shoreline Cleanup and Assessment Technique (SCAT) Cleanup Recommendations as presented in the September 14, 2010 Kalamazoo River/Enbridge Spill – Cleanup Recommendation Methods. The purpose of this SOP is to remove and recover free oil and oil that is likely to mobilize to the river. Additional investigation and remediation efforts will be conducted at sites identified for oil recovery at a later date and will follow the requirements of the MDEQ consent order.

2.0 SITE SELECTION

The selection of sites for overbank oil recovery using the outlined techniques will be jointly determined by Enbridge, the U.S. EPA, and the MDEQ based on current observed site conditions and the results of the reassessment process. Specific application of one or more of the presented oil recovery procedures will depend upon a number of factors including:

- Site access and logistics;
- Type(s) of remaining oil;
- Ecological setting/sensitivity, and
- Physical setting of the area (wetlands, wood, vegetative cover, etc.).

Overbank locations will be delineated and flagged prior to recovery operations. Areas of concern (i.e. sensitive areas, priority areas, hotspots) will be clearly marked. All boundaries (pre and post removal) will be documented using global positioning survey (GPS) equipment capable of sub-meter accuracy. This information, along with photographs and field notes,

will be recorded. Concurrence of the agencies with the locations delineated will be obtained prior to commencement of operations.

All response activities will be communicated to and coordinated with the U.S. EPA and the MDEQ prior to mobilization. Oil recovery activities will be conducted in a manner that is safe, and that minimizes the potential to contaminate adjacent areas included the migration of contaminants deeper into the soil. Appropriate personal protective equipment (PPE) will be worn and appropriate measures, including decontamination will be developed and implemented to protect un-impacted areas. All generated waste will be safely handled, containerized, transported, and disposed of pursuant to the approved Waste Treatment, Transportation and Disposal Plan (WTTD).

3.0 OVERBANK OIL RECOVERY PROCEDURES

The following approved oil recovery methods are described in the September 14, 2010 Kalamazoo River/Enbridge Spill – Cleanup Recommendation Methods:

- Manual removal (raking, shoveling, hand);
- Vegetation removal;
- Low pressure cold water flushing, and
- Sorbent material (booms, snares).

In addition to the above approved methods, the following techniques are proposed. These may be used as standalone options or in combination:

- Mechanical soil removal;
- Vacuum removal, and
- Organic sorbents.

3.1 Mechanical Soil Removal

The use of small excavators may be employed at sites where the area of a maximum of oil recovery makes manual recovery inefficient. The maximum depth of excavation will not exceed 6 inches. Small excavators will be used to scrap soil and vegetation to remove oil and oil saturated media. Consideration will be given to minimize impact to the site by the excavator during both access and oil recovery. Excavators will avoid wetlands and sensitive

areas. Mats will be used as applicable to minimize disturbance to the soil. Care will be taken to minimize the impact to woody vegetation.

The oily material will be containerized and transport to Frac Tank City for proper characterization and disposal pursuant to the approved WTTD.

3.2 Vacuum Removal

The use of vacuum devices to remove oil and oil saturated media may be employed at sites. Vegetation will be cleared from the area to be vacuumed and oil and oily soil will be collected using a portable vacuum or other suction device. Areas accessible by land may utilize truck mounted vacuum units.

All oiled soil and debris will be double bagged or drummed and transport to Frac Tank City for proper characterization and disposal pursuant to the approved WTTD.

3.3 Organic Sorbent Application

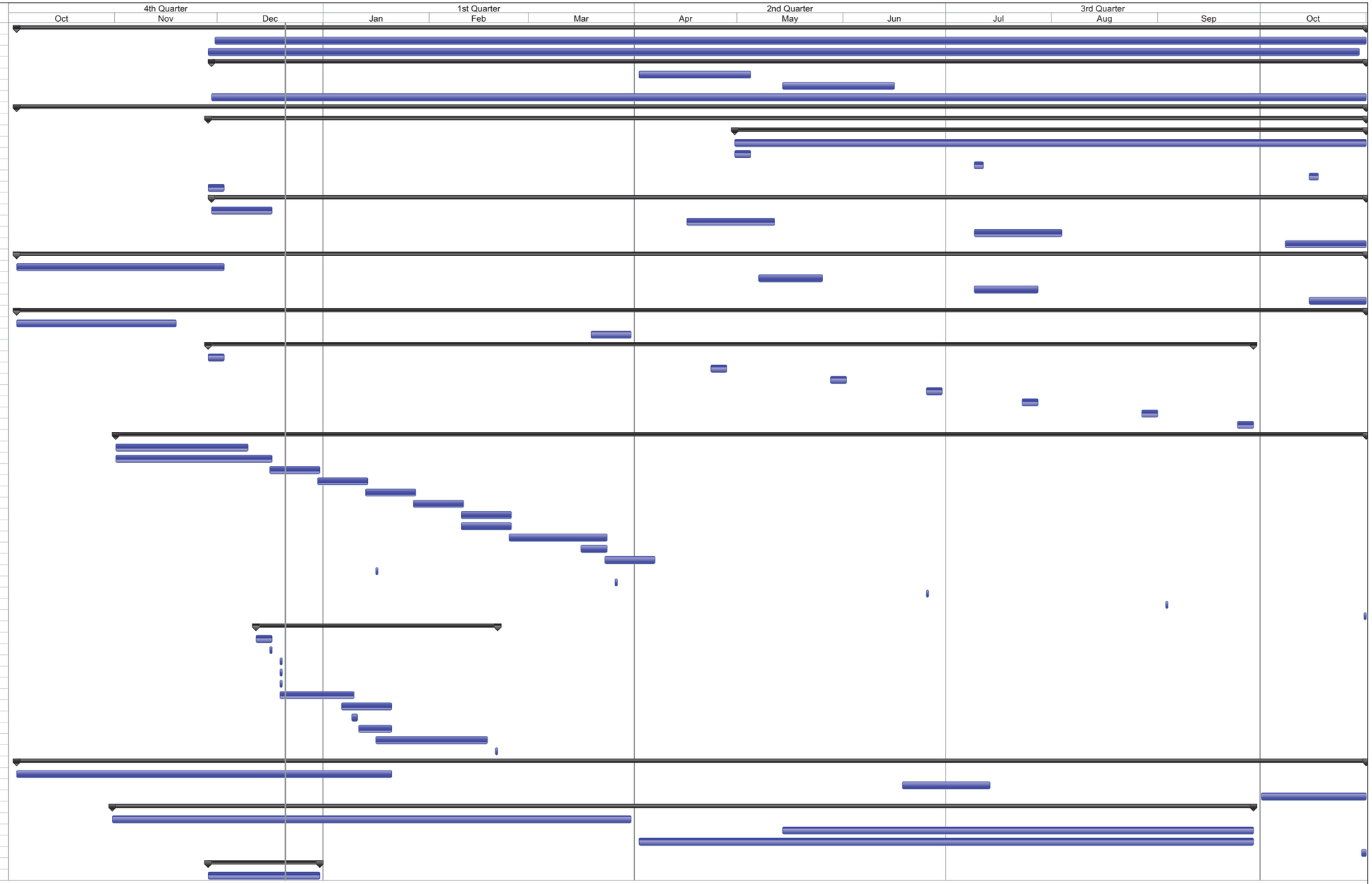
The use of organic oil sorbent material (peat) may be employed at sites to remove free oil. Vegetation will be cleared from around identified location and the selected sorbent will be by applied by hand and gently raked into the oiled areas. The applied sorbent will remain for a minimum of 24 hours for absorption. Following 24 hours, the area will be examined to determine if additional treatment is needed.

All used sorbent will be removed using rakes and/or vacuum and will be double bagged or drummed and transport to Frac Tank City for proper characterization and disposal pursuant to the approved WTTD.

Attachment F

Schedule

ID	Task Name
1	**Consolidated Work**
2	Scientific Support Coordination Group with FOSC
3	OSCAR Process
4	**Reassessment**
5	Spring 2012 Shoreline and Overbank Reassessment
6	Spring 2012 Submerged Oil Reassessment
7	Data Analysis
8	**Submerged Oil Characterization**
9	**Hydrodynamic Assessment**
10	**Morrow Lake Poling**
11	Upstream MLD (During Recovery)
12	Downstream MLD - Seasonal
13	Downstream MLD - Seasonal
14	Downstream MLD - Seasonal
15	Cohesion Erodability Testing
16	**Water Velocity Profiling**
17	Fall 2011
18	Spring 2012
19	Summer 2012
20	Fall 2012
21	**Sediment Characterization Coring/Analyses**
22	Fall 2011
23	Spring 2012
24	Summer 2012
25	Fall 2012
26	**Sediment Transport/Walling Tubes**
27	Set Walling Tubes - Fall 2011
28	Set Walling Tubes - Spring 2012
29	**Inspection & Potential Sampling**
30	Fall 2011
31	April 2012
32	May 2012
33	June 2012
34	July 2012
35	August 2012
36	September 2012
37	**Hydrodynamic Modeling**
38	Bathymetry and Terrain Submittal
39	Grid Setup
40	Configuration for Flow and Velocity
41	Analysis of Sediment Samples and Cohesion Data
42	Complete Configuration including Sediment Processes
43	Model Calibration
44	Preliminary and Baseline Model Scenarios
45	Sensitivity Testing
46	Develop Scenarios/Various Simulations
47	Completion of Simulation
48	Run Modified Scenarios
49	Quarterly Update Report Due
50	Quarterly Update Report Due
51	Quarterly Update Report Due
52	Quarterly Update Report Due
53	Quarterly Update Report Due
54	**Temperature Effects Study**
55	Equipment and Supplies Acquistion and Setup
56	Presentation of Proposed Sediment Sample Locations
57	Sediment Sample Collection
58	Sampling of Sediment for Chemical and Physical Parameters
59	Sample Preparation
60	Sediment Sample Storage and Stabilization
61	Receive and Compile Analytical and Chemical Results
62	Conduct Temperature Test
63	Compile and Evaluate Results
64	Prepare QA/QC Report of Findings
65	Submit Report of Findings to U.S. EPA
66	**equipment and Supplies Acquistion and Setup**
67	Fall 2011
68	Spring 2012 (pre-recovery)
69	Fall 2012 (post-recovery)
70	**Oil Recovery**
71	Winter 2011 SO Recovery Activities
72	Spring/Summer 2012 SO Recovery Activities
73	Shoreline and Overbank Oil Recovery
74	Containment Plan
75	**Passive Sediment Collection**
76	Design & Site Selection



Project: 2012 Project Schedule rev2.mpp
Date: Wed 12/21/11

Task | Summary | Project Summary

Approved

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Sediment Trap Monitoring and Maintenance Plan

Prepared for United States Environmental Protection Agency

Enbridge Energy, Limited Partnership

Originally Submitted: January 27, 2012

Resubmitted: February 27, 2012

Resubmitted: April 25, 2012

Resubmitted: June 14, 2012

Approved: July 10, 2012

Approved

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3.0 Sediment Trap Locations 1

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3.3 MP 10.40 N 3
3.4 MP 10.50 L2 3
3.5 MP 10.75 LDB 3
3.6 MP 14.75 RDB 3
3.7 MP 19.25 LDB 4
3.8 MP 21.50 RDB 4
3.9 MP 26.00 RDB 4
3.10 MP 28.25 RDB 4
3.11 MP 30.80 LDB 5
3.12 MP 33.00 A 5
3.13 MP 33.00 B 5
3.14 MP 36.10 NW 5
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3.16 Delta Z 6
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5.4 Frequency 10

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7.1 Frequency/Triggers for Removal 11

Approved

7.2 Coordination with Maintenance Activities 12

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9.0 References 13

FIGURES

Figure 1 Sediment Trap Details Plan & Section – Typical

Figure 2 Sediment Monitoring Details – Proposed Cylindrical Sampling Device

Figure 3 Potential Active (Structure) Sediment Trap Locations and Proposed Cylindrical Sampling Device Locations

Approved

LIST OF ACRONYMS

ADCP	Acoustic Doppler Current Profiler
ADV	Acoustic Doppler Velocimeter
cfs	cubic feet per second
cm	centimeter
Consolidated Work Plan	*Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to Source Area Response Plan, and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan Commonly referred to as "Consolidated Work Plan from Fall 2011 through Fall 2012"* approved by the U.S. EPA on December 21, 2011
CSD	Cylindrical Sampling Device
GPS – RTK	Global Positioning System – Real Time Kinematic
LDB	Left Descending Bank
MDEQ	Michigan Department of Environmental Quality
MP	Mile Post
RDB	Right Descending Bank
USGS	United States Geological Survey
U.S. EPA	United States Environmental Protection Agency

Approved

1.0 INTRODUCTION

A series of sediment traps located in natural and/or anthropogenic (i.e. Ceresco Dam, Mill Pond, Morrow Lake Delta, and Morrow Lake) depositional areas of the Kalamazoo River are proposed to enhance the natural accumulation of sediment and oiled sediments. These sediment traps will provide locations for the collection and removal of submerged oil and oiled sediments within the affected river system. This plan describes the methods by which designated sediment trap areas will be monitored and maintained, as well as the schedule for installation and eventual removal of sediment trap structures and monitoring devices. Installation, monitoring, maintenance, and removal of the sediment traps will be performed under the direction of the Containment Branch of the Unified Command Operations Section. Remediation activities will be performed by the Submerged Oil Branch as necessary. The organization and responsibilities of the Containment and Submerged Oil Branches are outlined in the *Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to Source Area Response Plan, and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan Commonly referred to as "Consolidated Work Plan from Fall 2011 through Fall 2012"* (Enbridge, 2011) approved by the United States Environmental Protection Agency (U.S. EPA) on December 21, 2011 (Consolidated Work Plan).

2.0 SEDIMENT TRAP STRUCTURES

Sediment traps will consist of the placement of in-channel conifer tree structures to enhance the trapping and settling capabilities of existing depositional areas. Typical sediment trap structures are shown in *Figure 1*. In addition to the sediment trap structures, cylindrical sampling devices (CSDs) will be installed within the geomorphic feature. The CSDs are shown in *Figure 2.*

3.0 SEDIMENT TRAP LOCATIONS

Sediment trap structures will be installed in the Kalamazoo River between the confluence with Talmadge Creek and the Morrow Lake Dam. The proposed locations have been selected to represent a wide range of depositional areas within the Kalamazoo River

including: impounded areas, side channels, oxbows, areas of channel width increase, backwaters, and downstream of point bars. Strategic locations within the geomorphic features were selected for sediment trap structures to enhance sediment deposition and subsequent potential submerged oil accumulation based on the locations of 'heavy' and 'moderate' poling locations identified during 2011 poling activities. In addition, the locations were chosen based on site-specific criteria such as: flow characteristics within or around the geomorphic feature, the natural deposition of soft sediment, the depth of water within each feature, and 2011 poling results within the geomorphic features.

In consultation with the U.S. EPA and United States Geological Survey (USGS), 17 initial locations have been selected as possible sites for sediment trap structure placement. Final site selection among these 17 locations will be based upon the results of hydraulic calculations in addition to 2-dimensional hydrodynamic modeling of four representative flow scenarios. These proposed sites are shown in *Figure 3*. Other locations may be considered as possible sites for sediment trap structure placement based on on-going site assessment and hydrodynamic modeling results. Alternate locations for sediment trap structures within the geomorphic features may be considered depending on sedimentation rates determined by the hydrodynamic modeling results and site specific observations. Adjusting the location of previously permitted sediment structures within a geomorphic feature would require a new model run to determine the additional backwater effects of the proposed location and a minor revision to the existing MDEQ permit for the subject location. In the event a sediment structure is proposed for a geomorphic feature that has not been previously permitted by MDEQ, modeling to determine the backwater effects would be required, with the subsequent submittal of a new MDEQ permit application for the newly proposed locations. The following descriptions are provided for the 17 sites currently being evaluated for sediment trap structure placement.

3.1 MP 3.25 R1

Mile Post (MP) 3.25 R1 is a side channel located upstream of the impounded area upstream from Ceresco Dam that was excavated during Winter 2010-2011. This area did not accumulate heavy or moderate submerged oil in Spring or Fall 2011, although it remains a meaningful location for monitoring the potential for sediment and submerged oil deposition within side channel areas between Talmadge Creek and Ceresco Dam.

3.2 Ceresco

Ceresco is an impounded area located immediately upstream of Ceresco Dam that has been identified as a location of submerged oil accumulation. The Ceresco Dam area is an anthropogenic depositional area due to the decreased flow into the impounded area. Therefore, this area is subject to ongoing deposition, particularly in areas previously excavated during Fall 2010.

3.3 MP 10.40 N

MP 10.40 N is a backwater area located downstream of a point bar that indicated heavy submerged oil in both Spring and late Summer 2011. This area is located near a highly sinuous section of the river located approximately from MP 10.00 to MP 13.75.

3.4 MP 10.50 L2

MP 10.50 L2 is a backwater area that indicated heavy submerged oil in Fall 2010 and was subsequently excavated during Winter 2010-2011. This area accumulated new soft sediment including heavy submerged oil in Spring 2011. Additional sediment storage capacity is available at this location due to the previous excavation activities.

3.5 MP 10.75 LDB

MP 10.75 left descending bank (LDB) is a side channel at high water levels. During low water levels, it is open to the river at the downstream end (the upstream end being blocked by a sand bar deposit). This area has indicated heavy submerged oil accumulation since late Fall 2010 and was excavated during Winter 2010-2011. Poling in Spring and Fall 2011 indicated recent deposition.

3.6 MP 14.75 RDB

MP 14.75 right descending bank (RDB) is a side channel located within the impounded area upstream of the Mill Pond. The area is readily accessible and located outside the main channel; therefore, subject to ongoing deposition. This area indicated heavy submerged oil in Fall 2010, Spring 2011, and late Summer 2011.

3.7 MP 19.25 LDB

MP 19.25 LDB is a side channel that during periods of low water levels remains submerged; however, water does not flow through. This side channel indicated heavy submerged oil in Fall 2010, Spring 2011, and late Summer 2011. The area was excavated during Winter 2010-2011 and has since indicated the accumulation of soft sediment and submerged oil, particularly at the upstream and downstream ends.

3.8 MP 21.50 RDB

MP 21.50 RDB is an oxbow that has been an area of submerged oil accumulation located between the concrete channel in Battle Creek and the 35th Street Bridge, near Galesburg. The area was formerly the main channel of the Kalamazoo River, prior to the Kalamazoo River Diversion Project of 1960-1962 (Ashley, Martin & Thornton, Kurt, 2005). Excavation activities during Summer 2011 has increased its sediment storage capacity at this location. This oxbow is located immediately upstream of the transition from the low-gradient engineered channel to the higher-gradient naturally meandering river course. The initial sediment trap structure configuration considered for this location would be oriented parallel to overbank flood flows across the mouth of the oxbow at the downstream end where the oxbow reconnects to the main river channel.

3.9 MP 26.00 RDB

MP 26.00 RDB is a backwater area located at the downstream end of a point bar. This area contained submerged oil accumulation in Fall 2010 and in Spring 2011. The presence of extensive mudflats at low water levels indicates that this area accumulates soft sediment.

3.10 MP 28.25 RDB

MP 28.25 RDB is an oxbow that provides sediment storage. It has indicated heavy submerged oil in Fall 2010, Spring 2011, and late Summer 2011. Placement of a sediment trap structure would increase storage capacity and reduce sediment remobilization during high water flow events.

3.11 MP 30.80 LDB

MP 30.80 LDB is an extensive backwater area located at the downstream end of a point bar that was the site of submerged oil recovery work during 2011. Based upon the site history and geomorphic setting, this is an area of sediment deposition.

3.12 MP 33.00 A

MP 33.00 A is a complex area of channel widening located at the downstream end of a point bar. It includes backwater areas that may channel preferential flow during flood events. This area indicated heavy submerged oil accumulation during Fall 2010 and in Spring 2011. Due to the complex geomorphology of this area, hydraulic calculations to estimate the effectiveness of trapping and settling are not possible; therefore, selection of this area will be based upon 2-dimensional hydrodynamic modeling.

3.13 MP 33.00 B

MP 33.00 B is a backwater area located on the downstream side of a point bar where the channel widens. The area indicated heavy submerged oil accumulation in Fall 2010 and in Spring 2011 and is a known depositional area.

3.14 MP 36.10 NW

MP 36.10 NW is a side channel located at the upstream end of the Morrow Lake Dam impounded area. The area is considered a significant capture point for sediment and submerged oil deposition. There is a small channel at the upstream side that is connected to the river.

3.15 Delta A

Delta A is located furthest upstream of the delta's distributaries at the entrance to the Morrow Lake Delta. Delta A is a deposition area and was one of the original delta priority areas in Fall 2010. The area is considered important for monitoring sediment and/or submerged oil migration.

3.16 Delta Z

Delta Z was the most extensive surface area of heavy submerged oil in the Morrow Lake Delta in both 2010 and 2011. It is located at the downstream end of the delta's many distributary channels, where areas of confined flow between vegetated islands enter an area of more extensive open water.

3.17 MP 37.75 Islands

MP 37.75 Islands is the last depositional area prior to entering Morrow Lake. It is a shallow water area located south of the deeper main channel. The protection provided by the islands slows water velocities and encourages sediment deposition at this location.

4.0 INSTALLATION

The schedule and placement of sediment trap structures and the CSDs along with an initial site survey will be determined in coordination with U.S. EPA, Michigan Department of Environmental Quality (MDEQ), and USGS personnel.

4.1 Schedule

Installation of sediment trap structures and monitoring devices will occur in Spring 2012 following review of hydraulic calculations and 2-dimensional hydrodynamic modeling of proposed structure placements. The installation schedule will take place following approval of MDEQ permits. Additional considerations with regard to schedule include high water levels. If water levels rise prior to completion of the installation, work will be suspended until water levels recede to safe working conditions.

4.2 Site Survey

At each sediment trap structure location, initial monitoring measurements will be conducted prior to the installation of the sediment trap and a post installation survey will be conducted once the sediment trap structure has been installed. The initial monitoring survey will serve as a base line for future monitoring events. The initial monitoring survey and post installation survey will include detailed field mapping of three to five cross sections dependant on the size of the geomorphic features, which will consist of:

- Measuring channel width,
- Measuring channel length,
- Measuring depth of water,
- Measuring soft sediment thickness,
- Measuring depth to hard bottom,
- Classification of the geomorphic setting,
- GPS the location of the sediment trap structure,
- Measuring the length, width, and height of the structures and the depth below the water surface,
- Measuring and recording the number, size and species of trees installed, and
- Measuring flow velocities within the geomorphic setting pre- and post-installation.

The spatial extent for the three to five cross-sections will be determined by using the hydrodynamic model grid cells used to model sedimentation rates for each geomorphic feature. The locations of the cross-sections will be targeted towards grid cells that exhibited the greatest amount of sediment deposition. At each of the cross-sections, the bathymetry will be measured with a Geographic Positioning System – Real Time Kinematic (GPS-RTK) or equivalent unit to gather vertical (1 centimeter (cm) accuracy) and horizontal (2 cm accuracy) coordinates from bankfull to bankfull, with a minimum of 25 survey points, no greater than four feet apart, and identify slope breaks with 3 survey points per break within the geomorphic features. The data collected at each survey point will include the above mentioned criteria (depth of water, soft sediment thickness, and depth to hard bottom).

Flow velocity measurements will be conducted at five to eight locations along each of the cross-sections used for collecting bathymetry data. The flow velocity measurements will be conducted with an Acoustic Doppler Current Profiler (ADCP) or an Acoustic Doppler Velocimeter (ADV) as mentioned in the Consolidated Work Plan.

In coordination with U.S. EPA and USGS, the location of the sediment trap structure within the geomorphic feature will be determined based on the initial site survey, historic poling results, and hydrodynamic modeling results.

During the initial site survey and subsequent monitoring events, poling activities will occur when water and sediment temperatures reach or exceed the minimum approved temperature. Poling will be conducted at five to eight locations along the initial site survey

cross-sections by using a GPS-RTK unit to gather horizontal and vertical coordinates at the same poling locations within each feature during monitoring events. In an attempt to understand sedimentation rates, each geomorphic feature, depending on size, will have a minimum of five CSDs to collect sediment and oiled sediments as detailed in *Figure 2*. Larger geomorphic features will have 6 to 10 CSDs placed within their feature. The locations of the CSDs will be as follows, and is shown in *Figure 3*:

- One approximately 15 feet downstream of the structures within geomorphic features, which will be put in place one to two days after installation of the sediment trap structure,
- One approximately 15 feet upstream of the structures within geomorphic features, and
- The remaining samplers will be placed within the geomorphic feature targeting hydrodynamic model grid cells exhibiting the highest potential for sediment deposition.

5.0 MONITORING

Monitoring of the sediment trap sites will be performed on a regular schedule. The monitoring objectives are as follows:

- Determine the effectiveness of the sediment traps at each site,
- Document the performance of the sediment traps through quarterly bathymetry and flow velocity measurements,
- Check the site for submerged oil accumulation via poling or additional sample collection if temperatures are not at or above the minimum approved temperature of 60º Fahrenheit,
- Collect the sediment and oiled sediment from the CSDs and submit for analytical results when a sufficient volume is obtained,
- Analyze sediment samples according to *Section 4.2.5 Sediment Transport* of the Consolidated Work Plan. Additional analyses will be prioritized and conducted according to the "*Spring 2012 Analytical Chemistry Prioritization for Low Sample Volume Samples"* dated May 19, 2012 (U.S. EPA, 2012),
- Check the temperature of the water and sediment,
- Monitor the integrity of the sediment traps during routine site visits,

- Determine if maintenance is necessary to preserve oiled sediment trapping ability, and
- Determine if remediation is necessary to remove accumulated sediment and submerged oil.

Monitoring will be conducted once every two weeks for the first month and on a monthly basis thereafter. Each monitoring event will be documented and provided in the monthly report, which is submitted to U.S. EPA and MDEQ on the 27th of every month. Any and all geographic information system data can be provided upon request. Monitoring and maintenance of the sediment trap structures and/or sites will be performed under the direction of the Containment Branch.

5.1 Poling

Poling within the spatial extent of the sediment trap structure locations will be conducted to determine:

- The deposition of submerged oil,
- The thickness of soft sediment,
- The cross-sectional area of the sediment trap structure above the river bed, and
- The horizontal and vertical coordinates of the poling locations.

Poling will be conducted at five to eight locations along all of the initial site survey cross-sections from a shallow-draft water craft. During each monitoring event poling will be repeated at the five to eight poling locations within each geomorphic feature to characterize submerged oil.

5.2 Cylindrical Sampling Devices

There will be a minimum of five CSDs placed within the geomorphic features. Dependant on the size of the geomorphic features and the depositional rates determined by the grid cells of the hydrodynamic model, 6 to 10 additional CSDs placed within the sediment traps. During monitoring events, the CSDs will be sampled according to the following procedures:

- CSDs will be removed from the sediment trap from downstream to upstream to not disturb additional CSDs,

- Remove and make visual observations to determine if there is sufficient volume of sediment to sample,
- Photograph, measure, and record the volume of sediment within the sample jars,
- In the event that there is enough volume of sediment for analytical analysis, replace the jars with empty jars,
- Conduct poling activities at the above specified locations within the geomorphic feature, and
- Once all jars have been either collected and/or observed the CSDs will be repositioned in the sediment trap from upstream to downstream.

5.3 Repeat Bathymetry and Flow Velocity Measurements

The bathymetry and flow velocity measurements will be conducted within the geomorphic feature on a quarterly basis after the initial site survey. The purpose of the quarterly bathymetry and flow velocity measurements is to determine a sedimentation rate and identify spatial variation of sediment deposition within the geomorphic features. These measurements will be conducted at the same locations and follow the same procedures as the initial site survey.

5.4 Frequency

Monitoring frequency for observation and possible sampling of the CSDs will be every two weeks for the first month and then monthly thereafter. Poling activities will be conducted on a monthly basis following the initial site survey. Monitoring for all activities will also be performed following storm events when flows exceed 2,000 cubic feet per second (cfs), as measured at the USGS Battle Creek gage. A flow rate of 2,000 cfs was selected based upon a review of the historic flow rates of the past eight seasons provided by the USGS Battle Creek gage station. According to the gage station, a flow rate of 2,000 cfs is achieved approximately one to four times in any given season.

6.0 MAINTENANCE

Maintenance of the structures will be directed by the Containment Branch as needed following review of data collected during monitoring activities. Maintenance activities may include repair of structures, movement of structures, replacement of structures, or removal

of trapped sediment. Removal of trapped sediment, when applicable, will be considered when monitoring data suggests that the trap has reached its effective capacity. The effective capacity will be defined as a 50% reduction in the cross-sectional area of the sediment trap structure based on the initial site survey. Need for repair, movement, or replacement of structures will be based on routine site visits, the monitoring data collected during site monitoring checks, and following high flow events of 2,000 cfs or greater.

Prior to the initiation of site maintenance, siltation barriers will be installed downstream of each trap location to contain suspended sediment material mobilized through completion of the proposed maintenance activity. Siltation barriers will be designed to handle the sediment type, load, water depth, and flow conditions of each sediment trap location, and will be maintained in good working order throughout the duration of the maintenance effort.

7.0 REMOVAL OF SUBMERGED OIL

Removal of submerged oil from the sediment trap locations will be based on a review of data collected during monitoring events. Removal will be conducted under the direction of the Submerged Oil Branch using approved Operations and Maintenance 'toolbox' methods. Once a trigger has been identified within a geomorphic feature, a site specific plan will be developed at that time. All removal/recovery activities will be conducted in accordance with additional methods mentioned in the *Kalamazoo River – Subsurface Sediment Structures (14 Sites) – MEDQ Permit Application Submittal to Conduct Proposed Kalamazoo River Response Actions pursuant to Parts 31, 301, and 303 of NREPA,* (Enbridge, 2012).

7.1 Frequency/Triggers for Removal

Removal of submerged oil will be performed as necessary based on a review of the submerged oil poling data collected during monitoring. Removal activities will be conducted in consultation with U.S. EPA and USGS. The data review will incorporate both the extent and quantity of submerged oil, and the trend in the extent of submerged oil measured over time. Toolbox remediation will not occur in areas where 'none' or 'light' submerged oil is identified. Toolbox remediation will be initiated when poling results show 'moderate' and 'heavy' submerged oil has been identified over at least 50% of the sediment trap area as directed by U.S. EPA. Toolbox remediation will be initiated as necessaryto prevent the downstream migration of submerged oil.

Prior to the initiation of the removal of oiled sediments, siltation barriers will be installed downstream of each trap location to contain suspended sediment material mobilized through completion of the proposed maintenance activity. Siltation barriers will be designed to handle the sediment type, load, water depth, and flow conditions of each sediment trap location, and will be maintained in good working order throughout the duration of the maintenance effort.

7.2 Coordination with Maintenance Activities

Submerged oil remediation activities will be coordinated with sediment trap maintenance, if practical, to provide more efficient implementation of toolbox techniques and containment of submerged oil.

8.0 REMOVAL

Sediment trap structure and CSD removal will require prior approval from U.S. EPA, USGS, and MDEQ. Removal of the sediment trap structures and CSDs will occur prior to the river freezing unless it is determined that the structures can safely remain in place through the winter. The removal of the sediment trap structures and the CSDs will be coordinated with U.S. EPA, MDEQ, and USGS in accordance with the specifications mentioned in the *Kalamazoo River – Subsurface Sediment Structures (14 Sites) – MEDQ Permit Application Submittal to Conduct Proposed Kalamazoo River Response Actions pursuant to Parts 31, 301, and 303 of NREPA,* (Enbridge, 2012). All submerged oil assessment, removal, and/or recovery activities will be completed prior to the removal of the sediment trap structures and the CSDs in coordination with the U.S. EPA and MDEQ.

Prior to the initiation of the removal of any sediment trap structures and CSDs, siltation barriers will be installed downstream of each trap location to contain suspended sediment material mobilized through completion of the proposed maintenance activity. Siltation barriers will be designed to handle the sediment type, load, water depth, and flow conditions of each sediment trap location, and will be maintained in good working order throughout the duration of the maintenance effort.

Approved

9.0 REFERENCES

Ashley, Martin & Thornton, Kurt, 2005. *Then & Now: Battle Creek*. Charleston, South Carolina, Arcadia Publishing.

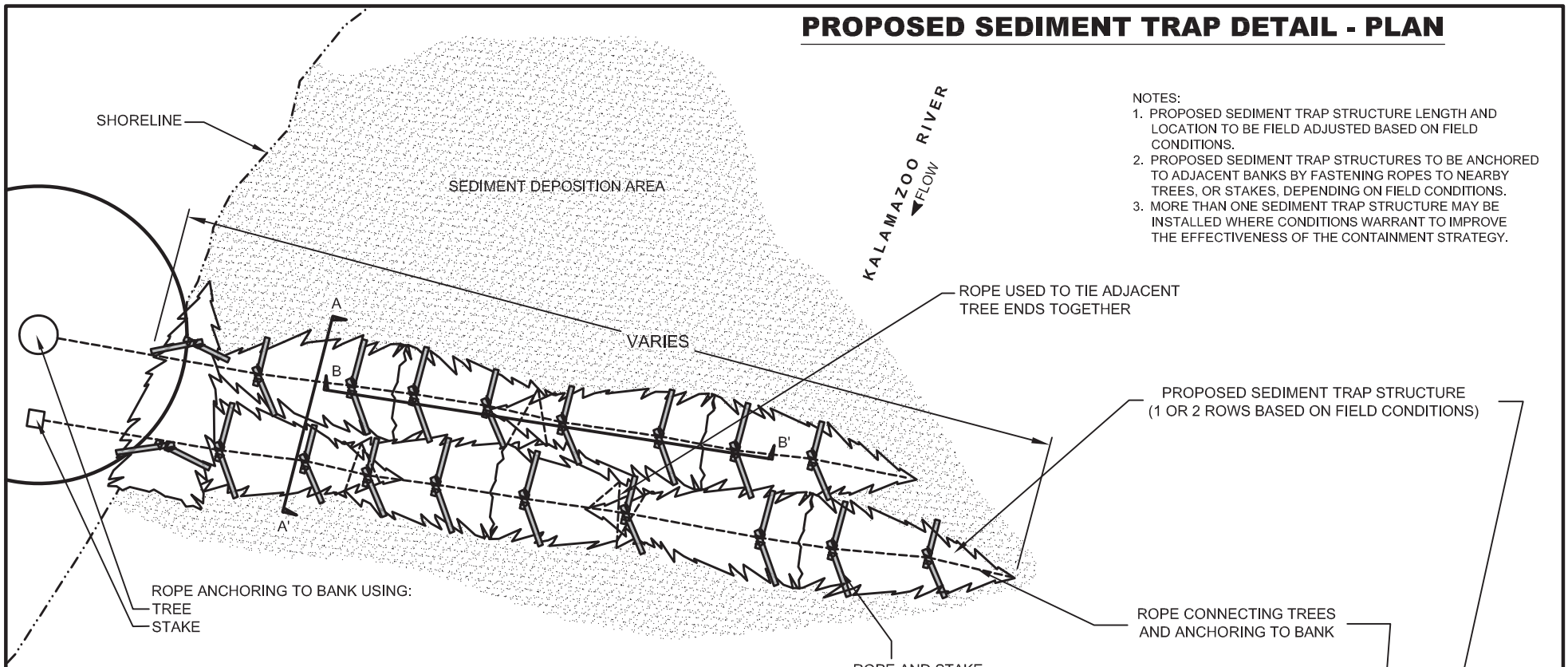
Enbridge, 2011. Enbridge Line 6B Pipeline Release, Marshall, Michigan; *Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to Source Area Response Plan, and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan Commonly referred to as "Consolidated Work Plan from Fall 2011 through Fall 2012".* December 21, 2011.

Enbridge, 2012. "Enbridge Line 6B Pipeline Release, Marshall, Michigan: *Kalamazoo River – Subsurface Sediment Structures (14 Sites) – MEDQ Permit Application Submittal to Conduct Proposed Kalamazoo River Response Actions pursuant to Parts 31, 301, and 303 of NREPA."*

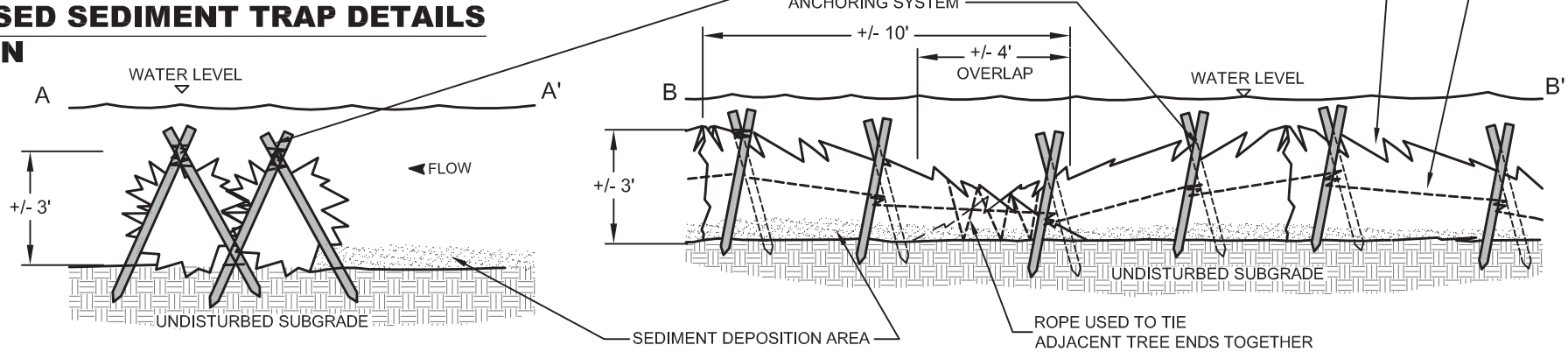
Figures

PROPOSED SEDIMENT TRAP DETAIL - PLAN

NOTES:
1. PROPOSED SEDIMENT TRAP STRUCTURE LENGTH AND LOCATION TO BE FIELD ADJUSTED BASED ON FIELD CONDITIONS.
2. PROPOSED SEDIMENT TRAP STRUCTURES TO BE ANCHORED TO ADJACENT BANKS BY FASTENING ROPES TO NEARBY TREES, OR STAKES, DEPENDING ON FIELD CONDITIONS.
3. MORE THAN ONE SEDIMENT TRAP STRUCTURE MAY BE INSTALLED WHERE CONDITIONS WARRANT TO IMPROVE THE EFFECTIVENESS OF THE CONTAINMENT STRATEGY.



PROPOSED SEDIMENT TRAP DETAILS SECTION



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Drawn: WL 04/23/2012
Approved: MZ 04/23/2012
Project #: 1008114.00

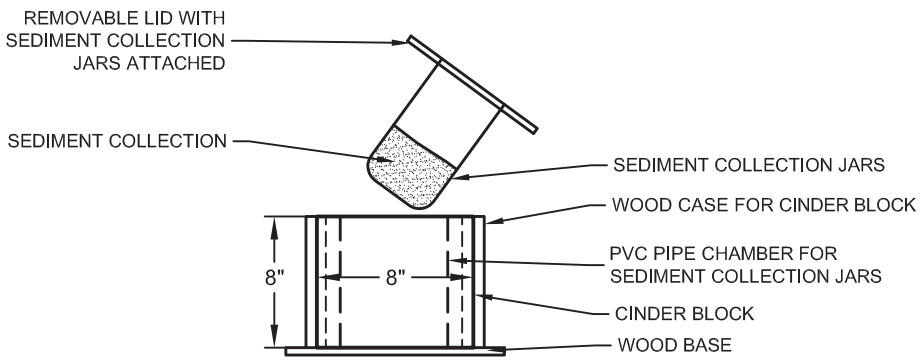
MAP LOCATION

LEGEND
SHORELINE
PROPOSED SEDIMENT DEPOSITION

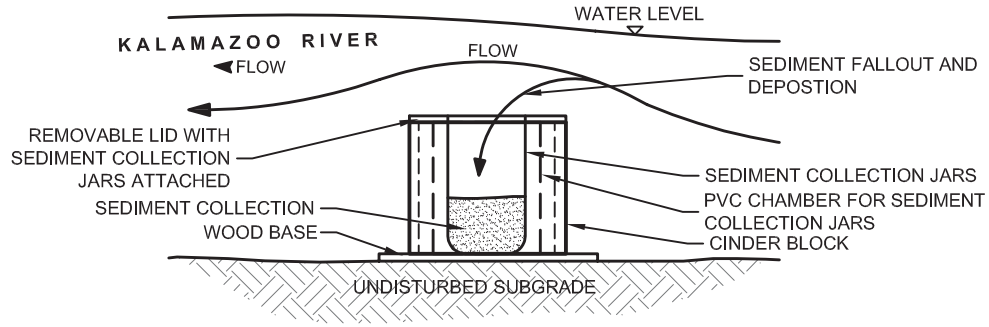
N
NOT TO SCALE

FIGURE 1
SEDIMENT TRAP DETAILS
PLAN AND SECTION - TYPICAL
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHI P

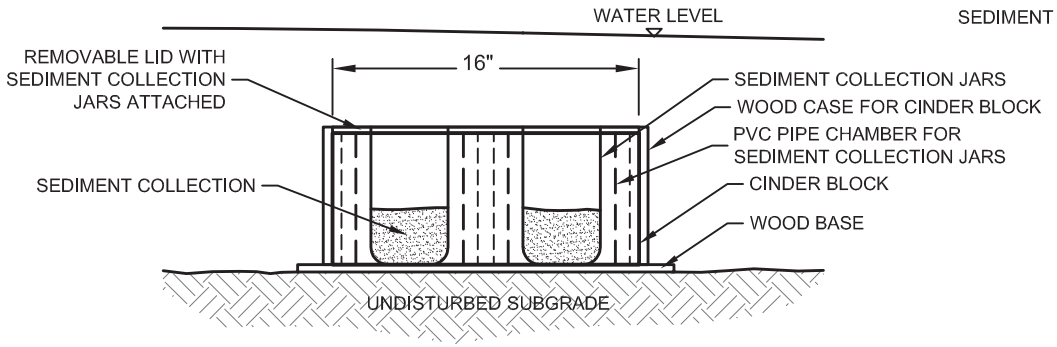
PROPOSED CYLINDRICAL SAMPLING DEVICE DETAIL



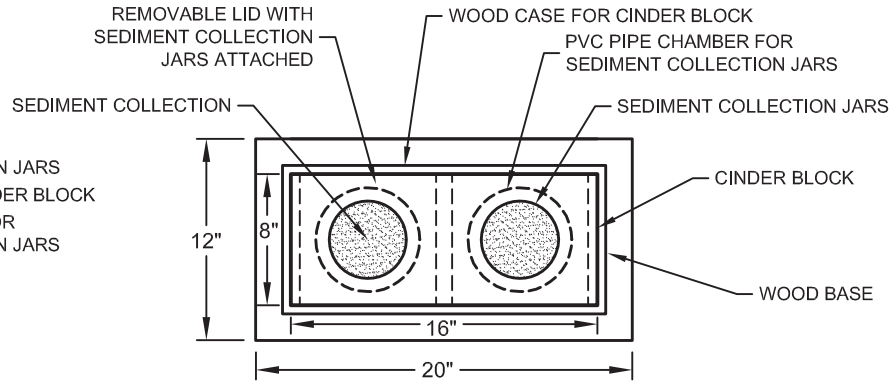
SEDIMENT MONITORING DETAIL



VIEW LOOKING PERPENDICULAR TO STREAM FLOW



VIEW LOOKING DOWNSTREAM



VIEW FROM ABOVE

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Drawn: WL 05/10/2012

Approved: MZ 05/10/2012

Project #: 1008114.00

MAP LOCATION

LEGEND

PROPOSED SEDIMENT COLLECTION

N

NOT TO SCALE

FIGURE 2
SEDIMENT MONITORING DETAILS
PROPOSED CYLINDRICAL SAMPLING DEVICE
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHI P

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 40 80 160
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
3.25 R1
SHEET: 1 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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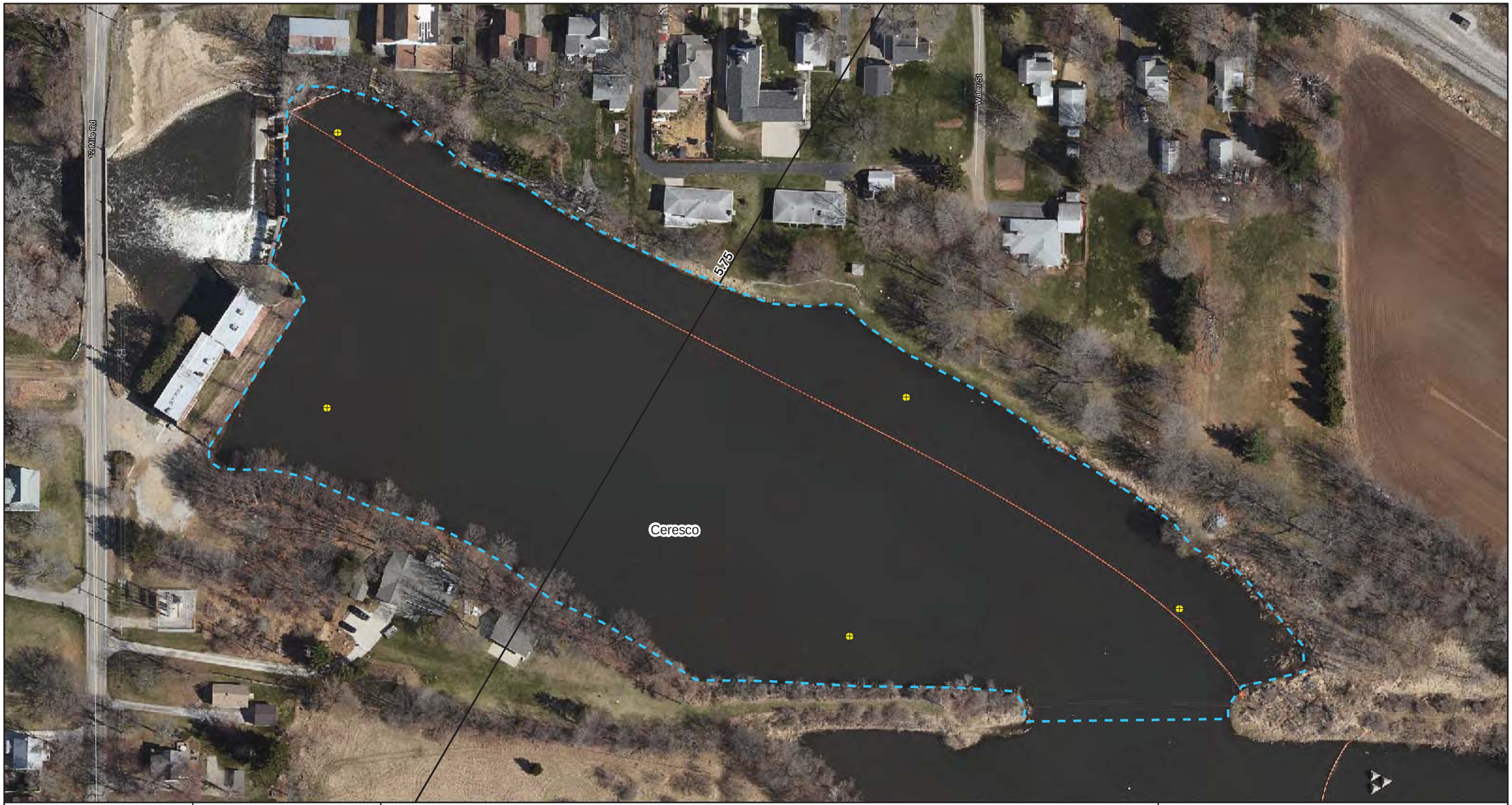
Aerial Photography Date: April 2011



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Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

- Proposed Cylindrical Sampling Device
- Sediment Trap Area
- Potential Containment Structures
- Quarter Mile Grid Segments

N

0 50 100 200
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
CERESCO
SHEET: 2 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
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Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 25 50 100
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
10.40 N
SHEET: 3 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

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Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 25 50 100
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
10.50 L2
SHEET: 4 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

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Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 25 50 100
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
10.75 LDB
SHEET: 5 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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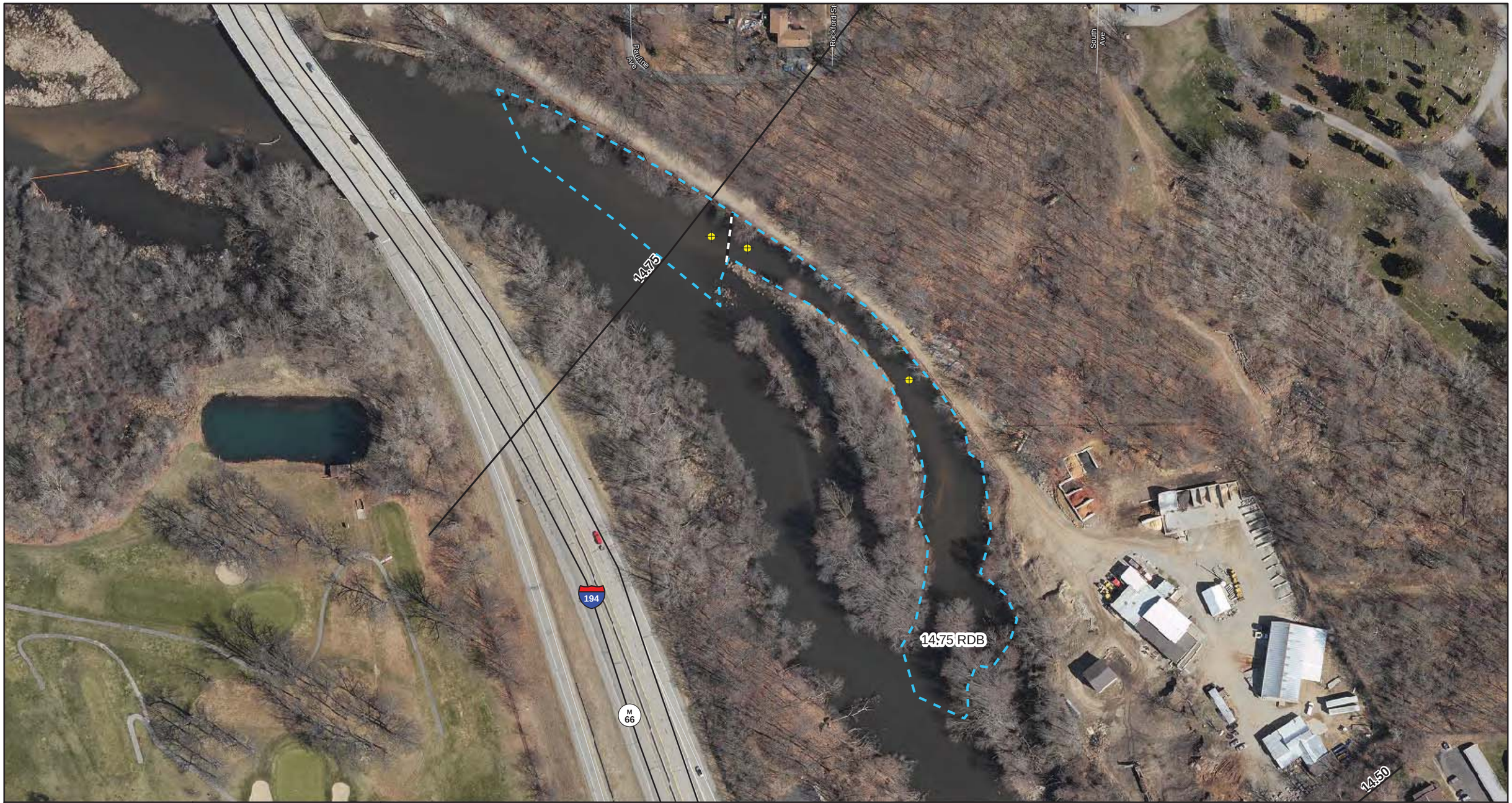
Aerial Photography Date: April 2011



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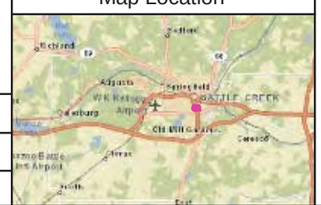
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location



Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 70 140 280
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
14.75 RDB
SHEET: 6 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

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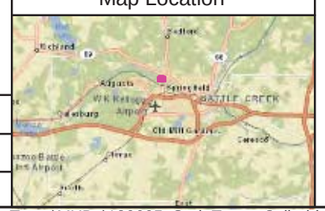
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location



Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 70 140 280
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
19.25 LDB
SHEET: 7 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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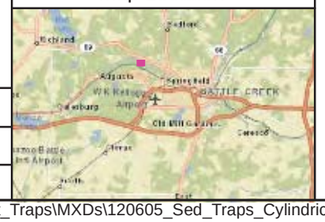
Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location



Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 50 100 200
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
21.50 RDB
SHEET: 8 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 50 100 200
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
26.00 RDB
SHEET: 9 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 50 100 200
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
28.25 RDB
SHEET: 10 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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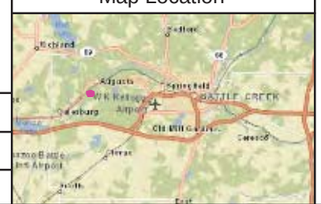
Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location



Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 50 100 200
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
30.80 LDB
SHEET: 11 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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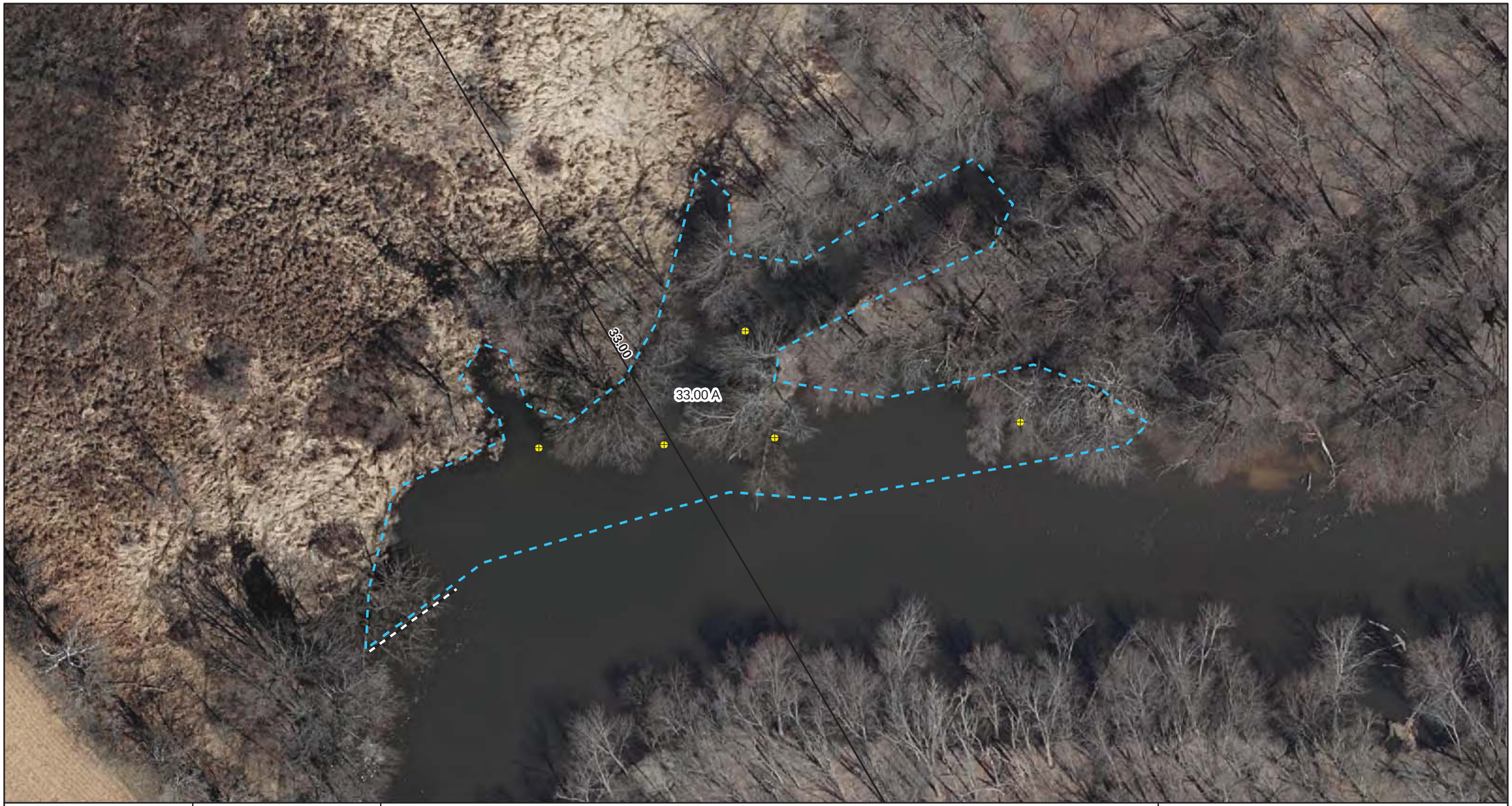
Aerial Photography Date: April 2011



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Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 25 50 100
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
33.00 A
SHEET: 12 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 40 80 160
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
33.00 B
SHEET: 13 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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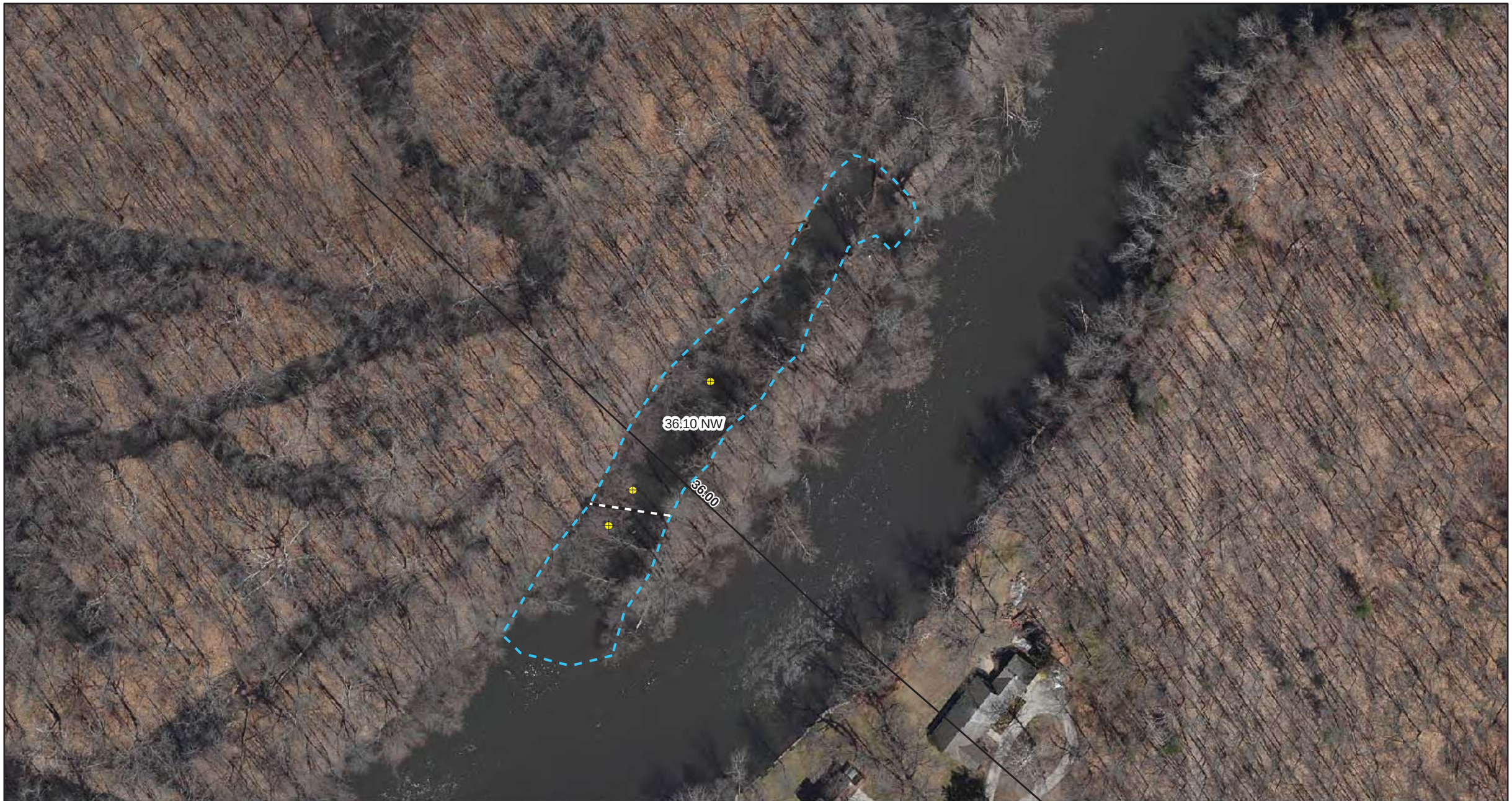
Aerial Photography Date: April 2011



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Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 40 80 160
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
36.10 NW
SHEET: 14 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 50 100 200
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
DELTA A
SHEET: 15 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location

Proposed Cylindrical Sampling Device

Sediment Trap Area

Potential Containment Structures

Quarter Mile Grid Segments

N

0 70 140 280

Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
DELTA Z
SHEET: 16 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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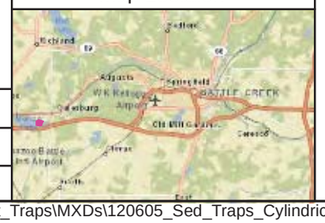
Aerial Photography Date: April 2011

ENBRIDGE

Drawn:	GM	6/5/2012
Approved:	EE	6/5/2012
Project #:	60246209	

Map Location



Proposed Cylindrical Sampling Device
Sediment Trap Area
Potential Containment Structures
Quarter Mile Grid Segments

N

0 40 80 160
Scale in Feet

FIGURE 3
POTENTIAL ACTIVE (STRUCTURE) SEDIMENT TRAP LOCATIONS AND PROPOSED CYLINDRICAL SAMPLING DEVICE LOCATIONS
37.75 ISLANDS
SHEET: 17 OF 17
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Z:\Work\GIS\Submerged_Oil\Sediment_Traps\MXDs\120605_Sed_Traps_Cylindrical.mxd

Aerial Photography Date: April 2011

Approval Pending

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Sediment Poling Standard Operating Procedure

Prepared for United States Environmental Protection Agency

Enbridge Energy, Limited Partnership

Submitted: May 11, 2012

1.0 SCOPE AND METHOD SUMMARY 1

2.0 PERSONNEL QUALIFICATIONS 1

3.0 HEALTH AND SAFETY 2

4.0 INTERFERENCES 2

5.0 EQUIPMENT AND SUPPLIES 2

6.0 METHODS 3

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7.0 DATA AND RECORDS MANAGEMENT 4

8.0 REFERENCES 5

FIGURE

Figure 1 Submerged Oil Field Observation Flowchart

LIST OF ACRONYMS

GPS	Global Positioning System
HASP	Health and Safety Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for conducting poling of sediments. For the purposes of this SOP, sediment is defined as soil, sand, silt, clay, organic matter, or other materials that accumulate on the bottom of a water body (U.S. EPA, 1998). The specific details of poling locations are dependent upon local conditions as well as the purpose of the poling.

Poling generally involves the measurement of sediment and water characteristics using specialized tooling designed for the task. Specific field conditions such as location, water depth and temperature, sediment thickness and temperature, and a qualitative determination of oil sheen and globule coverage over a specified surface area are recorded.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms, as appropriate, and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Poling is a relatively involved procedure requiring training and a variety of equipment. It is recommended that initial poling be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration* (OSHA, 29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP, with site specific procedures, the *Health and Safety Plan* (HASP) (Enbridge, 2012), and work plans under which the work will be conducted. Field personnel are responsible for data collection, decontamination of equipment, and proper documentation in the field logbook, field forms, and/or an electronic data collector such as the Leica®, Trimble Yuma® or equivalent (as appropriate).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, are addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross contamination between poling locations. Minimization of potential cross contamination will occur through the following:

- Avoidance of material (e.g., suspended sediment) that is not representative of the medium to be evaluated (this will be accomplished by performing poling in a downstream to upstream approach within a focus area).

5.0 EQUIPMENT AND SUPPLIES

The following equipment list contains materials which may be required to complete the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions or as specified in a work plan.

- Depth of water measurement/agitation pole (aluminum pole with a 8-inch diameter disk attached to one end),
- Sediment measuring pole (aluminum pole without a disk attached),
- Equipment decontamination supplies,
- Health and safety supplies (gloves, personal flotation devices, etc., as required by the HASP),
- Waterproof marker pens (Sharpie® or similar),
- Global Positioning System (GPS) unit,
- Electronic data collector,
- Field logbook,
- Digital camera, and
- Access to a boat when required for transportation.

6.0 METHODS

6.1 Poling Procedures

Water depth data shall be collected using a 8-inch diameter disk attached to the end of an aluminum pole approximately 2 inches in diameter marked at 0.1-foot intervals. At each poling location, the disc shall gradually be lowered to the top of the sediment bed, and the depth from the water surface to the top of soft sediment (water depth) shall be recorded to the nearest 0.1-foot.

Soft sediment thickness data shall be measured using a pole without a disk and marked at intervals of 0.1-foot. The pole shall be pushed vertically through the sediment until advancement is restricted. The difference between the depth to sediment surface (water depth) and maximum poling depth into the soft sediment shall determine the soft sediment thickness at each location. A description of the general sediment type shall be documented based on the poling results (e.g., soft sediment – silt over sand). An experienced poler can distinguish the difference between soft sediment, sand, and gravel by the feel of the sediment and the sound from the pole.

An approximate determination of the relative amount of oil/sheen created by sediment agitation at each poling location shall be made by using the pole with a 8-inch diameter disk to agitate the soft sediment. After agitation, the amount of oil/sheen observed at the water surface, within a square yard area, shall be described using the same categories as the 2011 field season (heavy, moderate, light, or none). These categories are outlined in the attached *Submerged Oil Field Observation Flow Chart* (*Figure 1*). If 'moderate' or 'heavy' submerged oil sheen/globules are observed, the area shall be delineated with additional poling. The poling teams shall work away from the 'moderate' or 'heavy' location until they have poled either a 'light' submerged oil classification, or no ('none') submerged oil.

A GPS unit shall be used to document the coordinates for each poling location. All poling locations shall be surveyed during the project to the extent practicable using a differential GPS unit with sub-meter accuracy. The horizontal coordinate system shall be the Michigan State Plane Coordinate System, South zone, referenced to the North American Datum ("NAD") 83, in international feet.

All poling activities shall be conducted while the measured temperature of both sediment and water is above 60° F. As such, sediment and water temperature data shall be collected during poling activities as thresholds for data reliability are approached.

6.2 Access to Poling Locations

Poling locations are presented in each specific work plan. A boat will be needed to pole most locations on ponds and the river. When boats are used for poling, health and safety procedures as described in the HASP must be followed. Wading to locations in the Kalamazoo River may be considered, but is not the preferred method. If it is necessary to wade into the water body to perform the work, the worker shall take care to minimize disturbance of bottom sediments and must enter the water body downstream of the poling location.

6.3 Poling Location

Poling locations will be identified with a GPS unit as discussed in *SOP EN-104 – Survey* (Enbridge, 2011a). Pre-determined GPS identification numbers and coordinates will be used to determine the correct poling placement whenever possible. The poling location must be maintained while poling from boats. The use of anchors and other stabilizing devices may be required to maintain a consistent poling location.

6.4 Equipment Decontamination

Reusable equipment shall be decontaminated in accordance with *SOP EN-105 Decontamination of Field Equipment* (Enbridge, 2011a). Investigation derived waste generated from the effort (gloves, disposable sampling equipment, decontamination water, etc.) shall be appropriately containerized and transported to the onsite collection area for appropriate disposal per *SOP EN-106 Investigation Derived Waste Management* (Enbridge, 2011a).

7.0 DATA AND RECORDS MANAGEMENT

The data associated with poling locations may be contained in the following:

- Field logbook,
- Sample collection records,
- Electronic data collection (Leica® ,Trimble Yuma®, or equivalent),

- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sediment sample collection process:

- *SOP EN-101 Field Records* (Enbridge, 2011a)*,*
- *SOP EN-104 Survey* (Enbridge, 2011a)*,*
- *SOP EN-105 Decontamination of Field Equipment* (Enbridge, 2011a)*, and*
- *SOP EN-106 Investigative Derived Waste Management* (Enbridge, 2011a)*.*

8.0 REFERENCES

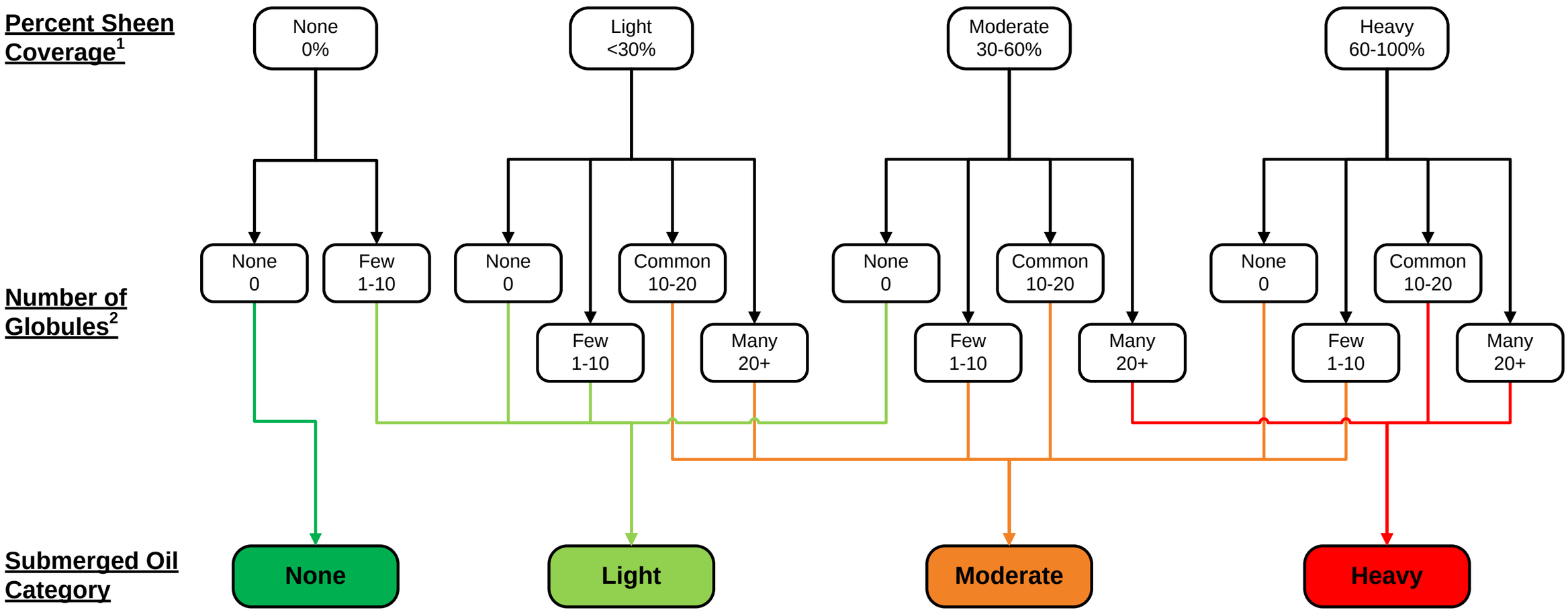
Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan*; SOP EN-101 –Field Records; SOP EN-104–Survey; SOP EN-105– Decontamination of Field Equipment; SOP EN-106 – Investigation Derived Waste Management*.

Enbridge, 2012. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan*; Health and Safety Plan* (HASP)*. v. 6.2.* April 17, 2012.

U.S. EPA. 1998. EPA's Contaminated Sediment Management Strategy. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 823/R-98/001.

Figure

Submerged Oil Field Observation Flowchart



Notes:
1. Percent coverage per square yard
2. Number of globules per square yard

ENBRIDGE		FIGURE 1 SUBMERGED OIL FIELD OBSERVATION FLOW CHART
Drawn: TT 5/4/2012		ENBRIDGE LINE 6B MP 608 MARSHALL, MI PIPELINE RELEASE ENBRIDGE ENERGY, LIMITED PARTNERSHIP
Approved: DD 5/4/2012		
Project #: 60246209		

Approved

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Submerged Oil Poling Ring Test Standard Operating Procedure for Dry Submerged Oil Sites and Overbank Sites

Prepared for United States Environmental Protection Agency

Enbridge Energy, Limited Partnership

Original Submitted: September 20, 2011
Resubmitted: October 4, 2011
Approved: October 12, 2011

Approved

1.0 SCOPE AND APPLICATION 1

2.0 SITES APPLICABLE FOR SUBMERGED OIL POLING RING TEST 1

3.0 SITE PREPARATION 1

4.0 EQUIPMENT AND PERSONNEL 2

5.0 METHODS 2

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7.0 DECONTAMINATION OF EQUIPMENT 4

8.0 OSCAR REVIEW 5

9.0 SAFETY CONSIDERATIONS 5

ATTACHMENT

Attachment A **Submerged Oil Poling Ring Test– Photo log**

Approved

LIST OF ACRONYMS

Enbridge	Enbridge Energy, Limited Partnership
GPS	Global Positioning System
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MDEQ	Michigan Department of Environmental Quality
MP	Mile Post
OSCAR	Outstanding Sites Characterization and Reconciliation
SO	Submerged Oil
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency

Approved

1.0 SCOPE AND APPLICATION

The purpose of the *Submerged Oil Poling Ring Test Standard Operating Procedure* (SOP) is to document a method to conduct poling activities at dry submerged and overbank sites. The SOP is a method to determine the relative amount of Submerged Oil (SO) remaining at SO sites that have undergone recovery activities and subsequently dried. The test is designed to simulate poling activities conducted in river conditions following recovery activities to assess recovery effectiveness. This SOP supplements the post-poling verification end points as described in the *2011 Summer Strategic Work Plan* submitted on August 18, 2011. The presence of SO is a result of the Enbridge Energy, Limited Partnership (Enbridge) Line 6B pipeline release in Marshall, Michigan.

2.0 SITES APPLICABLE FOR SUBMERGED OIL POLING RING TEST

The sites selected for the SO poling ring test are a subset of the sites characterized during the reassessment poling phase. The subset sites include overbank and SO sites that are currently dry or partially dry. The Kalamazoo River is a shallow river with fluctuating water levels. The fluctuating water levels cause river sites adjacent to the shoreline to dry. The river water level decrease creates mud flats and dry areas in the overbank that require poling evaluation.

3.0 SITE PREPARATION

The SO poling ring site preparation activities include:

- Identify the sites applicable for the SO poling ring test.
- Clear sites of surface debris and survey the site for roots and other obstacles.
- Determine the type of ring best suited for the specific site.
- Determine equipment requirements to transport water to the site.
- Prepare the equipment needed to conduct the SO poling ring test.

Adverse weather or river conditions may delay or impact the efficiency of the poling ring test.

Approved

4.0 EQUIPMENT AND PERSONNEL

The SO poling ring test crews will consist of five to seven personnel. On larger focus areas, crews will be merged together to form a team consisting of 10 to14 personnel.

The teams will be directed by a poling leader who is responsible for the team's location, test execution, written and photo documentation, and post poling activities. Each poling ring test will determine if that area passes (light to no SO sheen) or fails (heavy to moderate SO sheen). The remainder of the team will consist of a Global Positioning System (GPS) operator, a boat operator who will manage the water pump, an oversight person, and SO recovery technicians responsible for the use of the recovery tools and collection of the recovered SO.

The equipment list includes:

- GPS unit with poling point coordinates stored in memory,
- two airboats to transport equipment and personnel,
- Water pump with a 2-inch (hose and nozzle assembly),
- Galvanized or poly rings (4 – 5 feet in diameter),
- 4 x 4 post longer than 5 feet,
- Sledge hammer weighing more than 2 pounds,
- Straight pole and pole with a disk marked in tenths of feet,
- Personnel protective equipment,
- Camera, and
- Tracking Flashlight.

Additional supporting equipment and personnel will be available as needed.

5.0 METHODS

The methods to conduct the SO poling ring test are based on the September 14, 2011 *Submerged Oil Pilot Studies* for the poling ring. A sequential list of procedures is provided to implement the SO poling ring test.

- GPS and stake the poling sites located on the mud flat or dry overbank area. See *Attachment A, Photos 1, 2,* and 3 for reference.

- Select the appropriate ring type for the area to be poled. Poly rings are best suited for soft mudflat areas. The galvanized rings are best suited for areas with roots or other shallow debris or underlying sand or gravel.
- Install the ring at the poling location. Place the flat 4" x 4" post across the top of the ring and drive two sides of the ring simultaneously, using the sledge hammer. See *Attachment A, Photo 4 for reference*.
- Set up water pump with a 2-inch hose. The river is used as a water source to fill the ring. See *Attachment A, Photos 5* and *6*.
- Begin filling the ring with water. Aim the nozzle along the side of the ring to dissipate the energy of the water stream from the hose. Limit disturbance of the sediment surface while filling. See *Attachment A, Photos 7 – 10 for reference*.
- Fill the ring to a minimum depth of 6-inches. See *Attachment A, Photo 11*.
- Check the ring for water leaks. Re-install the ring if significant leaking occurs. Re-fill the ring with water. See *Attachment A, Photo 11 for reference*.
- Allow the water to sit in the ring for 10 minutes prior to poling. Note any oil sheen present on the water surface prior to poling. If sheen is noted, the sheen should be recovered before poling begins.
- Pole inside the ring to determine the relative amount of SO. See *Attachment A, Photos 12* and *13 for reference.*
- Determine if the poling location passes (light or none) or fails (heavy or moderate) using the SO Field Observation Flow Chart.
- If the poling ring test passes, the field activity log can be signed by the Enbridge and United States Environmental Protection Agency (U.S. EPA) personnel that the work has been completed.
- If the poling ring test fails at a poling location, the data will be presented to and reviewed by the Outstanding Sites Characterization and Reconciliation (OSCAR) group.
- Any deviations from the method due to site-specific conditions will be recorded following documentation procedures.
- The data obtained from the poling ring tests and other submerged oil poling conducted at the recovery area will be reviewed by the OSCAR group.

6.0 PILOT STUDY

A pilot study was conducted at location Mile Post (MP) 31.25 North. This area consists of a mud flat and open water area. The mud flat had a heavy and a moderate poling point identified during the Spring 2011 reassessment. The mud flat has not been addressed with the *Submerged Oil Toolbox*. This location was selected to verify if SO can be found using the SO poling ring test.

A total of five rings, two poly and three galvanized, were placed in the dry area to test the proposed poling method at the mud flat. The poly ring sealed and held water in a mud flat area with no underground obstructions. The poly ring did not seal well in an area of the mud flat with tree roots. One of the galvanized rings was placed in the root area. This ring sealed and held water. The galvanized rings were sealed and filled with water at each location. The galvanized ring was easily driven, so it is more versatile across various mud flat conditions including tree roots and other obstruction areas. The test is most applicable on relatively flat areas.

Moderate SO was identified in the galvanized ring located between the Spring 2011 reassessment heavy and moderate poling locations. The moderate result included greater than (>) 30% sheen with common globules. Key elements of the pilot study included adding the water slowly to the ring to not disturb the sediment surface; allowing the water to sit in the ring for a minimum of 10 minutes prior to poling; and looking at the water surface after poling from a number of different angles to offset poor lighting conditions due to the tree cover. A tracking flashlight will be provided to each team to illuminate sheen and globules.

7.0 DECONTAMINATION OF EQUIPMENT

Oiled debris including the sorbent booms, pads, and other material used to collect the recovered oil identified by this poling procedure will be disposed in accordance with the *Enbridge Waste Treatment, Transportation, and Disposal Plan* dated May 20, 2011.

All equipment impacted as a result of SO poling ring testing will be decontaminated using approved decontamination procedures. Approved decontamination methods include dry decontamination on site or a full decontamination at Frac Tank City.

8.0 OSCAR REVIEW

Following the SO poling ring test activities for the dry portion of the SO recovery sites, the water portion of the SO recovery site will be poled per the *Submerged Oil Recovery SOP*. If the entire site passes post recovery poling, U.S. EPA oversight and the Enbridge poling leader will sign and date the Completeness Check Form stating the site met the objective of reducing the SO to a light or none category. The Completeness Check Form and the site specific poling data for the recovery area will be reviewed by the OSCAR group. The OSCAR group participates in data review, quality control, and site closure process to ensure that all pending issues are addressed.

9.0 SAFETY CONSIDERATIONS

All activities will adhere to Incident Action Plan and the Enbridge Health and Safety Plan procedures and policy. All operations and targets described in this SOP are based on the observations and judgment of Enbridge field supervisors.

Attachment A

Submerged Oil Poling Ring Test– Photo log

Submerged Oil Poling Ring Test Standard Operating Procedure – Field Photographs

Photo #1

Photo #2

Submerged Oil Poling Ring Test Standard Operating Procedure – Field Photographs

Photo #3

Photo #4

Photo #5

Photo #6

Photo #7

Photo #8

Photo #9

Photo #10

Photo #11

Photo #12

Photo #13

Approved

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Water and Sediment Temperature Collection
Standard Operating Procedure

Prepared for United States Environmental Protection Agency

Enbridge Energy, Limited Partnership

Originally Submitted: May 11, 2012

Approved: September 13, 2012

Approved

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LIST OF ACRONYMS

HASP	*Health and Safety Plan*
MDEQ	Michigan Department of Environmental Quality
PFA	Poly-fluoroacetate
PVC	polyvinyl chloride
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency

1.0 SCOPE AND METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for the collection of water and sediment temperatures. The specific details of actual temperature collection are dependent upon local conditions as well as the purpose of the intended sampling. For the purposes of this SOP, sediment is defined as soil, sand, silt, clay, organic matter, or other materials that accumulate on the bottom of a water body (U.S. EPA, 1998).

Water and sediment temperature collection generally involves collecting multiple water column temperatures and a single sediment temperature at specific locations on a water body (e.g., river, stream, wetland, pond, or lake). Water and sediment temperatures collected during sampling events (e.g., poling or sediment coring) are critical components ensuring quality data is collected.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on *Field Modification Forms* as appropriate and will be approved in advance by the Task Manager (or other appropriate personnel). Deviations and the reason for deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Water and sediment temperature collection is a relatively involved procedure requiring general training on different thermometer models and types (e.g., thermocouple and thermistor). It is recommended that initial temperature collection procedures be supervised by experienced field personnel. Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration* (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

Task managers (or other appropriate personnel) will be notified of any adverse field condition or problems with field equipment during temperature collection.

It is the responsibility of the field personnel to be familiar with the temperature collection procedures outlined within this SOP, with specific collection procedures, quality assurance, and health and safety requirements under which temperature collection will be conducted. Field personnel are responsible for calibration, maintenance, temperature collection, decontamination of equipment, and proper documentation in the field logbook, field forms, or electronic data collector such as the Trimble Yuma® or Leica®.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific *Health and Safety Plan (HASP)* (Enbridge, 2012) (HASP). All work will be conducted in accordance with the HASP.

4.0 EQUIPMENT AND SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Additional equipment may be required, pending field conditions or as specified in a work plan. This SOP explains and requires two different models and types of thermometers be present for temperature collection during sampling events. Not all equipment listed below may be necessary for a specific activity, but is required present during temperature collection to ensure consistency.

4.1 HH41 Thermistor Thermometer with Thermistor Sensor (Primary)

- Ultra-high accuracy and resolution handheld thermistor thermometer,
- Tubular thermistor sensor for immersion temperature measurements, and
- Precision thermistor sensor for air temperature measurements.

4.2 HH12B Digital Thermometer with Thermocouple Probe

- Portable 3 ½ digit Omega® digital thermometer,
- Omega® rugged heavy duty transition-joint thermocouple probe (K-type or other-type), and
- Poly-fluoroacetate (PFA) coated stranded lead wire.

4.3 Additional Field Equipment

- Applicable manufacturers equipment manuals,
- Schedule 40 polyvinyl chloride (PVC) and/or fiberglass hollow rods, 6 or 8 foot length, 1-inch in diameter,
- Decontamination supplies for reusable equipment,
- Waterproof marker pens (Sharpie® or Write in the Rain®),
- Tools to make fine adjustments to the thermocouple in the HH12B digital thermometer probe (i.e., bucket or cooler, ice, and a flathead screwdriver),
- Water and sediment temperature collection field sheets or electronic data collector,
- Field logbook, and
- Health and safety supplies (personal flotation devices, etc., as required by the HASP).

5.0 METHODS

5.1 Temperature Probe Construction

5.1.1 HH41 Digital Thermistor Thermometer with Thermistor Sensor (Primary)

The primary temperature instrument for sediment, water, and air temperatures will consist of an Omega® tubular thermistor immersion sensor connected to the Omega® HH41 digital thermistor thermometer. The tubular thermistor immersion sensor will be affixed to the end of a 6 or 8 foot PVC schedule 40 or fiberglass hollow rod with a compression fitting to protect wiring from moisture. The thermistor immersion sensor wiring leads are contained in a flexible polyvinyl chloride cable which will be placed inside the hollow rod through a drilled hole or slot in the rod. The sensor cable has a phone plug end connector that will be attached to the HH41 digital thermistor thermometer. The HH41 digital thermistor thermometer has one input connection. When connected to the tubular thermistor immersion sensor, the HH41 will be used to read water and sediment temperatures. When an air temperature needs to be collected, the tubular thermistor immersion sensor will be disconnected and a separate precision thermistor air temperature sensor will be connected.

5.1.2 HH12B Digital Thermometer with Thermocouple Probe

The backup or secondary temperature instrument will consist of a thermocouple probe (K-type or other-type) connected to the Omega® HH12B digital thermocouple thermometer. The thermocouple probe will be affixed to the end of a 6 or 8 foot PVC schedule 40 or fiberglass

hollow rod with a compression fitting to protect wiring from moisture. The thermocouple lead wires (PFA coated) will be placed inside the hollow rod through a drilled hole or slot in the rod. The thermocouple lead wires will include a standard mini-jack end plug for connection to the HH12B digital thermocouple thermometer. The HH12B has two input connections (T1 and T2). The T1 input connection will be used for ambient air temperature readings and T2 will be used for water and sediment temperature readings.

5.2 Temperature Probe Calibration

5.2.1 HH41 Digital Thermistor Thermometer with Thermistor Sensor (Primary)

This particular model thermistor thermometer only needs to be calibrated annually to maintain its accuracy as recommended by Omega®, the manufacturer. The annual calibration date should be documented and verified before use. The calibration should only be performed by an Omega® technician. When the thermistor thermometer requires calibration, contact Omega® Customer Service Department for instructions on returning the unit. This thermistor thermometer includes a National Institute of Standards and Technology traceable calibration certificate. This specific instrument's manufacturer's stated accuracy is ±0.027 ºF.

5.2.2 HH12B Digital Thermometer with Thermocouple Probe

The temperature sampling probe will be adjusted every day before sampling commences. Both the T1 and T2 inputs will need to be adjusted. This specific instrument's accuracy is ±2 ºF as provided by Omega®. As described in the equipment manual, the following steps will be taken during temperature probe fine adjustments:

1. Connect the thermocouple probe to the input (T1 or T2) that will be adjusted.
2. Place the thermocouple probe into a bucket or cooler of an ice-water mixture. Make sure 75% or more of the surface area of the thermocouple probe is submerged into the ice-water. Allow for the readings on the digital thermometer to stabilize for a 10 minute time period.
3. Once the 10 minute time period has passed slowly adjust the OFFSET control dial for the input being adjusted. The OFFSET control dial will need to be adjusted until the thermometer reads 32 ºF. Once this is completed for both inputs the temperature probe is ready to be used.
4. Document all fine adjustment activities.

If the instrument does not properly adjust or if any other operational issues are noted at anytime, perform the troubleshooting tasks as described in *Section 5.4*. If operational issues are not resolved, contact your Task Manager (and other appropriate personnel). Tag the unit as not to be used, and use a properly adjusted probe that is in good working order.

5.3 Temperature Collection

Once the location has been established with a Trimble Yuma® or Leica®, and the boats are positioned, water and sediment temperature collection will be conducted as follows:

1. The poling rod will be used in recording the depth of the water at the specific location. The pole with the attached disk should be gently lowered to the water-sediment interface being careful to limit sediment disturbance.
2. Once the depth has been recorded the primary temperature probe will be used to collect the sediment temperature first. Place the probe end gently into the sediment and record the temperature.
3. After the sediment temperature has been recorded, pull the probe to the water's surface to visually check the probe end to ensure no sediment or aquatic vegetation remains fixed to the probe end.
4. Once the probe end is clean the water temperature just above the sediment should be recorded, as well as the surface water temperature..

5.4 Troubleshooting and Operator Maintenance

5.4.1 HH41 Digital Thermistor Thermometer with Thermistor Sensor (Primary)

If this particular model temperature sampling thermometer and sensor is yielding suspect or inaccurate readings, an inspection of the phone plug connector, the exposed polyvinyl chloride cable, the thermistor sensor, and a battery replacement is required. If during the inspection anything is noticeably wrong (e.g., cuts in the cable sheathing, loose phone plug connection, or a bent or dented thermistor sensor) the unit should be tagged for repair/replacement. The Task Manager (and other appropriate personnel) should be notified and a calibrated replacement probe in good working order should be used. Tag the unit as not to be used, and use a probe that is in good working order. The thermistor thermometer sensor setup (i.e., hollow rod with attached thermistor sensor) should not be disassembled at anytime during field activities. The digital handheld thermistor thermometer is not waterproof but is water resistant. Care must be

taken at all times to prevent the unit from being exposed to excessive amounts of water contact. Do not store the probe in places with high humidity and excessively high temperatures.

5.4.2 HH12B Digital Thermometer with Thermocouple Probe

If this particular model temperature sampling probe is yielding suspect or inaccurate readings, an inspection of both inputs (T1 and T2), the exposed PFA coated stranded lead wire, the thermocouple probe, and battery replacement is required. If during the inspection anything is noticeably wrong (e.g., cuts in the stranded lead wire sheathing, loose input connections, or a bent or dented thermocouple probe) the unit should be tagged for repair/replacement. The Task Manager (and other appropriate personnel) should be notified and a calibrated replacement probe in good working order should be used. Tag the unit as not to be used, and use a probe that is in good working order. This temperature sampling probe setup (i.e., hollow rod with attached thermocouple probe) should not be disassembled at anytime during field activities. The digital handheld thermometer is not waterproof but is water resistant. Care must be taken at all times to prevent the unit from being exposed to excessive amounts of water contact. Do not store the probe in places with high humidity and excessively high temperatures.

5.5 Equipment Decontamination

All reusable equipment will be decontaminated in accordance with *SOP EN-105 Decontamination of Field Equipment*. All investigation derived waste generated from the sampling effort (gloves, disposable sampling equipment, decontamination water, etc.) will be appropriately containerized and transported to the onsite collection area for appropriate disposal per *SOP EN-106 Investigation Derived Waste Management.*

6.0 DATA AND RECORDS MANAGEMENT

The data associated with water and sediment temperature collection may be contained in the following:

- Field logbook,
- Temperature collection field sheets,
- Electronic data collection (Trimble Yuma® or Leica®),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the water and sediment temperature collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-104 Survey,*
- *SOP EN-105 Decontamination of Field Equipment, and*
- *SOP EN-106 Investigative Derived Waste Management.*

See the referenced *SOPs* for additional details.

7.0 REFERENCES

Enbridge, 2011. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan*; Sampling and Analysis Plan (SAP); SOP EN-101 –Field Records; SOP EN-104– Survey; SOP EN-105– Decontamination of Field Equipment; SOP EN-106 – Investigation Derived Waste Management.* August 30, 2011.

Enbridge, 2012. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan*; Health and Safety Plan (HASP).* April 17, 2012.

U.S. EPA. 1998. *EPA's Contaminated Sediment Management Strategy. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 823/R-98/001.*