Appendix B: Floodplain Oiling Report

STRATUS CONSULTING

Kalamazoo River Floodplain Oiling Survey Data Report

Prepared for:

Stephanie Millsap
U.S. Fish and Wildlife Service
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Kalamazoo River
Floodplain Oiling Survey
Data Report

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Contents

Appendices

Figures

Tables

Acronyms and Abbreviations

DBH	diameter at breast height
GIS	geographic information system
GPS	global positioning system
ID	identification
MP	mile post
NRDA	natural resource damage assessment
ODA	oil delineation area
QA	quality assurance
QC	quality control
SCAT	Shoreline Cleanup and Assessment Technique
USFWS	U.S. Fish and Wildlife Service

Executive Summary

The Enbridge Oil spill occurred on July 26, 2010, near Marshall, Michigan. Soon after the spill, the state and federal natural resource Trustees and Enbridge cooperated on a floodplain survey. The purpose of the survey was to use ground surveys to document the degree and extent of oiling in the Kalamazoo River floodplain from Talmadge Creek (where the spill originated) downstream to approximately five miles upstream of Morrow Lake and to record the types of habitat and specific habitat features within this floodplain. This report describes the objectives, approach, and methods of the floodplain oiling survey, and presents the results of the survey. The report does not present any interpretation of the results in terms of natural resource injury or restoration scaling.

The survey took place from August 13, 2010, to September 2, 2010. The survey was conducted according to detailed written protocols that were developed specifically for this survey. Multiple field teams that included both trustee and Enbridge representatives conducted the survey. The written field protocols were modified during the course of the survey to adjust to field conditions and to incorporate the transition from using hardcopy forms to computer tablets for data recording. The field-collected data were tracked and managed under chain of custody procedures to ensure the integrity of the raw data.

Floodplain on both sides of the river from Talmadge Creek to Morrow Lake, a distance of approximately 25 river miles, was surveyed by field crews. The field surveys were conducted primarily along linear transects situated either perpendicular to river flow or along N-S compass lines. Transects were approximately 50 m apart from each other. Selected areas (e.g., islands, areas of heavy oiling of at least 50 ft^2 in the floodplain) were surveyed at a more detailed level. Field crews surveyed a total of 742 transects on both sides of the river.

The raw field survey data was processed to allow for data presentation in maps and tables, which are presented in this report. Any decisions that were made during data processing were carefully recorded and are presented in this report for transparency. The intent of the data processing was to be able to present and summarize the data in figure and table format in ways that accurately reflect the original raw field data as closely as possible. We intentionally minimized as much as possible any data interpretation in the data processing step.

The results of the floodplain oiling survey are presented here in tables and maps. The highest degree of oiling occurred from mile post (MP) 2.25 to MP 17.25 (Division C). In this area, 76% of surveyed transects were 1–10% oiled. All areas with heavy oiling at least 50 ft^2 in size (called "oil delineation areas," or ODAs) identified by field crews were located between MP 2.25 and MP 17.25. Downstream of MP 17.5, few observations of oil were made along transects and no ODAs were identified. The maps and tables presented here show that the predominant habitat

type identified during the survey was forested wetland. The types of habitat features observed included water features, vernal pools, downed trees, and skunk cabbage.

1. Introduction

On July 26, 2010, a discharge of heavy crude oil (Cold Lake Blend) from the Enbridge Energy Partners, L.P. (Enbridge) line 6B, located along Talmadge Creek, was discovered near the Town of Marshall in Calhoun County, Michigan. The oil traveled down Talmadge Creek approximately 2.2 miles and into the Kalamazoo River (AECOM, 2011). The line 6B discharge point is on the outskirts of Marshall (North ½ Section 2, T3S, R6W, Latitude: 42.2395273, Longitude: -84.9662018). Upon discovery of the discharge, the pipeline was shut down and isolation valves were closed, stopping the discharge of the oil. Enbridge estimates that approximately 20,082 barrels (843,444 gallons) of heavy crude oil were discharged (AECOM, 2011).

Prior to the spill event, from July 22 through 25, 2010, heavy rains had fallen in the area of and upstream of the oil spill, increasing the volume of water in the Kalamazoo River and inundating the floodplain. During this period, the Town of Ceresco (approximately 5 miles west of the spill) received an estimated 5.70 in. of rain and the Town of Albion (approximately 10 miles east of the spill) received an estimated 5.65 in. of rain (AECOM, 2011). Based on readings at the stream gauge in Marshall (gauge 4103500), at the time of the spill event, the flood stage was estimated to be between a 10- and 25-year flood event (AECOM, 2011). When the oil was discharged, it was carried with the flooding river and distributed in the inundated floodplain. Within a few days of the spill event, the water had receded from the floodplain to the main river channel.

The Trustees have engaged in preassessment activities since the occurrence of the spill. The Trustees include the Michigan Department of Environmental Quality, the Michigan Department of Natural Resources, the Michigan Department of the Attorney General, the U.S. Department of Interior acting through the U.S. Fish and Wildlife Service (USFWS) and the Bureau of Indian Affairs, the U.S. Department of Commerce acting through the National Oceanic and Atmospheric Administration, the Nottawaseppi Huron Band of the Potawatomi, and the Match-E-Be-Nash-She-Wish Band of the Potawatomi. Many of these activities have been conducted cooperatively with Enbridge.

The Trustees and Enbridge, working together as a cooperative natural resource damage assessment (NRDA) group (the NRDA group), conducted a floodplain survey soon after the oil spill occurred. The purpose of the survey was to document the spatial extent and degree of oiled habitat within the Kalamazoo floodplain, between the confluence with Talmadge Creek [defined as mile post (MP) 2] and approximately five miles upstream of Morrow Lake (MP 32.25). This report, produced by Stratus Consulting on behalf of the Trustees, describes the methods used in the field to collect data and the data management methods and geographic information system (GIS) database development. The field survey results are also presented in tables and maps.

1.1 Objectives and Scope

Based on field reconnaissance of the floodplain by the Trustees and Enbridge representatives soon after the spill (August 9–12, 2010) and reports and observations made by response personnel, it was clear that there was oil in the floodplain as a result of the incident. The NRDA group estimated that floodplain vegetation and soils were oiled at a background level of 1–10% (as defined in Owens and Sergy, 1994), interspersed with much more heavily oiled patches of varying spatial dimensions. Response activities were focused on characterizing oil within the river and along the shoreline using the Shoreline Cleanup and Assessment Technique (SCAT), which is focused on assessing shoreline areas. Based on initial floodplain reconnaissance, the NRDA group determined that there was a need to document the amount of oil present in the floodplain and designed a floodplain survey that was implemented independently of the SCAT survey. The primary study objectives of the floodplain survey were to characterize the areal extent and degree of oiling in the Kalamazoo River floodplain that resulted from the Enbridge pipeline spill and the general floodplain habitat types that were oiled. The NRDA floodplain survey results could be evaluated in conjunction with the SCAT survey results, and later response efforts to document the extent of floodplain oiling, in order to develop a more comprehensive, overall description of shoreline and floodplain oiling.

The geographical scope of the oiled floodplain study encompassed the Kalamazoo River floodplain from the confluence of Talmadge Creek and the Kalamazoo River (MP 2.0) to just upstream of Morrow Lake (MP 32.25; Figure 1). Incident Command designated Talmadge Creek and the Kalamazoo River downstream of the pipeline break into Divisions A through E. Division A encompassed the spill area on Talmadge Creek (MP 0–0.25), Division B encompassed the area just downstream of the spill to the confluence of Talmadge Creek and the Kalamazoo River (MP 0.25–2), Division C extended from the confluence of Talmadge Creek and the Kalamazoo River downstream past Battle Creek (MP 2.25–17.25), Division D extended from MP 17.5 through 23.75, and Division E extended from MP 24 to Morrow Dam at MP 40. The Kalamazoo River floodplain between MP 2 and MP 32.25 (including Divisions B, C, D, and part of E), where the NRDA group had permission to access, was surveyed. Response actions or private property restrictions precluded access to some parts of the floodplains; consequently, these parcels could not be surveyed.

The survey work was initiated in early August and completed in early September 2010. The initial reconnaissance work was undertaken between August 9 and 12. Survey work took roughly three weeks, and was conducted from August 13 to September 2, 2010.

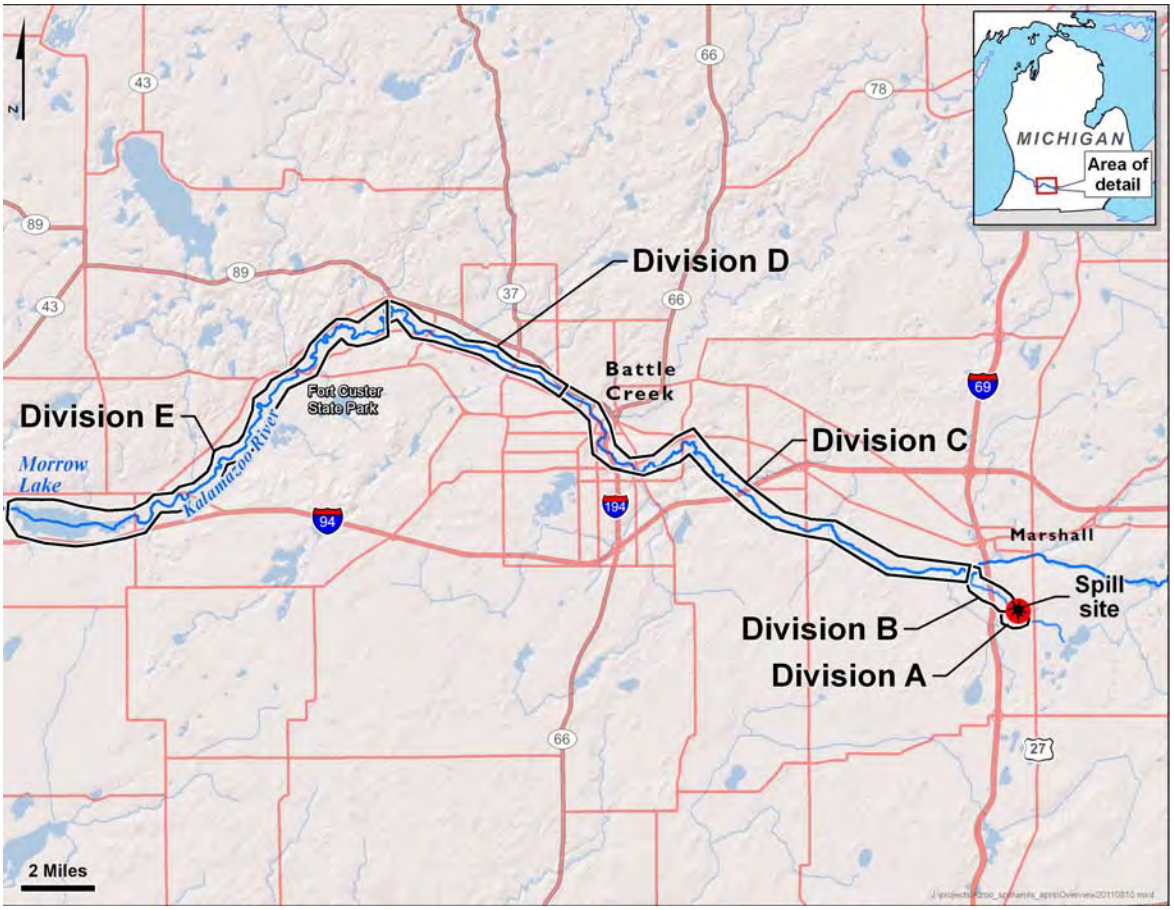

Figure 1. Overview of the study area.

The remainder of this report is organized as follows:

- Section 2 describes the field survey methods
- Section 3 describes database development and GIS mapping methods
- Section 4 presents results of the floodplain survey.

2. Field Survey Methods

Initial field reconnaissance indicated that the floodplain areas which were under water at the time of the spill were oiled at a background level of 1–10%, interspersed with much more heavily oiled patches of varying spatial dimensions. For the purposes of the floodplain survey, sporadic oiling was specifically defined as 1% (trace) to 10% oil covering floodplain surfaces including soil, vegetation, and tree trunks. Figure 2 provides an example of 1–10% oiling, and Figure 3 provides an example of heavy oiling. Additional examples are provided in the floodplain characterization protocol in Appendix A.

Figure 2. Example of 1–10% oiling.

Figure 3. Heavy oiling on emergent vegetation.

The main objectives of the survey was to characterize the areal extent and degree of oiling in the Kalamazoo River floodplain that resulted from the Enbridge pipeline spill, and to characterize the general floodplain habitat types that were oiled.

The remainder of this section is structured as follows:

- Section 2.1 describes protocol development, based on initial reconnaissance work in the field
- Section 2.2 describes the survey approach
- Section 2.3 describes field data collection methods
- Section 2.4 describes daily data management methods.

2.1 Protocol Development

Representatives of the cooperative NRDA group conducted four days (August 9–12, 2010) of reconnaissance in Division C, near MP 10 and the C3.2 boat ramp. The purpose of the reconnaissance work was to understand field conditions, including oiling and habitat, to inform the study design. The reconnaissance team found that the floodplain vegetation and soils were oiled throughout and that there were areas with heavy oiling.

After completing the initial reconnaissance investigation (August 9–12, 2010), the NRDA group developed a protocol to survey the floodplain. The protocol was tested in the field on August 13–14, 2010. The floodplain survey protocol, "Protocols for Characterizing Kalamazoo River Floodplain Oiling," is included in Appendix A, and the survey methods are summarized below.

Due to changing field conditions, observations made during the field sampling effort, and availability of data collection tools, the protocol was revised several times during the survey (the final version of the protocol is included in Appendix A). These revisions were made to improve the efficiency or methods of data collection based on field experience, address new conditions encountered in the field (e.g., areas where response occurred before the floodplain survey reached that location), and include new technology as it became available (e.g., electronic data entry tablets). Protocol modifications are described in relevant sections of this report. In addition, Table 1 summarizes all modifications made to the protocol as field work progressed.

2.2 Survey Approach: Floodplain Sections and Transects

The survey was conducted using a systematic approach in which the floodplain was split into 400-m-wide sections (sections) and each section was further divided into eight transects (transects) spaced 50 m apart. In the original protocol, the transects were oriented perpendicular to the river, with the 50-m spacing measured along the Kalamazoo River shoreline. However, that approach resulted in an uneven density of surveyed areas within sections, especially in areas where the river was more sinuous. For example, some transect lines cross and others diverge, leaving large unsurveyed areas within sections.

To address this uneven transect coverage, a revised approach was developed in which the transects were oriented parallel to each other in a N-S direction. All transect lines were generated using GIS and assigned a unique identifier. This modification became effective August 17, 2010 (Figure 4).

Table 1. Inventory of floodplain protocol changes

Section in this report	Floodplain protocol change	Protocol revision date	Reason
2.2	Orient transects N-S rather than perpendicular to the river	8/17/2010	Improve consistency, predetermine transect locations, follow general orientation of the floodplain
Implementation of use of electronic tablets			
2.3.2	Use electronic tablets to record field data	8/19/2010	Enter data directly in electronic format, integrate data in field (observations, waypoints, photographs), avoid errors related to data entry
2.3.1	Use Bluetooth global positioning system (GPS) unit to collect waypoint coordinates	8/19/2010	GPS coordinates automatically inserted into data entry form
2.3.1	Stop taking photographs of handheld GPS units	8/19/2010	GPS information integrated directly into data entry form
Implementation of revised protocol			
2.3.1	Waypoint transitions simplified to three types: start, habitat transition, end	8/28/2010	Provide increased clarity in data collection
2.3.1	For transect waypoints, do not record specific habitat features [pooled oil, water feature, vernal pool, downed tree, and skunk cabbage (*symplocarpus foetidus*)]	8/28/2010	Simplify data collection in the field, reduce the amount of information recorded at each point
2.3.1	For transect waypoints, degree of oiling is set to default of 1–10%; if oiling outside of this range is observed, record information about the percent of oiling in the notes field	8/28/2010	Simplify data collection in the field, reduce the amount of information recorded at each point
2.3.1	For oil delineation area (ODA) waypoints, identify the purpose (start, directional transition, end)	8/28/2011	Provide increased clarity ODA delineation
2.3.1	For ODAs, record specific habitat features once per ODA rather than at each ODA waypoint (pooled oil, water feature, vernal pool, downed tree, and skunk cabbage)	8/28/2010	Simplify data collection in the field, reduce the amount of information recorded at each point
2.3.1	For ODAs, record the habitat type once per ODA rather than at each ODA waypoint (forested upland, prairie, forested wetland, human managed, other)	8/28/2010	Simplify data collection in the field, reduce the amount of information recorded at each point
2.3.1	Record percent of oiling for ODA once; oiling still recorded for soil, herbs, shrubs, and trees	8/28/2010	Simplify data collection in the field, reduce the amount of information recorded at each point

Table 1. Inventory of floodplain protocol changes (cont.)

Report section	Floodplain protocol change	Date implemented	Reason
Implementation of surveys on islands and in response areas			
2.3.3	Document oil on islands	8/25/2010	Capture information about oil on islands in the Kalamazoo River
2.3.4	Document areas where cleanup actions have been completed	8/23/2010	Record areas where oil was removed from the floodplain (these areas would have been ODAs if field crews encountered them before response crews cleaned them), document areas where a substantial amount of oil had been present in the floodplain

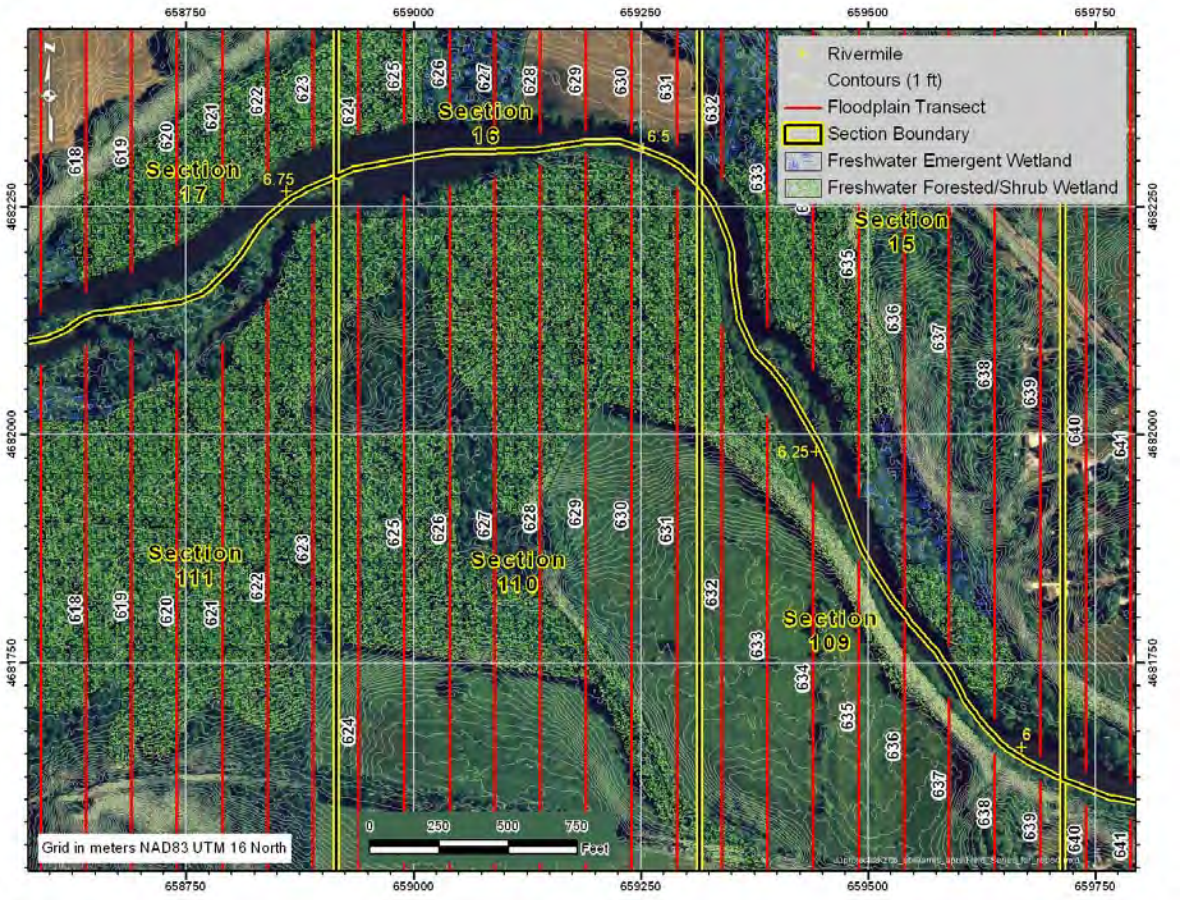

Figure 4. GIS-generated N-S transects in the Kalamazoo River floodplain.

A random sampling technique (with a random number generator) was used to select the sections to be surveyed daily. Upon implementation of the survey, it became evident that some private lands could not be accessed for surveying. Thus, accessibility dictated where work could be conducted, and sections were randomly selected within those areas where the crew had access to the floodplain. The NRDA group coordinated with Enbridge personnel daily to identify which land parcels were accessible for surveying (i.e., permission given by owners to access their land). By August 17, 2010, field work was no longer limited by access in Division C. Permission was not granted for large areas in Divisions D and E within the timeframe of the survey, but the areas where permission was granted were surveyed.

2.2.1 Transect naming conventions

When recording data, each transect was assigned a unique identification (ID). Individual floodplain transect IDs were generated using a combination of the unique transect ID and riverbank orientation when facing downriver. For example, transect number 124 located on the right riverbank was labeled 124R.

Island transects were named using a similar convention. Island transects in Division C downriver of Ceresco Dam were named sequentially, working upriver from the Mill Pond in Battle Creek (Division C and D boundaries) to Ceresco Dam starting at 900. Similarly, island transects in Division C between Ceresco Dam and the Talmadge Creek confluence were labeled sequentially from 1,000. All island transects were given a left riverbank orientation code, regardless of which side of the river they were located. For example, the fifth island located upriver from Ceresco Dam was labeled 905L.

2.3 Field Data Collection Methods

This section describes the methods used to collect data in the floodplain.

2.3.1 Survey field methods

The floodplain survey was conducted by teams of two field personnel (field crews). Each crew included one member representing the Trustees and one member representing Enbridge. On occasion, one crew consisted of two Trustee representatives or two Enbridge representatives. Most days, four crews of two field personnel each were deployed in the field.

Transects

The field crews verified the start location of each transect using a GPS unit and detailed transect maps. Once correctly positioned, the crew took three photographs marking the start of the transect: one of the GPS unit with coordinates visible, one facing north, and the other facing south. For each waypoint, the data recorder filled out the field datasheet (specific information recorded at each waypoint is described below). Field crews were instructed to note any instances where terrain or vegetation made it difficult to observe 25 m on either side of the transect. Data collection sheets included a space for recording additional relevant notes and observations (Figure 5).

Each transect was initiated with a waypoint. If there was no oil present at the first waypoint or if the habitat was physically inaccessible (e.g., a steep bank), only one waypoint was collected and the transect was ended. If the first waypoint was in an area at least sporadically oiled, and the location was physically accessible, the field crew began walking along the transect. At specific transitions, field crews marked additional waypoints and recorded data on the field datasheet. Transitions that warranted a waypoint and data collection included:

- Habitat transition
- Beginning of an ODA, defined as an area with oil coverage greater than 1–10%, covering a surface area least 50 ft^2
- End of a transect, defined as:
    - The point at which oiling is reduced to "no visible oil"
    - An area of greatly reduced habitat quality (e.g., housing development or agricultural field)
    - A point 15 ft past the edge of the floodplain (based on visual estimation).

For each transect, general information was recorded about the location of the transect, the date, field crew members, and equipment.

Floodplain Characterization Data Sheet (Version 5.0) Site ____/_____ (Sheet ___ of ___)

River Mile (tenths) ____.____ Bank Side Descending (R/L) ____ Date ___/___/2010 Data Collector/Recorder ______________________________

GPS/Photo Operator _____________ GPS Unit ID __________ GPS Photo (Y ___, #______) GPS Start Waypoint _____ Camera ID_____________

TRANSECT ID (Rivermile.transect):________________________OIL DELINEATION AREA ID (A-Z): ________ Time:_______________________

Waypoint # (___) **Habitat type (FU, P, FW, M, H, O):** _______ If O, describe ____
Oiling: Soil visible? (Y__/N__) If Y % oil covered soil (___%) % oil covered herbs (___%) % oil covered shrubs (___%) % oil covered trees (___%)
Features: Pooled oil (>50ft^2)?[1] (Y_/N_) Water feature (>50ft^2)?[2] (Y_/N_) Vernal pool (>50ft^2)?[3] (Y_/N_) Downed tree (>4" DBH)?[4] (Y_/N_) **Skunk**
Cabbage: Present? (Y__/N__) If present, healthy___/defoliated___/new shoots____ (combination ok) **Photos #s** ____________________
Notes: ____

Waypoint # (___) **Habitat type (FU, P, FW, M, H, O):** _______ If O, describe ____
Oiling: Soil visible? (Y__/N__) If Y % oil covered soil (___%) % oil covered herbs (___%) % oil covered shrubs (___%) % oil covered trees (___%)
Features: Pooled oil (>50ft^2)?[1] (Y_/N_) Water feature (>50ft^2)?[2] (Y_/N_) Vernal pool (>50ft^2)?[3] (Y_/N_) Downed tree (>4" DBH)?[4] (Y_/N_) **Skunk**
Cabbage: Present? (Y__/N__) If present, healthy___/defoliated___/new shoots____ (combination ok) **Photos #s** ____________________
Notes: ____

Waypoint # (___) **Habitat type (FU, P, FW, M, H, O):** _______ If O, describe ____
Oiling: Soil visible? (Y__/N__) If Y % oil covered soil (___%) % oil covered herbs (___%) % oil covered shrubs (___%) % oil covered trees (___%)
Features: Pooled oil (>50ft^2)?[1] (Y_/N_) Water feature (>50ft^2)?[2] (Y_/N_) Vernal pool (>50ft^2)?[3] (Y_/N_) Downed tree (>4" DBH)?[4] (Y_/N_) **Skunk**
Cabbage: Present? (Y__/N__) If present, healthy___/defoliated___/new shoots____ (combination ok) **Photos #s** ____________________
Notes: ____

Waypoint # (___) **Habitat type (FU, P, FW, M, H, O):** _______ If O, describe ____
Oiling: Soil visible? (Y__/N__) If Y % oil covered soil (___%) % oil covered herbs (___%) % oil covered shrubs (___%) % oil covered trees (___%)
Features: Pooled oil (>50ft^2)?[1] (Y_/N_) Water feature (>50ft^2)?[2] (Y_/N_) Vernal pool (>50ft^2)?[3] (Y_/N_) Downed tree (>4" DBH)?[4] (Y_/N_) **Skunk**
Cabbage: Present? (Y__/N__) If present, healthy___/defoliated___/new shoots____ (combination ok) **Photos #s** ____________________
Notes: ____

Waypoint # (___) **Habitat type (FU, P, FW, M, H, O):** _______ If O, describe ____
Oiling: Soil visible? (Y__/N__) If Y % oil covered soil (___%) % oil covered herbs (___%) % oil covered shrubs (___%) % oil covered trees (___%)
Features: Pooled oil (>50ft^2)?[1] (Y_/N_) Water feature (>50ft^2)?[2] (Y_/N_) Vernal pool (>50ft^2)?[3] (Y_/N_) Downed tree (>4" DBH)?[4] (Y_/N_) **Skunk**
Cabbage: Present? (Y__/N__) If present, healthy___/defoliated___/new shoots____ (combination ok) **Photos #s** ____________________
Notes: ____

Figure 5. Example hard copy datasheet used in the field from August 13 to 18, 2010.

At each waypoint, the following information was recorded:

- Waypoint ID (number identifying the waypoint in the handheld GPS unit)
- Habitat type (these are broad categories intended only to provide documentation of the general habitat present):
  - Forested upland
  - Prairie
  - Forested wetland
  - Human managed (e.g., pasture, lawn)
  - Other (if other, field crews provided a description)
- Oiling – percent of oil present on soil and vegetation for the following specific habitat features:
  - Percent of oil-covered soil if soil visible
  - Percent of oil-covered herbs
  - Percent of oil-covered shrubs
  - Percent of oil-covered trees
- Habitat features (recorded as presence or absence):
  - Pooled oil (> 50 ft^2)
  - Water feature (> 50 ft^2)
  - Vernal pool (> 50 ft^2)
  - Downed tree [> 4-in. diameter at breast height (DBH)]
- Skunk cabbage:
  - Whether present
  - If present
    - Healthy
    - Defoliated
    - New shoots
- Photographs
- Notes – an area was left for field crews to record notes.

Some logistical modifications were made to the protocol when the tablets were introduced. First, waypoint coordinates were taken using a Bluetooth-linked GPS unit that was integrated into the data entry form (see Section 2.3.2 for more details) at each waypoint. Table 1 summarizes all protocol changes.

Oil delineation areas

ODAs were defined as areas with greater than sporadic oiling covering an area at least 50 ft^2 (Figure 3). Crews were instructed to leave the transect to inspect any suspected ODAs, such as side channels connected to the river, and return to the transect at the point where they left the transect. Every ODA encountered was delineated.

ODAs were delineated by taking waypoints at key points of direction change to make a polygon encompassing the ODA. Figure 6 shows a single, example ODA delineated in the field and associated photograph taken at one of the ODA waypoints. At each point defining an ODA the same information was recorded using the same methods and data entry forms described above for waypoints in a transect. ODA waypoints were recorded on a separate data entry form and labeled with the transect where the ODA was found and a unique ODA identifier. As with the transect waypoint data, this information was recorded, initially on field datasheets from August 13 to 18, 2010, and later in electronic format on the tablets from August 19 to September 2, 2010. If the team could not safely walk the perimeter of the oiled area, a waypoint was taken in the center of the area and dimensions were visually estimated.

On August 27, 2010, the data collected to date were reviewed. Based on this review and on an assessment of remaining available crew time to complete the survey, changes were made to the information recorded at transect waypoints and at ODAs. Figures 7 and 8 show the revised datasheets that were used to develop the revised tablet data entry form. Table 1 summarizes all protocol changes.

Specifically, the following modifications were made to the field data collection methods.

Transect waypoints

- Transitions that warranted a transect waypoint were simplified from the list provided in Section 2.3.1 to three types:
  - Start
  - Habitat transition
  - End

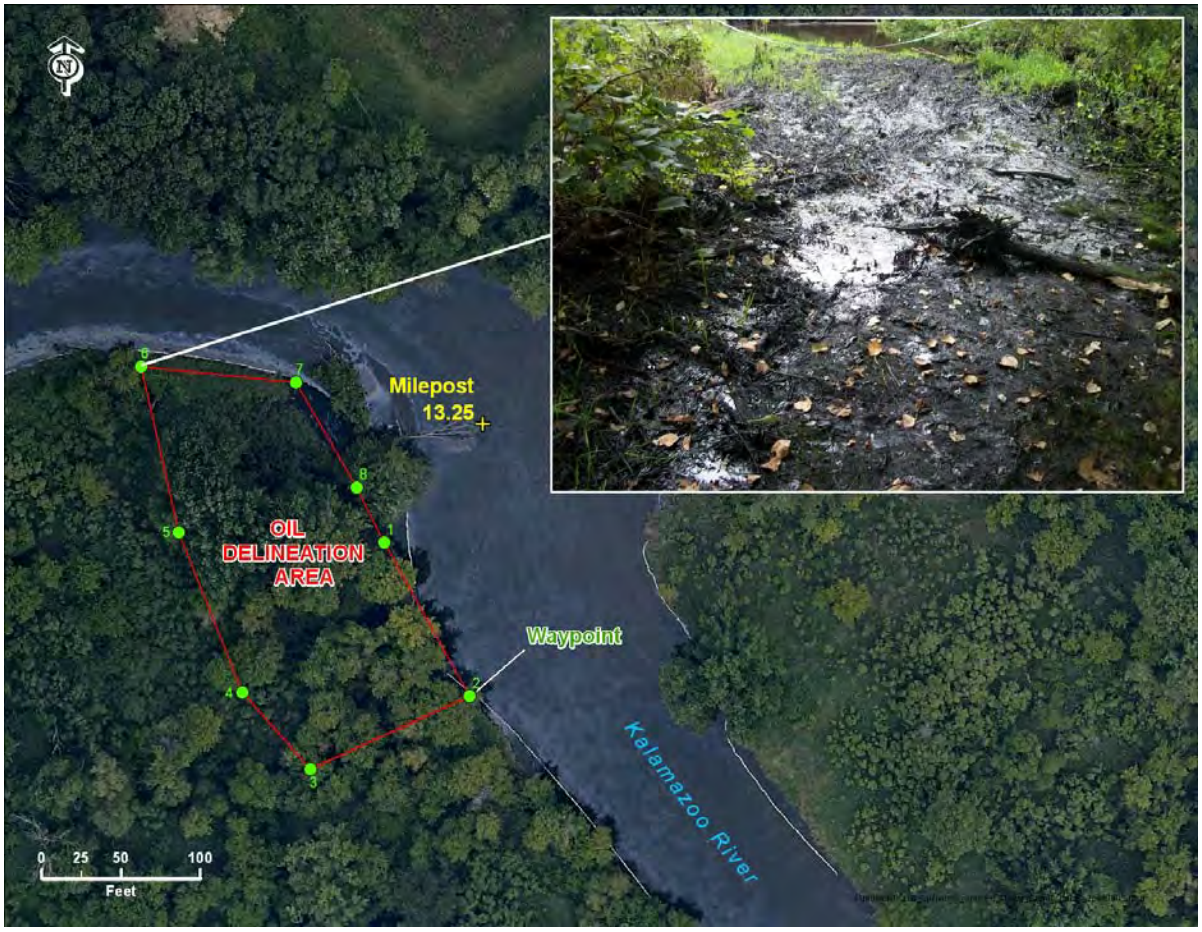

Figure 6. Example ODA delineated in the Kalamazoo River floodplain and a photograph taken during data collection at one of the ODA waypoints.

Floodplain Characterization **Transect** Data Sheet (Version 6.0) Site ____/_____ (Sheet __ of __)

River Mile ____ Bank Side Descending (R/L) ____ Date ___/___/2010 Data Collector/Recorder ____________________

GPS/Photo Operator __________ GPS Unit ID ________ GPS Photo (Y ___, #______) GPS Start Waypoint _____ Camera ID__________

TRANSECT ID:__________________OIL DELINEATION AREA ID (A-Z): ________ Time:________________

Waypoint # (___) Waypoint Type (S,HT,E):________Habitat type (FU, P, FW, M, H, O): _______ If O, describe ____________________
Photos #s ______________________________
Notes: ____

Waypoint # (___) Waypoint Type (S,HT,E):________Habitat type (FU, P, FW, M, H, O): _______ If O, describe ____________________
Photos #s ______________________________
Notes: ____

Waypoint # (___) Waypoint Type (S,HT,E):________Habitat type (FU, P, FW, M, H, O): _______ If O, describe ____________________
Photos #s ______________________________
Notes: ____

Waypoint # (___) Waypoint Type (S,HT,E):________Habitat type (FU, P, FW, M, H, O): _______ If O, describe ____________________
Photos #s ______________________________
Notes: ____

Waypoint # (___) Waypoint Type (S,HT,E):________Habitat type (FU, P, FW, M, H, O): _______ If O, describe ____________________
Photos #s ______________________________
Notes: ____

Waypoint Type: S = Start, HT: Habitat Transition; E = End **Habitat types**: FU = forested upland, P = prairie, FW = forested wetland, M= marsh, H = human managed (e.g. pasture, lawn), O = other (if other, describe)

Figure 7. Revised data entry form for transects, implemented August 28, 2010.

Floodplain Characterization **Oil Polygon** Data Sheet (Version 6.0) Site ____/_____ (Sheet __ of __)

River Mile _____ Bank Side Descending (R/L) ____ Date ___/___/2010 Data Collector/Recorder _____

GPS/Photo Operator _____ GPS Unit ID _____ GPS Photo (Y ___ #_____) GPS Start Waypoint _____ Camera ID_____

TRANSECT ID:_____OIL DELINEATION AREA ID (A-Z): _____ Time:_____

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Waypoint # (____) , **Waypoint Type (S, DT, E)**:_____**Photos #s** _____<take GPS coordinates>

Oil Polygon Habitat type (FU, P, FW, M, H, O): _____ If O, describe _____

Polygon Oiling: Soil visible? (Y___/N___) If Y % oil covered soil (____%) % oil covered herbs (____%) % oil covered shrubs (____%) % oil covered trees (____%)

Oil Polygon Features: Water feature (>50ft²)? (Y__/N__) Vernal pool (>50ft²)? (Y__/N__) Downed tree (>4" DBH)? (Y__/N__)
Skunk Cabbage: Present? (Y___/N___) If present, healthy___/defoliated____/new shoots_____ (combination ok)
Notes:
_____
_____
_____

Waypoint Type: S = Start, DT = Directional Transition: E = End
Habitat types: FU = forested upland, P = prairie, FW = forested wetland, M= marsh, H = human managed (e.g. pasture, lawn), O = other (if other, describe)

Figure 8. Revised data entry form for ODAs, implemented August 28, 2010.

- The percent of oiling was not recorded for transect waypoints. The default value for all transect waypoints was 1–10%, and field crews were instructed to record information about the percent of oiling, if different from the 1–10% in the notes.
- Specific habitat features (i.e., pooled oil, water feature, vernal pool, downed tree, and skunk cabbage) were not recorded at transect waypoints.
- Marsh was added to the list of habitat types.

The habitat type (i.e., forested upland, prairie, forested wetland, human managed, other) continued to be recorded, and as with the previous format, a space was provided for notes.

Oil delineation areas

- At each ODA waypoint, the waypoint number was recorded and the waypoint was classified into one of three categories (simplified from the list of transitions provided in Section 2.3.1):
  - Start
  - Directional transition
  - End
- Oil polygon habitat type – the habitat type (i.e., forested upland, prairie, forested wetland, human managed, or other) present in the ODA was recorded once for each polygon, rather than for each individual waypoint.
- Polygon oiling – the degree of oiling observed in each polygon was recorded once for the entire ODA (rather than at each waypoint). Field crews were instructed to estimate the average degree of oiling over the ODA for the same features as the original form as follows:
  - Presence of visible soil
  - Percent of oil-covered visible soil
  - Percent of oil-covered herbs
  - Percent of oil-covered shrubs
  - Percent of oil-covered trees
- Oil polygon habitat features – the presence of habitat features [same as those described in Section 2.3.1, including pooled oil (> 50 ft^2), water feature (> 50 ft^2), vernal pool (> 50 ft^2), downed tree (> 4-in. DBH, and skunk cabbage) was recorded once for the entire ODA, instead of by waypoint.

2.3.2 Data recording methods

Field data were collected using hardcopy datasheets from August 13 to 18, 2010 (Figure 5, Section 2.3.1). Data were collected using electronic tablets from August 19 to September 2, 2010.[1] On a few occasions after August 18, some field crews used hardcopy datasheets due to computer problems (August 20) or rainy weather conditions that prevented computer use in the field (September 2).

When tablets became available on August 19, 2010, the field crews spent one day together testing the tablets. Data collection with the tablets began on August 20, 2010.

The tablets were IBM ThinkPad computers with a touch screen and stylus. The tablets were supplied and maintained by Burns and McDonnell, an Enbridge contractor.

The tablet capabilities included:

- Electronic data entry form
- Linked GPS for generating waypoints within the electronic data entry form
- Software to link photographs to waypoints.

Waypoint coordinates were recorded using the GPS unit integrated with the tablet, which had the ability to import the GPS information directly into the data entry form. Handheld GPS units were used to locate transects and help field crews orient themselves in the field. Data collection methods in the field were the same when using hardcopy datasheets and tablets, except when the use of technology led to changes in the logistics and mechanics of data collection methods. Photographs were manually linked to the waypoints at the end of each day using the software provided with the tablet computers. Field crews used the handheld GPS units to orient themselves along the proper transect, and waypoints were recorded using a remote GPS unit connected to the tablet and electronic data entry form using Bluetooth technology.

2.3.3 Surveying of islands

Island survey field data were collected from August 25 to August 29, 2010, using tablets. All islands in Divisions C and D were surveyed.

1. The original intent was to collect data using an electronic tool throughout the survey. However, because the electronic data collection tablets were not available when the NRDA group began collecting data, the group agreed to initiate field data collection using hardcopy field sheets (Figure 5). When the electronic tablets became available on August 19, 2010, the protocol was revised to reflect changes that occurred when the tablets were deployed in the field.

Data collection on islands followed the same protocol as for floodplain data collection, with the following exceptions. One transect was walked longitudinally along the center of each island. The islands were small enough that the field crew could see the entire island from the mid-point, and the entire island was inspected for ODAs that were delineated when appropriate. When surveying islands, teams started at the most downriver end of the island, recorded a waypoint, took one photograph facing upriver toward the island, and then took another photograph downriver facing away from the island. A waypoint was recorded and photographs were taken in a similar manner at the end of each island transect.

2.3.4 Surveying areas impacted by response activities

As response activities within the floodplain and field work progressed, floodplain field crews began encountering areas that had been cleaned and cleared of vegetation and oil as part of these activities. Field crews were instructed to treat the cleaned and cleared areas as ODAs, record waypoints and take photographs, and identify the area as being cleaned. They clearly identified these areas as having been cleaned and recorded the percent of oiling that was observed at the time of the floodplain survey.

2.4 Daily Data Management Methods

Field crews returned to the Incident Command Center at the end of each day to download collected data. Data were distributed to both Trustee and Enbridge representatives each day. Daily data management and recordkeeping activities were the responsibility of a designated member of each team. The rest of this section describes the data management methods.

From August 13 to 18, 2010, and on August 20, 2010, when data were collected using hardcopy sheets, the following daily data management protocols were followed. After completion of each day's field activities, hardcopy field datasheets were brought to the Incident Command Center. Two photocopies of each datasheet were made; the original datasheets remained with the Stratus Consulting field supervisor, one photocopy was given to a USFWS representative, and one photocopy was given to Entrix staff. Each datasheet was also scanned into a PDF document and saved to a project folder on a USB drive and a laptop hard drive. Folders were organized by date and survey name. Data were then transcribed from the hardcopy datasheets into an Excel template. All photographs, GPS coordinates, and Excel datasets were saved in the project folder according to the predetermined data date/surveyor/data type naming conventions specified in the protocol. Each day, all data were saved in folders in individual laptops and then backed up on an external hard drive dedicated to the project, to the Entrix FTP site dedicated to the project, and to jump drives.

From August 19 to September 2, 2010, when data were collected with the tablets, the following data management protocols were followed. Each day after the field work was completed, the tablet files were saved as .xml files labeled with the date and survey name information: <date>_<last name>. (On September 2, 2010, when data were collected in the field using hardcopy datasheets due to rainy weather, field crew members entered the day's data into their tablets back at the Incident Command Center and those data were then handled as if collected using the tablets.)

Floodplain assessment photographs were uploaded to the tablet hard drive at the end of each day and saved to the Floodplain_Assessment_Survey_Photos folder and named using a predetermined convention, summarized in the protocol, that included the map transect number, L/R descending side, and photograph number. Photograph file paths were inserted into respective transect-specific files on each team's tablet, linking the photographs with the waypoint at which they were taken.

At the end of each day, after saving the complete .xml file with associated photographs, the entire file was saved on an external hard drive dedicated to the project and an additional jump drive before returning the tablet to the Burns and McDonnell trailer at the Incident Command Center. Burns and McDonnell had their own daily data management protocol, which included uploading the data to their OneTouch PM site, a Google Earth-based application that was established and intended to contain all data collected as part of the response activities related to the incident.

On August 20, 2010, the thumb drive with downloaded data from that day was lost prior to uploading the data to the external hard drive. Data for that day were recovered from the Burns and McConnell OneTouch PM site.

3. Database Development and GIS Mapping Methods

Stratus Consulting incorporated the data collected as part of the floodplain sampling effort into an Access database. The data were then summarized in tables and GIS maps (the results are presented in Section 4). Section 3.1 describes the database development and Section 3.2 the GIS mapping methods used to compile the data into electronic format.

3.1 Database Development

After all field data were collected, Stratus Consulting created an Access database to compile and manage the data.

All data were preserved in their original format and structure on a write-protected hard drive before incorporation into the database. Data included all original GPS waypoint data, scanned images of hardcopy datasheets, photographs, and .xml files from the tablets. Using an Excel spreadsheet, the original data were then inventoried as follows: collection format (hard copy or tablet), date collected, field crew members, transect IDs, GPS waypoints (for waypoints collected with handheld GPS units), approximate MP and shore side (left or right), GPS unit ID (for data collected with handheld GPS units), GPX export file name and location (for handheld GPS unit data), .xml file name (for data collected using tablets), location and name of PDF scans of hardcopy field forms, location of transect and ODA data on Stratus Consulting network, and whether data were imported into the Access database.

Next, all data entered on the hardcopy datasheets (i.e., transect ID, date, field crew members, GPS unit ID, waypoint ID, camera ID, MP, habitat type, oiling, habitat features, skunk cabbage, and photograph numbers) were entered into the Access database. Although field crews entered the data into an Excel file after returning from the field each day, a quality assurance/quality control (QA/QC) comparison of the hardcopy sheets to the Excel files indicated that there were inconsistencies between the original field sheets and the data entered into the Excel templates. Additionally, the Excel files were not in a format that would allow easy incorporation into an Access database. Therefore, it was determined to be more efficient and accurate to re-enter the data into the database from the original field datasheets. Data collected using the tablets were imported into the Access database from the .xml files using an XML translator (translates files from .xml format into Access 2010 format) provided by Burns and McDonnell, the Enbridge contractor who developed and managed the tablets in the field.

Data collected on hardcopy datasheets, the original tablet form, and modified tablet entry forms were stored in separate tables within the database. Photographs were saved as separate files, electronically linked to the database, and associated with the correct waypoints.

After data were incorporated into the Access database, a 100% QA/QC was performed on data that were manually entered into the database from the hardcopy field datasheets according to the following steps:

- Stratus Consulting received the original field datasheets and scanned PDFs. The first QA/QC step was to verify that there was an electronic version of every hardcopy datasheet.

- The data were then entered into the Access database from the PDF scans of the hardcopy datasheets.

- After all the data had been entered into the Access database, a version of the database was printed. The printed Access database was compared against the original datasheets, and any errors were identified and corrected.

- The identified errors were random and consisted of:
  - Typographical errors
  - Differences in handwriting interpretation because the handwriting was sometimes difficult to read
  - Missing information.

A QA/QC of the .xml data was not required because they were not manually entered into the database. However, to ensure that the data were translated properly from .xml format to the Access database format, we performed a QA/QC by verifying that all data in the .xml files were incorporated into the Access database.

3.2 GIS Methods

The floodplain survey results are summarized in maps and tables generated in GIS. Three sets of maps were generated. The first set of maps shows the degree of oiling recorded in the floodplain during the survey and the locations of each transect, transect waypoint, and ODA. Locations encountered in the floodplain that were impacted by response actions are also shown. The second set of maps shows what habitat type (i.e., forested upland, prairie, forested wetland, human managed, or other) was recorded in the field at each waypoint. The third set of maps shows the waypoints where water features and vernal pools were observed and the degree of oiling. Data summarized in tabular format include the number of transects walked in each division and the degree of oiling, the number of miles walked and the number of waypoints recorded, the degree of oiling associated with each habitat type, observations of habitat features, and observations about skunk cabbage and skunk cabbage health.

3.2.1 Transects and oil delineation areas by percent oiling

All waypoints collected as part of the floodplain sampling effort were imported from the Access database into GIS format. Transect waypoints were then connected to form transect lines to represent the path walked by the field crews. ODA waypoints were connected to create polygons encompassing the ODA. Each ODA polygon was created in GIS by evaluating the order in which waypoints were recorded for the ODA by the field crews, and any field crew notes describing the oiled area in relation to geographic features and physical obstructions (e.g., “edge of water closes polygon”). Notes on the generation of each polygon in GIS are provided in Appendix B.

Once the transects and ODA polygons were generated in GIS, each feature (i.e., waypoint, transect, ODA) was assigned the percent of oiling from the Access database. This was done as follows:

Waypoints

In the original protocol, the percent of oiling was recorded at each waypoint for visible soil, herbs, shrubs, and trees. Waypoints were assigned as 1–10% oiling if a value between 1 and 10% was recorded at the waypoint for least one type of vegetation or soil. If all vegetation types and soil were assigned 0% oil at a waypoint, that waypoint was assigned 0% oil. If the percent of oiling for at least one type of vegetation or soil was recorded by crews as greater than 10%, the waypoint was assigned the highest percent of oiling recorded (e.g., for a waypoint with the following recorded oiling: visible soil = 0%, herbaceous vegetation = 15%, shrubs = 0%, and trees = 0%, the waypoint would be assigned an oiling of 15%). Based on visual examination of photographs, the vegetation type with the highest recorded percent of oiling at a given waypoint was often the dominant vegetation type present at that waypoint.

Transects

Transects were assigned a percent of oiling based on the oiling information recorded at the transect waypoints. The following logic was adopted for assigning the percent of oiling to transects:

- Transects between two waypoints with 0% oiling were assigned 0% oiling
- Transects between one waypoint with 0% oiling and one waypoint with 1–10% oiling (in at least one vegetation type) were assigned 1–10% oiling
- Transects between two waypoints with 1–10% oiling (in at least one vegetation type) were assigned 1–10% oiling
- Transects between two waypoints with greater than 10% oiling were assigned 1–10% oiling (it is assumed that ODAs were not delineated at these locations because the observed greater than 10% of oiling covered an area less than 50 ft^2 at the waypoints.

According to the revised protocol, a default value of 1–10% oiling was assigned to the transect waypoints, unless information in the field notes indicated a different percent of oiling. The percent of oiling was assigned to transect lines between waypoints collected using the modified protocol by following the same logic described above.

Oil delineation areas

For ODAs mapped under the original protocol, the percent of oiling for each waypoint in the ODA was recorded on soil and on vegetation layers. Review of the photographs taken at ODA waypoints indicate that the dominant vegetation layer or soil typically had the highest percent oiling at each ODA waypoint. Thus, the overall degree of oiling for ODAs was assigned by

identifying the highest degree of oiling across soil and vegetation layers at each waypoint (which for the most part was either soil or the herbaceous layer), and then taking the average of these highest oiling percentages for all of the ODA waypoints. This method of assigning oiling to ODAs was used for data collected from August 13 to August 27, 2010. For data collected using the revised protocol (August 28 to September 2, 2010) in which a percent oiling was assigned to soil and each vegetation layer for the entire ODA, the highest percent of oiling across soil and vegetation types was assigned to the polygon.

Exceptions to GIS mapping methods

Waypoints and linear features with greater than 10% oiling

In some cases, the crews recorded greater than 10% of oiling at a single waypoint along a transect, but no ODA was delineated at those points presumably because the area with greater than 10% oiling was less than 50 ft^2.

There were also some instances where field crews specified an ODA but marked it with only two waypoints but did not provide an explanation in the field notes. These are shown on the maps as linear features, and the degree of oiling is assigned according to the values recorded by the field crews.

Transects with 0% oiling

If locations with no oil observed were encountered either at the start or at some point along a transect, the protocol indicated that the field crews should take a waypoint and end the transect. At some locations, field crews specifically indicated that there was no oil (0%) present at a waypoint but then continued along the transect. In these instances, the waypoints and transects were mapped as recorded by the field crews using the logic for assigning the percent of oiling to transects described above.

ODAs with less than 10% oiling

There were two instances where the percent of oiling for an ODA was recorded as less than 10%. In one case all waypoints in the polygon were assigned 5% oiling; in the other, the average oiling was 10%. It is unclear why the field crews delineated these areas as ODAs given that the degree of oiling was not greater than 10%. These polygons are shown in Figures 17, 18, and 21 in Section 4.1.

3.2.2 Habitat types

In the original protocol (August 13–27, 2010), the type of habitat was recorded at each transect and ODA waypoint. The habitat types were forested upland, prairie, forested wetland, human managed, or other (if other, field crews were instructed to provide a description). In the revised protocol (August 28–September 2, 2010), the type of habitat was recorded at each transect waypoint and for each ODA (i.e., habitat types were recorded once for each ODA and not at each ODA waypoint). From these data we generated a series of maps that identify the habitat type assigned to each waypoint or ODA and a table summarizing the same information.

3.2.3 Habitat features

Information about specific habitat features was collected for transects and ODAs during the floodplain survey. In the original protocol (August 13–27, 2010), the habitat features were recorded at each transect and ODA waypoint. The habitat features observed included pooled oil greater than 50 ft^2, water feature greater than 50 ft^2, vernal pool greater than 50 ft^2, downed tree greater than 4 in. DBH, and the presence and relative health of skunk cabbage, if present. After the protocol was revised to streamline data collection (August 28– September 2, 2010), habitat features were no longer recorded at transect waypoints, and were recorded for the entire ODA (not by ODA waypoint). This information was summarized in a table. A series of maps were generated identifying water features and vernal pools classified according to degree of oiling. Those areas for which this information was not collected due to the protocol revision are indicated on the maps.

4. Results

Section 4.1 presents the floodplain oiling results, Section 4.2 presents the habitat types, and Section 4.3 presents the habitat features.

4.1 Floodplain Oiling Results

The floodplain sampling effort was conducted between MP 2 in Division B and the most downstream section surveyed at MP 32.25 in Division E (approximately five miles upstream of the entrance to Morrow Lake). Field crews walked 744 transects throughout the floodplain.Table 2 summarizes the number of transects walked in each Kalamazoo River division. The majority of transects (79%) walked were in Division C (MP 2.25–17.25). The total length of transects walked was 25 miles. Table 3 summarizes transect miles walked by division.

Table 2. Number of transects walked by division

Division	MP[a]	Number of transects	Number of transects with at least 1–10% oiling	Number of transects with 0% oiling
A	0–0.25	0	0	0
B	0.25–2.00	3[b]	3[b]	0
C	2.25–17.25	581[b]	439[b]	142
D	17.5–23.75	94	35	59
E	24–40	64	7	57

a. MP shown as the nearest quarter mile that falls within each division.
b. One transect crosses from Division B to Division C (a two-waypoint transect with one waypoint in each division, which we assigned to Division B).

Table 3. Total floodplain miles walked by division

Division	MP[a]	Transect miles walked	Number of individual waypoints
A	0–0.25	0	0
B	0.25–2.00	< 0.01	2
C	2.25–17.25	17.5	170
D	17.5–23.75	6	51
E	24–40	1	28

a. MP shown as the nearest quarter mile that falls within each division.

Figures 9–35 show all transects where data were recorded during the floodplain survey and the percent of oiling recorded at each waypoint, transect, and ODAs. Figures 9–12 are overview maps that show the full extent of the survey. Figures 13–35 are detailed maps that show the sections where transects were walked. All ODAs (areas with greater than 10% oiling covering at least 50 ft^2) are located in Division C. The total area delineated as ODAs throughout the floodplain was 10.2 acres. The percent of oiling observed in ODAs ranged from 11 to 100%, except for two ODAs (described above) where the percent of oiling recorded by the field crews was less than 10%. The largest number of ODAs were in the 71–90% oiling category (34% of all ODA observations, not including the two ODAs with less than 10% oiling).

Field crews were unable to survey Division A due to response actions. Only two full transects were completed in Division B (Table 2), also due to limited access as a result of response actions. Areas in Divisions D and E where field crews did have access had some areas of sporadic oiling, although the degree of oiling observed in these two divisions was less than

Division C based on the number of transects with sporadic oiling (Table 2). Of the areas sampled during the floodplain survey, Division C had the most oil present throughout the floodplain, based on the proportion of transects with at least 1–10% oiling (Table 3), and the distribution of ODAs in the floodplain. Particularly heavily oiled areas in Division C were observed at MP 10 to 12 (Figures 20–22). Most of the single waypoints with greater than 10% oiling were also observed in Division C. In particular, a high concentration of single waypoints with greater than 10% oiling was identified from MP 10 to 12. It is presumed that these areas with greater than 10% oiling that were less than 50 ft^2. The field crews observed some locations in Division C that were not oiled. These areas were located primarily near MP 3.25, 6, and 10.5.

Field crews resurveyed some of the most heavily oiled areas later in the survey process to ensure that all ODAs were characterized. For this reason, the maps in Figures 9–35 show some overlapping of the ODAs. One ODA identified in the field notes was marked with a single point; this area was observed when data were collected using the hardcopy datasheets and waypoints were marked using handheld GPS units (maps 2 and 12, Figures 10 and 24). Two ODAs were delineated by the field crews as having 1–10% oiling, and it is unclear from the field notes and photographs why these were identified as ODAs if they were sporadically oiled (see Figures 17–19).

All of the 63 islands in the study area (MP 2.25 to 32.25) were surveyed. All islands in Division C up to MP 12.5 were sporadically oiled (Figures 9–35). Only two islands, one at MP 12.5 and one between MP 14.5 and 14.75, were not oiled. The island at MP 14.5–14.75 shows an ODA where response actions had been completed.

In general, a trend of decreasing oiling can be seen in the maps, and is illustrated in Table 2. In Division C, 76% of transects walked were sporadically oiled; in Division D, 37% of transects walked were sporadically oiled; and in Division E, 12% of transects walked were sporadically oiled. In particular, downstream of MP 18, 0% oiling was recorded at most transects. One exception occurs between MP 21.25 and 22.5, where sporadic oiling was observed (Figures 9–35).

4.2 Habitat Type Results

Figures 36–39 shows what type of habitat was identified for each waypoint during the floodplain survey. The predominant habitat types identified during the floodplain survey were forested wetland and forested upland. In areas where the heaviest oiling was observed, the most commonly identified habitat was forested wetland (e.g., the areas near MP 11–12). Table 4 summarizes these data.

Table 4. Oiling by habitat type

Habitat type	Total number of waypoints	Percent oiling									
		0	1–10	11–30	31–50	51–70	71–90	91–100	%0	%1–10	% > 10
Forested wetland	0	0	0	0	0	0	0	0			
Forested upland	0	0	0	0	0	0	0	0	NA	NA	NA
Human managed	0	0	0	0	0	0	0	0	NA	NA	NA
Marsh	1	0	1	0	0	0	0	0	0%	100%	0%
Prairie	0	0	0	0	0	0	0	0	NA	NA	NA
Other	2	0	2	0	0	0	0	0	0%	100%	0%
Not reported	0	0	0	0	0	0	0	0	NA	NA	NA
Division C – MP 2-5.75											
Forested wetland	56	21	19	13	1	1	0	1	38%	34%	29%
Forested upland	92	37	52	0	2	1	0	0	40%	57%	3%
Human managed	13	8	5	0	0	0	0	0	62%	38%	0%
Marsh	84	27	48	2	1	4	2	0	32%	57%	11%
Prairie	30	8	17	0	0	1	4	0	27%	57%	17%
Other	4	4	0	0	0	0	0	0	100%	0%	0%
Not reported	5	0	0	0	0	0	0	5	0%	0%	100%
Division C – MP 5.75–13											
Forested wetland	566	167	158	49	44	47	88	13	30%	28%	43%
Forested upland	259	132	82	20	17	5	3	0	51%	32%	17%
Human managed	23	15	6	1	1	0	0	0	65%	26%	9%
Marsh	74	34	23	10	4	0	3	0	46%	31%	23%
prairie	42	27	8	1	5	0	1	0	64%	19%	17%
Other	19	9	3	2	5	0	0	0	47%	16%	37%
Not reported	6	3	3	0	0	0	0	0	50%	50%	0%

Table 4. Oiling by habitat type (cont.)

Habitat type	Total number of waypoints	Percent oiling							%0	%1–10	% > 10
		0	1–10	11–30	31–50	51–70	71–90	91–100			
Division C – MP 13–15.25											
Forested wetland	89	25	46	7	4	2	5	0	28%	52%	20%
Forested upland	58	19	18	12	9	0	0	0	33%	31%	36%
Human managed	1	1	0	0	0	0	0	0	100%	0%	0%
Marsh	35	17	11	1	4	0	1	1	49%	31%	20%
Prairie	8	4	3	1	0	0	0	0	50%	38%	13%
Other	20	2	7	11	0	0	0	0	10%	35%	55%
Not reported	4	0	2	2	0	0	0	0	0%	50%	50%
Division D – MP 18–19.75											
Forested wetland	5	5	0	0	0	0	0	0	100%	0%	0%
Forested upland	8	7	1	0	0	0	0	0	88%	13%	0%
Human managed	0	0	0	0	0	0	0	0	NA	NA	NA
Marsh	0	0	0	0	0	0	0	0	NA	NA	NA
Prairie	4	4	0	0	0	0	0	0	100%	0%	0%
Other	7	6	1	0	0	0	0	0	86%	14%	0%
Not reported	0	0	0	0	0	0	0	0	NA	NA	NA
Division D – MP 20.25–22.75											
Forested wetland	66	35	31	0	0	0	0	0	53%	47%	0%
Forested upland	66	54	12	0	0	0	0	0	82%	18%	0%
Human managed	2	1	1	0	0	0	0	0	50%	50%	0%
Marsh	3	3	0	0	0	0	0	0	100%	0%	0%
Prairie	0	0	0	0	0	0	0	0	NA	NA	NA
Other	0	0	0	0	0	0	0	0	NA	NA	NA
Not reported	0	0	0	0	0	0	0	0	NA	NA	NA

Table 4. Oiling by habitat type (cont.)

Habitat type	Total number of waypoints	Percent oiling							%0	%1–10	% > 10
		0	1–10	11–30	31–50	51–70	71–90	91–100			
Division E – MP 23.25–24.25											
Forested wetland	3	2	1	0	0	0	0	0	67%	33%	0%
Forested upland	6	5	1	0	0	0	0	0	83%	17%	0%
Human managed	2	2	0	0	0	0	0	0	100%	0%	0%
Marsh	0	0	0	0	0	0	0	0	NA	NA	NA
Prairie	0	0	0	0	0	0	0	0	NA	NA	NA
Other	0	0	0	0	0	0	0	0	NA	NA	NA
Not reported	0	0	0	0	0	0	0	0	NA	NA	NA
Division E – MP 28.75–32.25											
Forested wetland	56	52	4	0	0	0	0	0	93%	7%	0%
Forested upland	35	35	0	0	0	0	0	0	100%	0%	0%
Human managed	0	0	0	0	0	0	0	0	NA	NA	NA
Marsh	2	1	1	0	0	0	0	0	50%	50%	0%
Prairie	0	0	0	0	0	0	0	0	NA	NA	NA
Other	0	0	0	0	0	0	0	0	NA	NA	NA
Not reported	0	0	0	0	0	0	0	0	NA	NA	NA

4.3 Habitat Feature Results

Table 5 summarizes the results of the habitat feature data collection. Because of the change in protocols, habitat feature data collected before and on August 27, 2010 may not be comparable to data collected after August 27, 2010. Table 6 summarizes the information on observations of skunk cabbage. These data were collected because the NRDA group had anecdotal evidence at the time of the survey that this species may be sensitive to oil (Chuck Getter, Research Planning Inc., Senior Ecologist, personal communication, August 18, 2010). These data show that skunk cabbage was observed at 212 locations; defoliated plants were observed at 160 locations,and plants growing new shoots were observed in 87 locations.

Table 5. Summary of habitat feature results[a]

	Number of observations				
Division (MP)[b]	**Pooled oil > 50 ft^2**	**Water feature > 50 ft^2**	**Vernal pool > 50 ft^2**	**Downed tree > 4 in. DBH**	**Skunk cabbage**
Division C (MP 2.25–17.25)					
ODA	60	60	17	81	62
Transect	15	185	36	270	141
Division D (MP 17.5–23.75)					
ODA[c]	NA	NA	NA	NA	NA
Transect	0	4	0	9	0
Division E (MP 24–40)					
ODA[c]	NA	NA	NA	NA	NA
Transect	0	50	1	42	8

a. From August 13 to 27, 2010, habitat features were recorded for all waypoints. During this time, the floodplain survey covered most areas in Division C, island habitats, and 11 transects in Division D. From August 28 to September 2, 2010 (during which time the survey covered Division E, and parts of Division D), observations of habitat features were recorded only for ODAs as a whole, and no longer for transect waypoints or for each individual waypoint in an ODA.
b. Although 2 transects were completed in Division B, the data were collected using the modified protocol and there were no ODAs delineated. Thus, no data about habitat features were recorded in Division B.
c. No ODAs were identified in Divisions D and E.

Figures 40–43 show the waypoint locations where water features or vernal pools were identified and the degree of oiling recorded at those locations for the time period that information on these habitat features was collected. The maps show the transects where this information was and was not collected.

Figures 40–43 illustrate that the highest density of water features and vernal pools were observed from MP 7–15. This is also the area where the highest degree of oiling was observed in the field.

Table 6. Presence and health of skunk cabbage

	Skunk cabbage (number of observations)			
Division (MP)[a]	**Presence**	**Healthy**	**Defoliated**	**New shoots**
Division C (MP 2.25–17.25)				
ODA	62	4	50	40
Transect	141	37	110	46
Division D (MP 17.5–23.75)				
ODA[b]	NA	NA	NA	NA
Transect	0	0	0	0
Division E (MP 24–40)				
ODA[b]	NA	NA	NA	NA
Transect	8	2	5	1

a. Although 2 transects were completed in Division B, the data were collected using the modified protocol and there were no ODAs delineated. Thus, no data about habitat features were recorded at these two transects.
b. No ODAs were identified in Divisions D and E.

References

AECOM. 2011. Enbridge Energy, Limited Partnership Line 6B Incident, Marshall, Michigan. Conceptual Site Model. Prepared May 10, 2011, approved July 8, 2011. Available: http://www.michigan.gov/deq/0,4561,7-135-3313_56784-248127--,00.html. Accessed 8/2/2011.

Owens, E.H. and G.A. Sergy. 1994 *Field Guide to the Documentation and Description of Oiled Shorelines*. Environment Canada, Edmonton, Alberta, Canada. March. ISBN 0-662-22048-X.

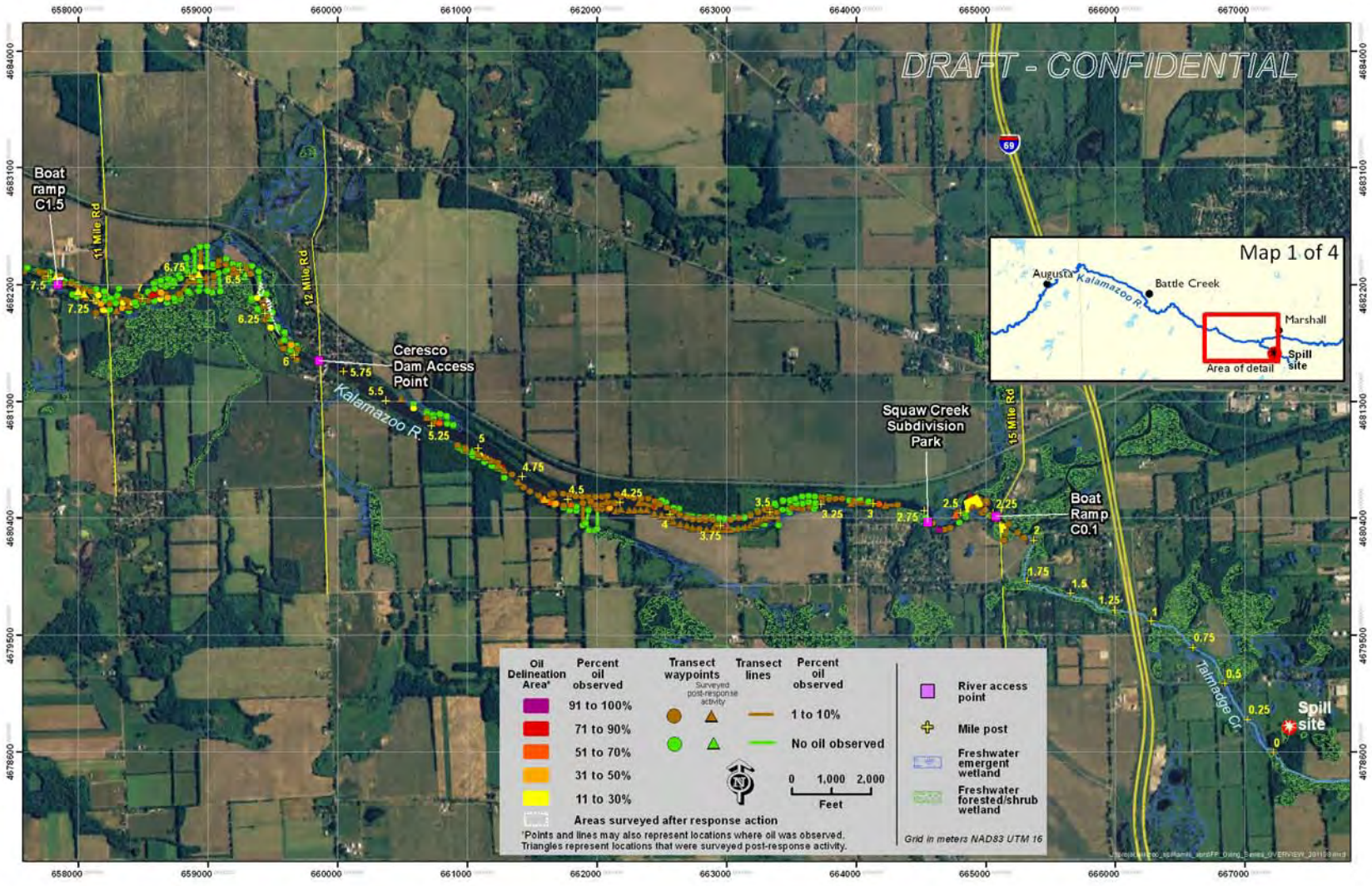

Figure 9. Overview map showing the transects and ODAs surveyed during the floodplain survey (MP 0–7.5).

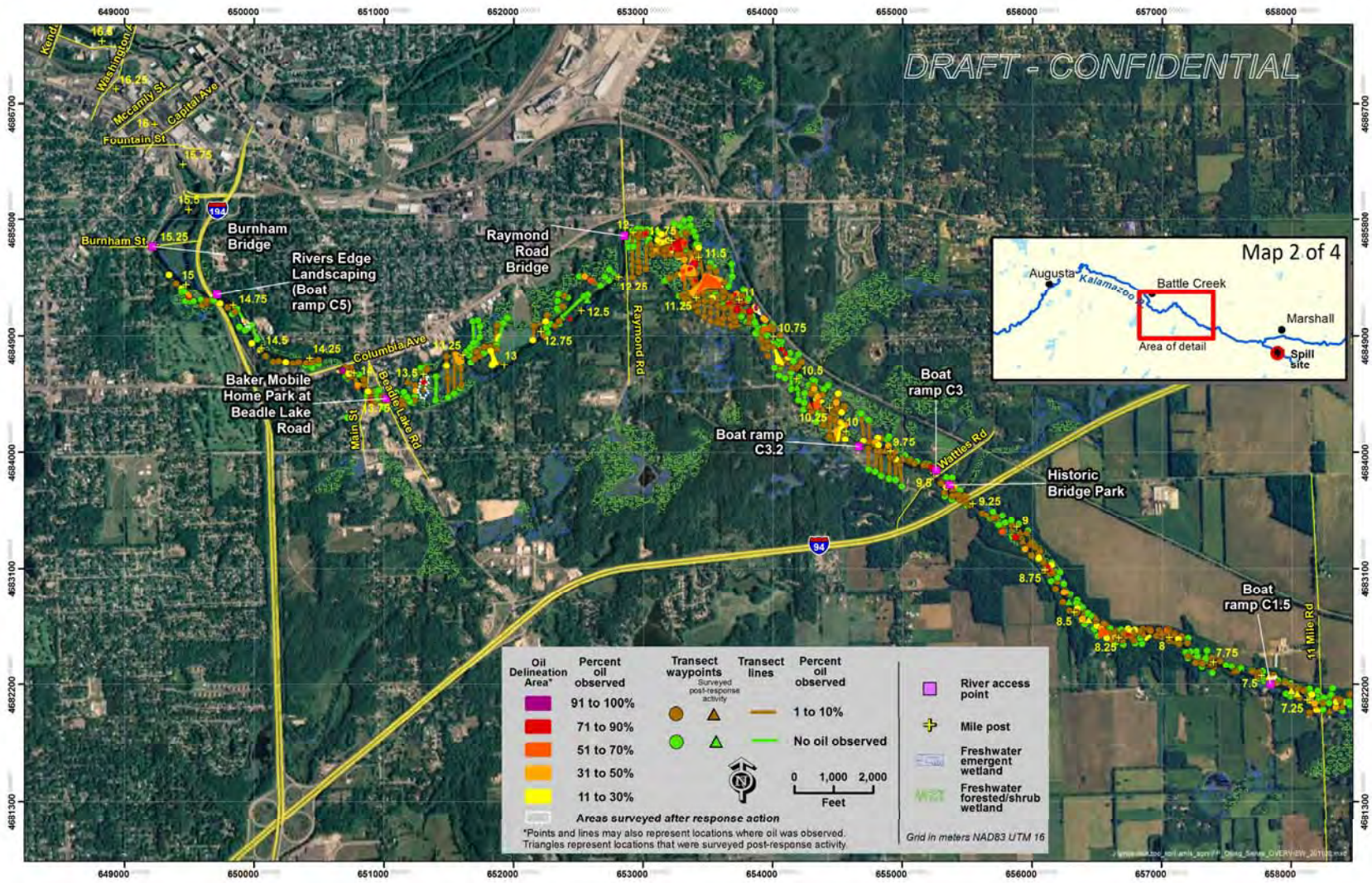

Figure 10. Overview map showing the transects and ODAs surveyed during the floodplain survey (MP 7.25–16.5).

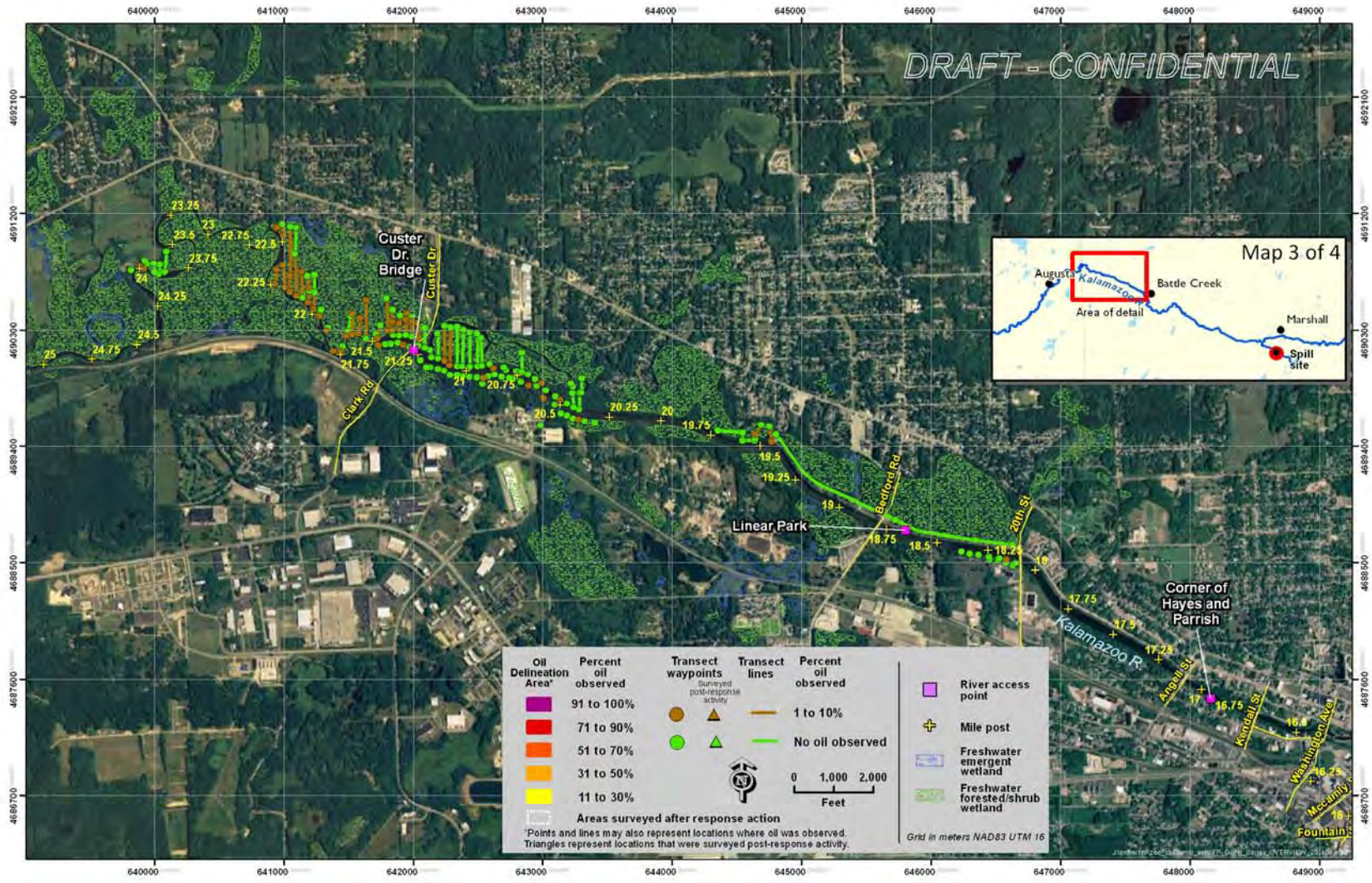

Figure 11. Overview map showing the transects and ODAs surveyed during the floodplain survey (MP 16–25).

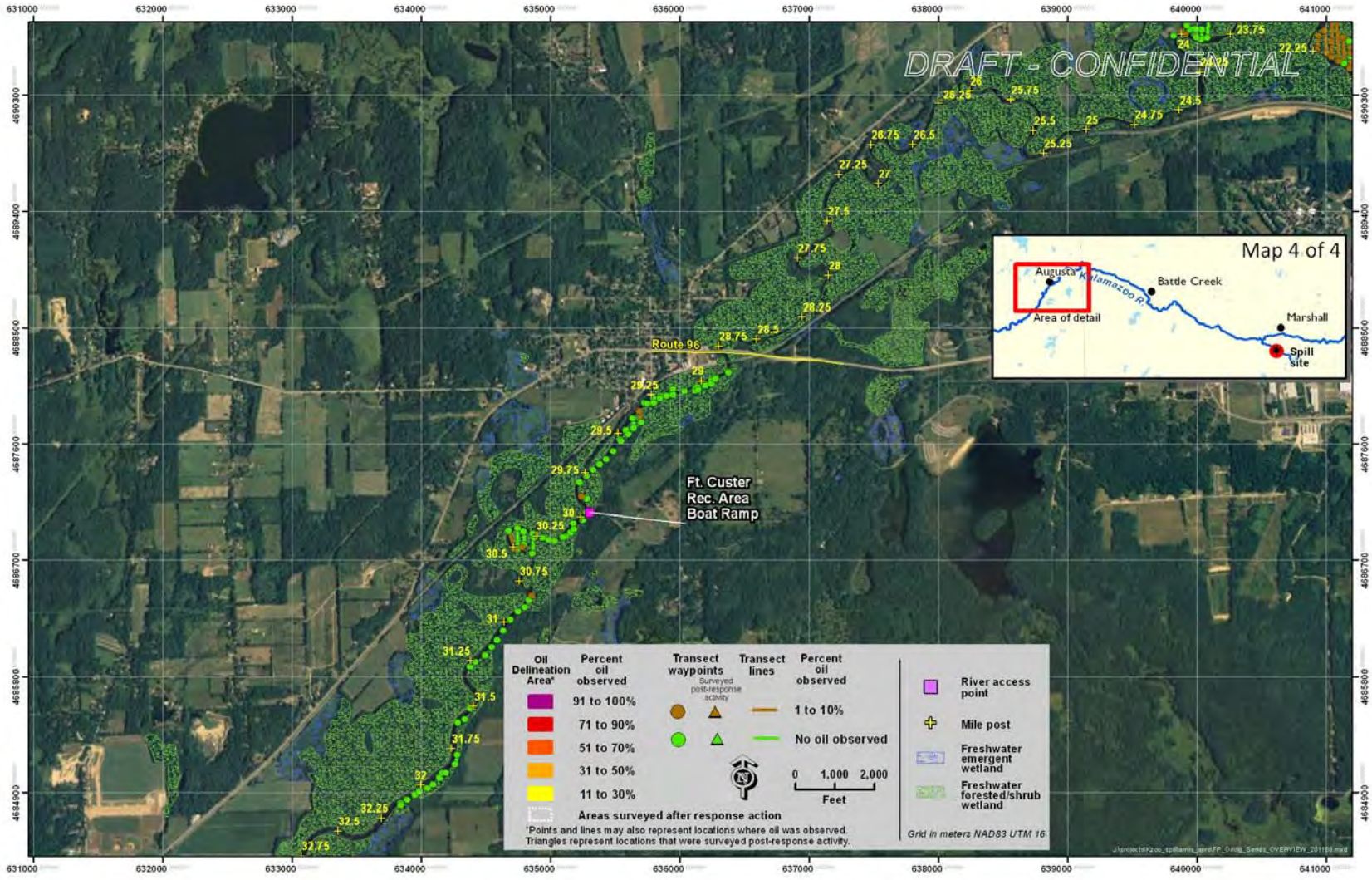

Figure 12. Overview map showing the transects and ODAs surveyed during the floodplain survey (MP 22.25–32.75).

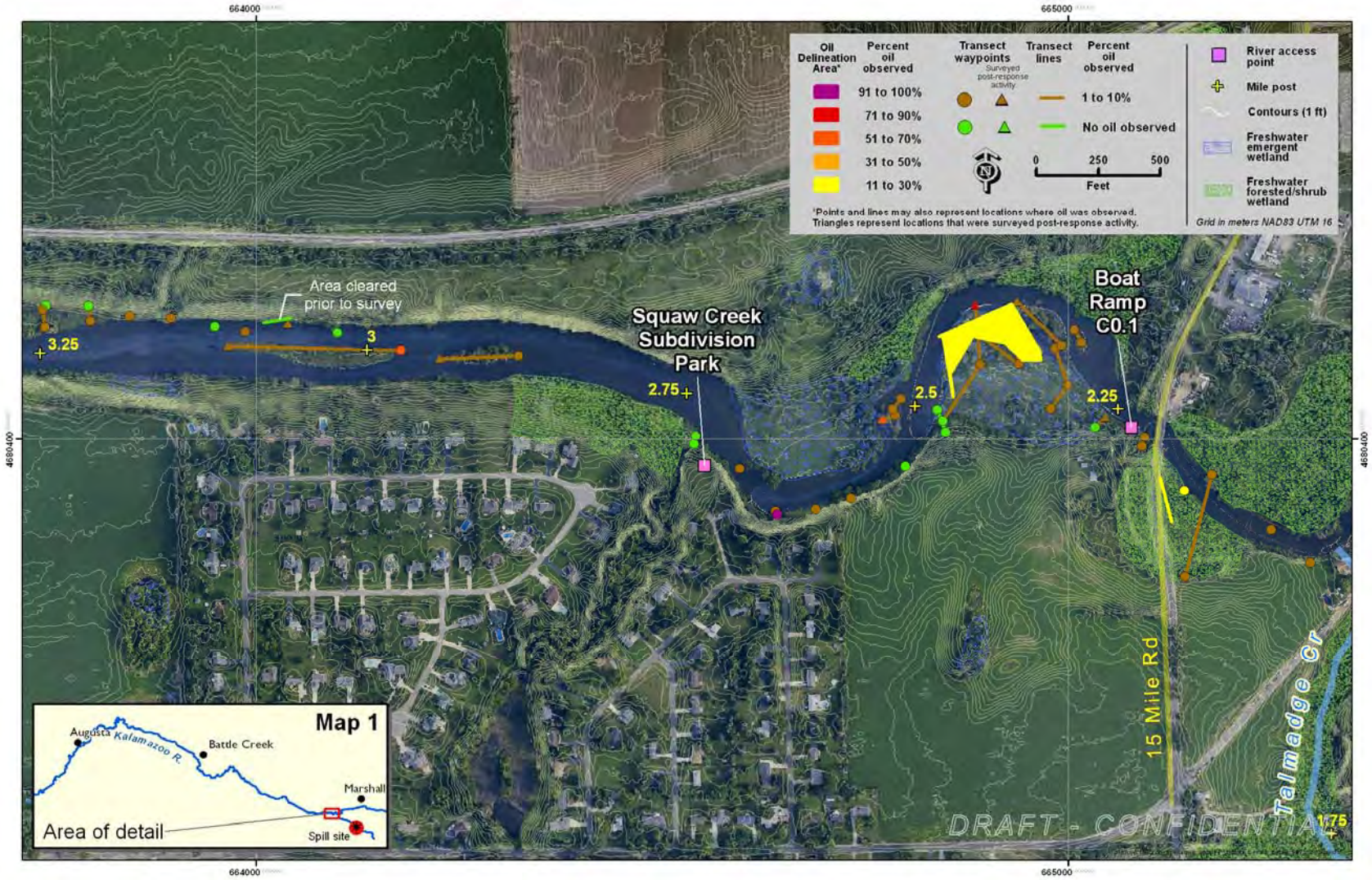

Figure 13. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 2.25–3.25).

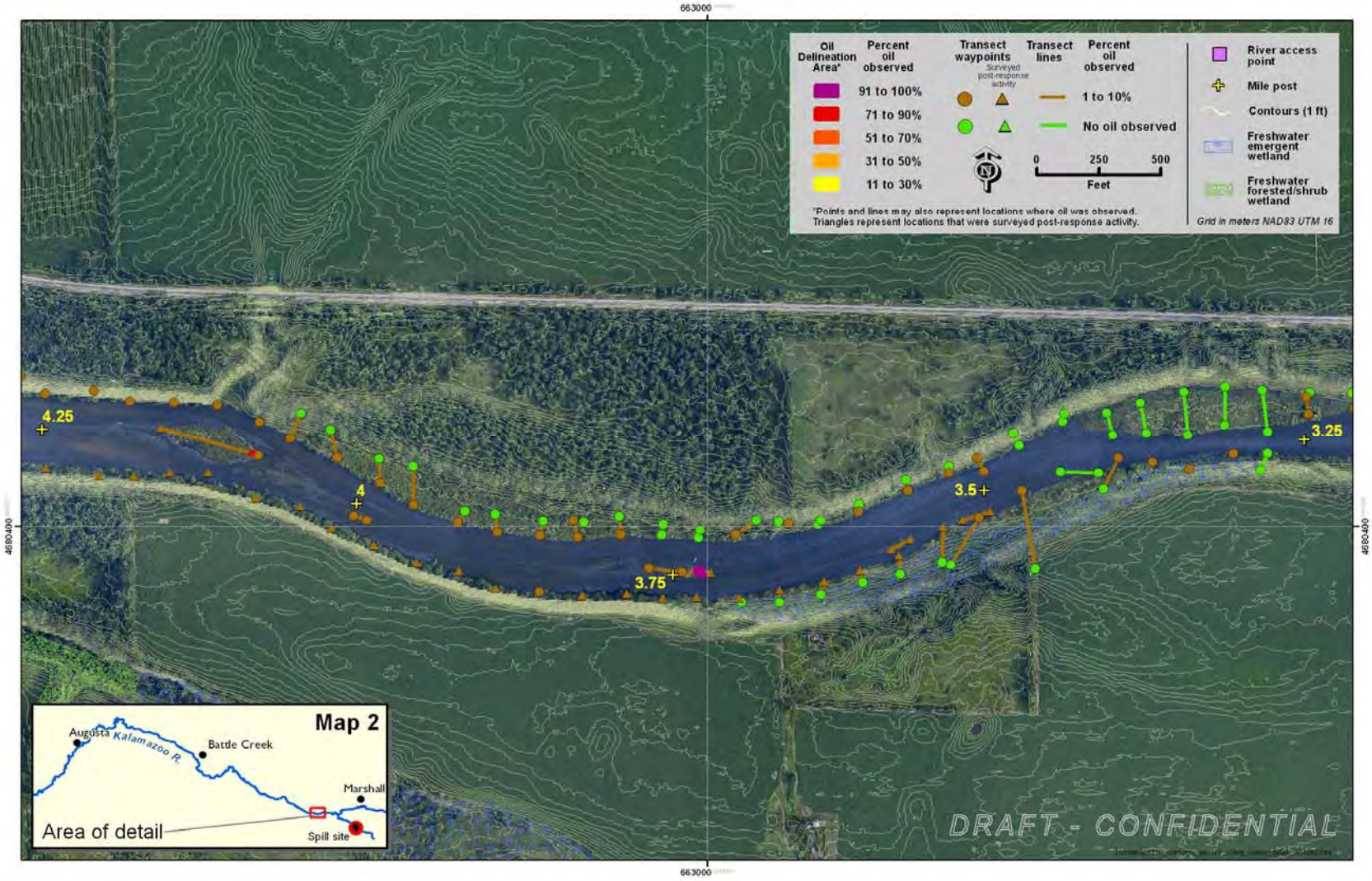

Figure 14. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 3.25–4.25).

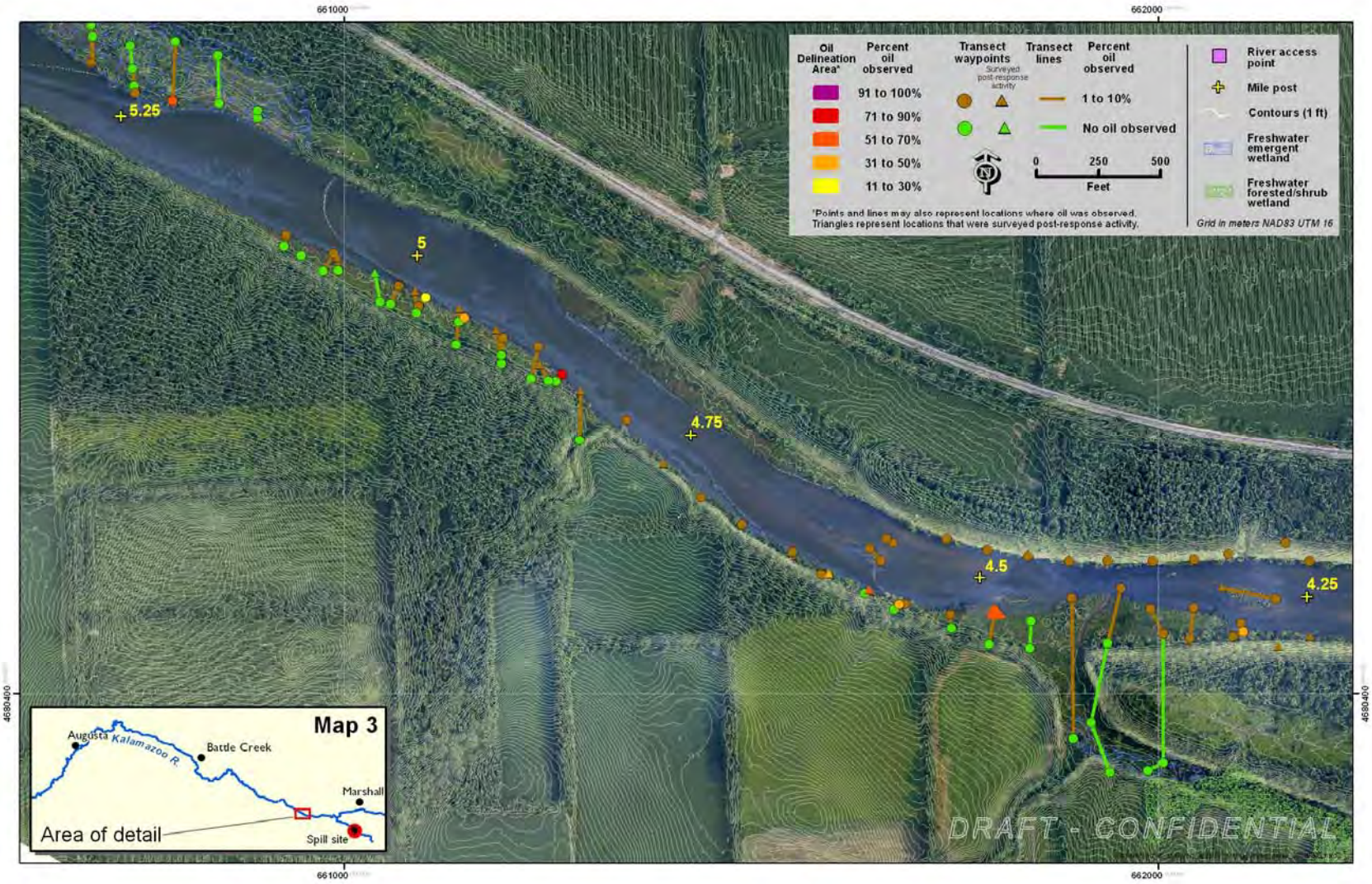

Figure 15. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 4.25–5.25).

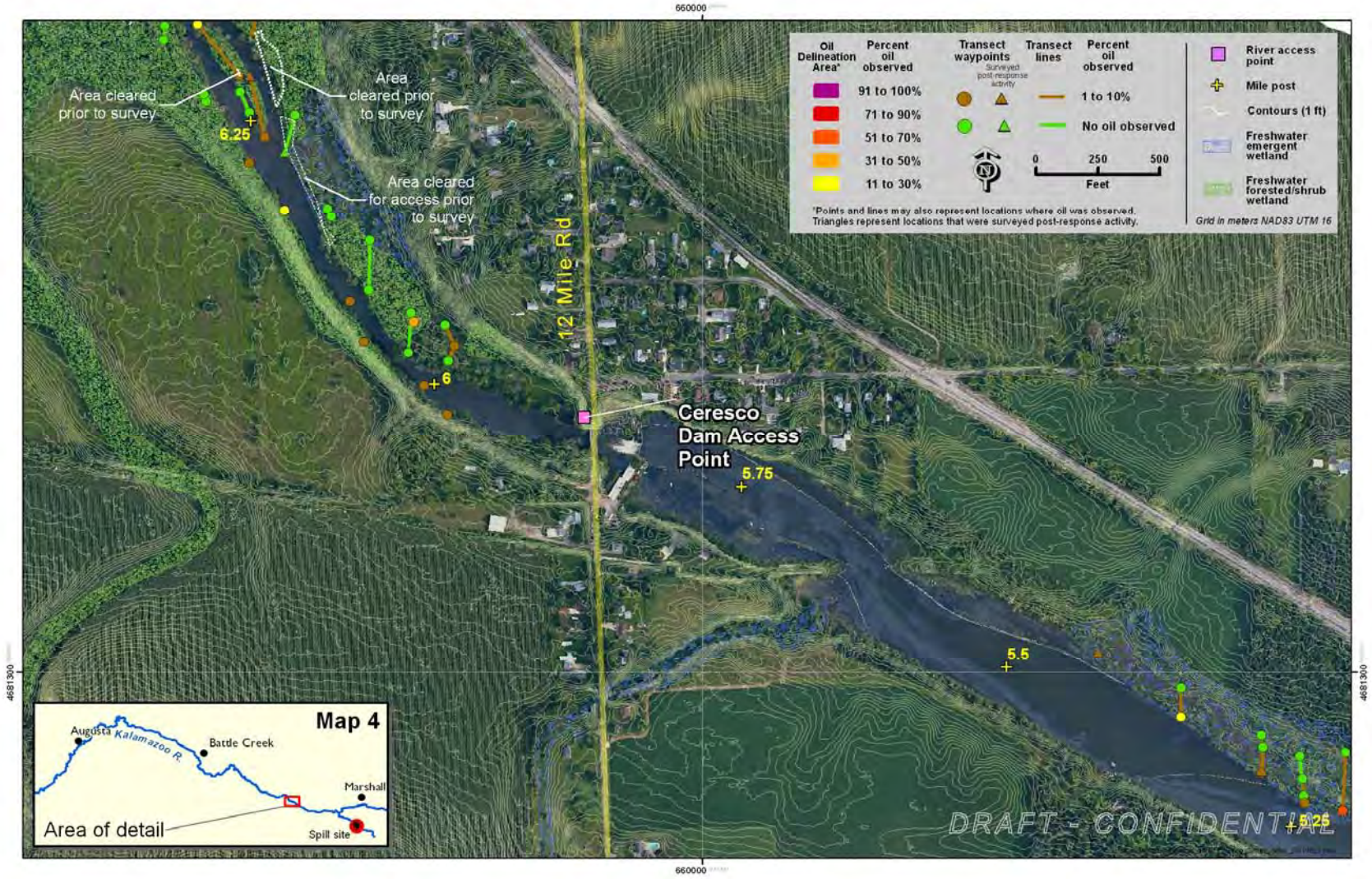

Figure 16. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 5.25–6.25).

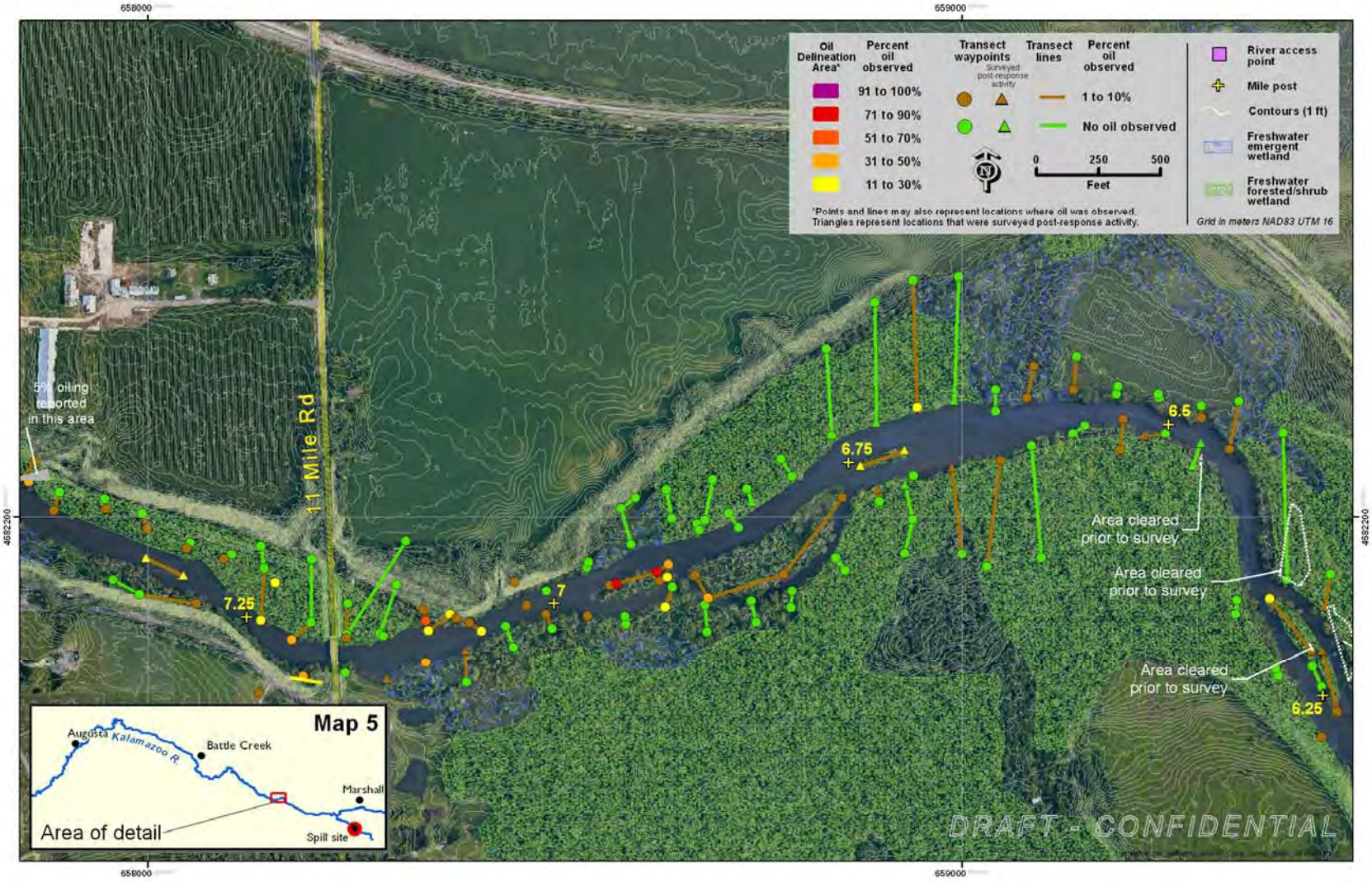

Figure 17. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 6.25–7.25).

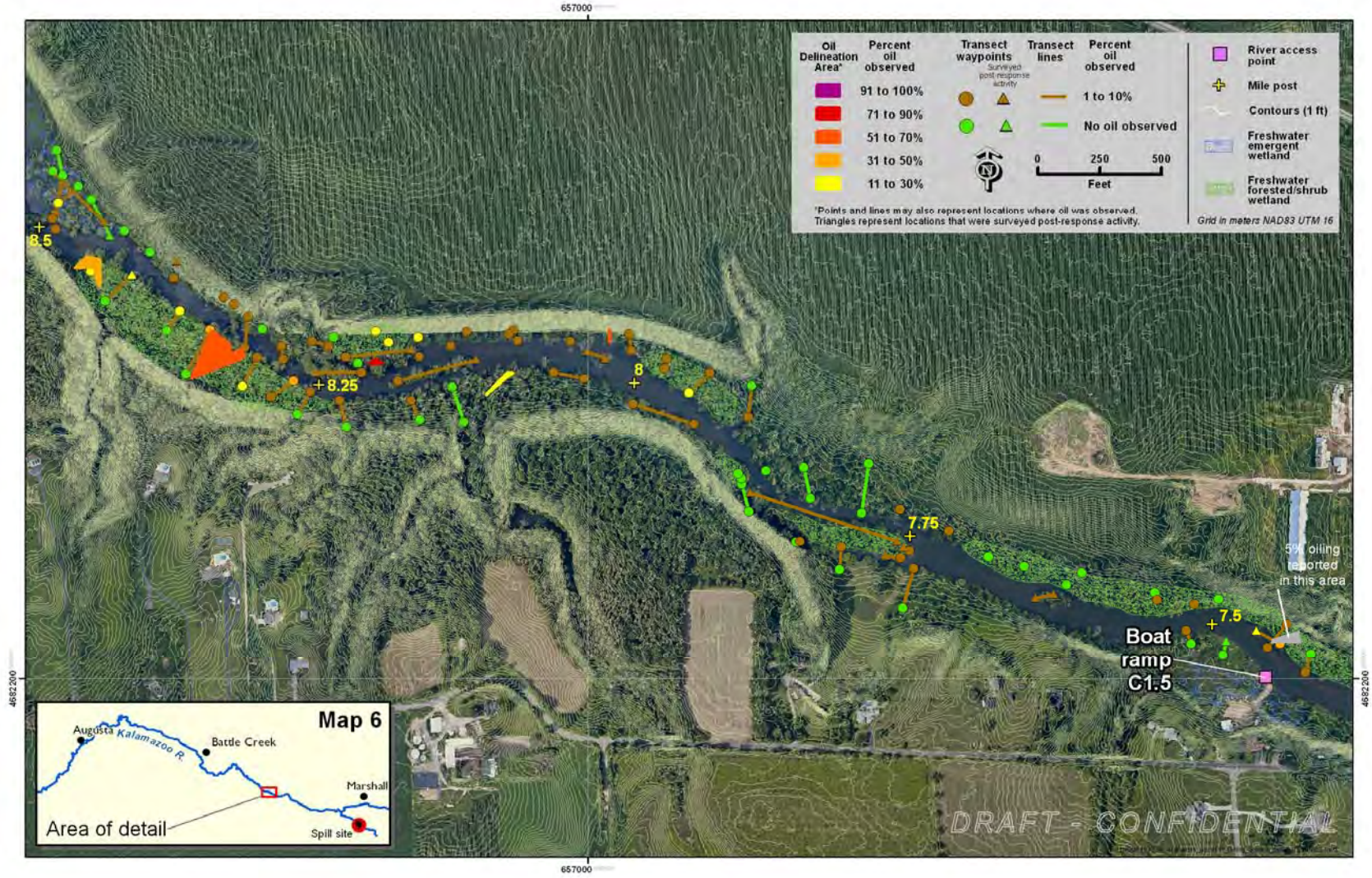

Figure 18. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 7.5–8.5).

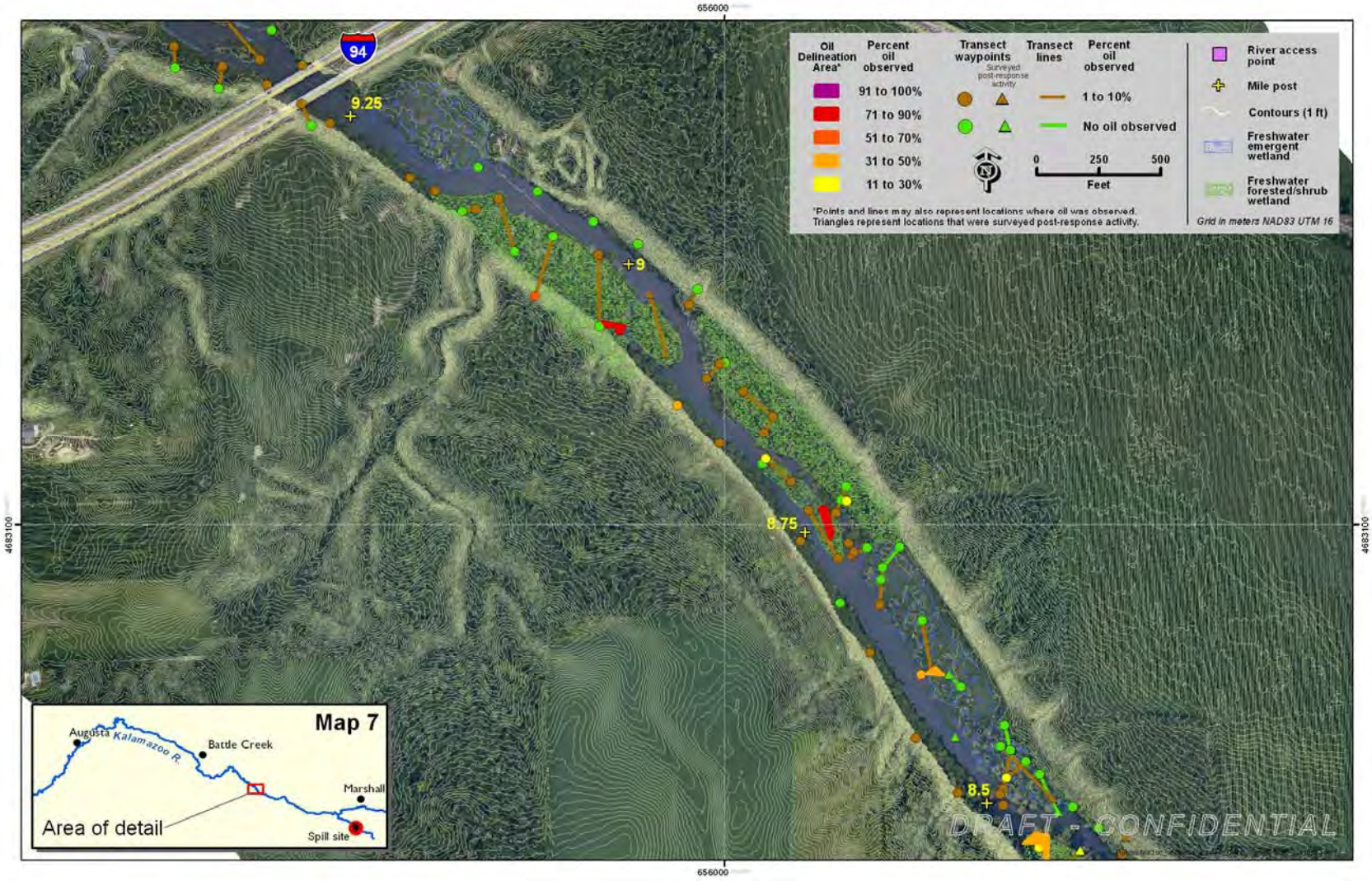

Figure 19. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 8.5–9.25).

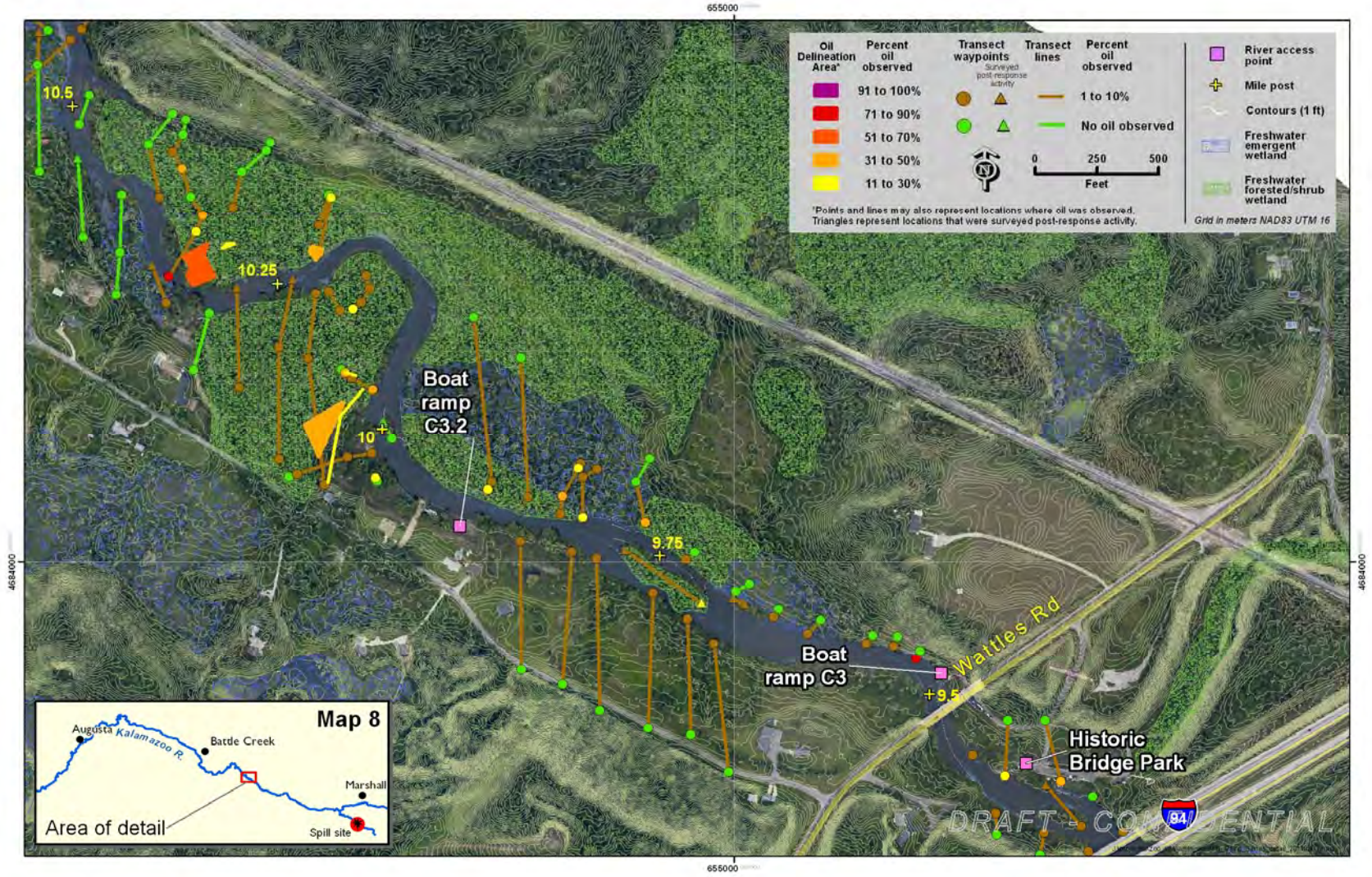

Figure 20. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 9.5–10.5).

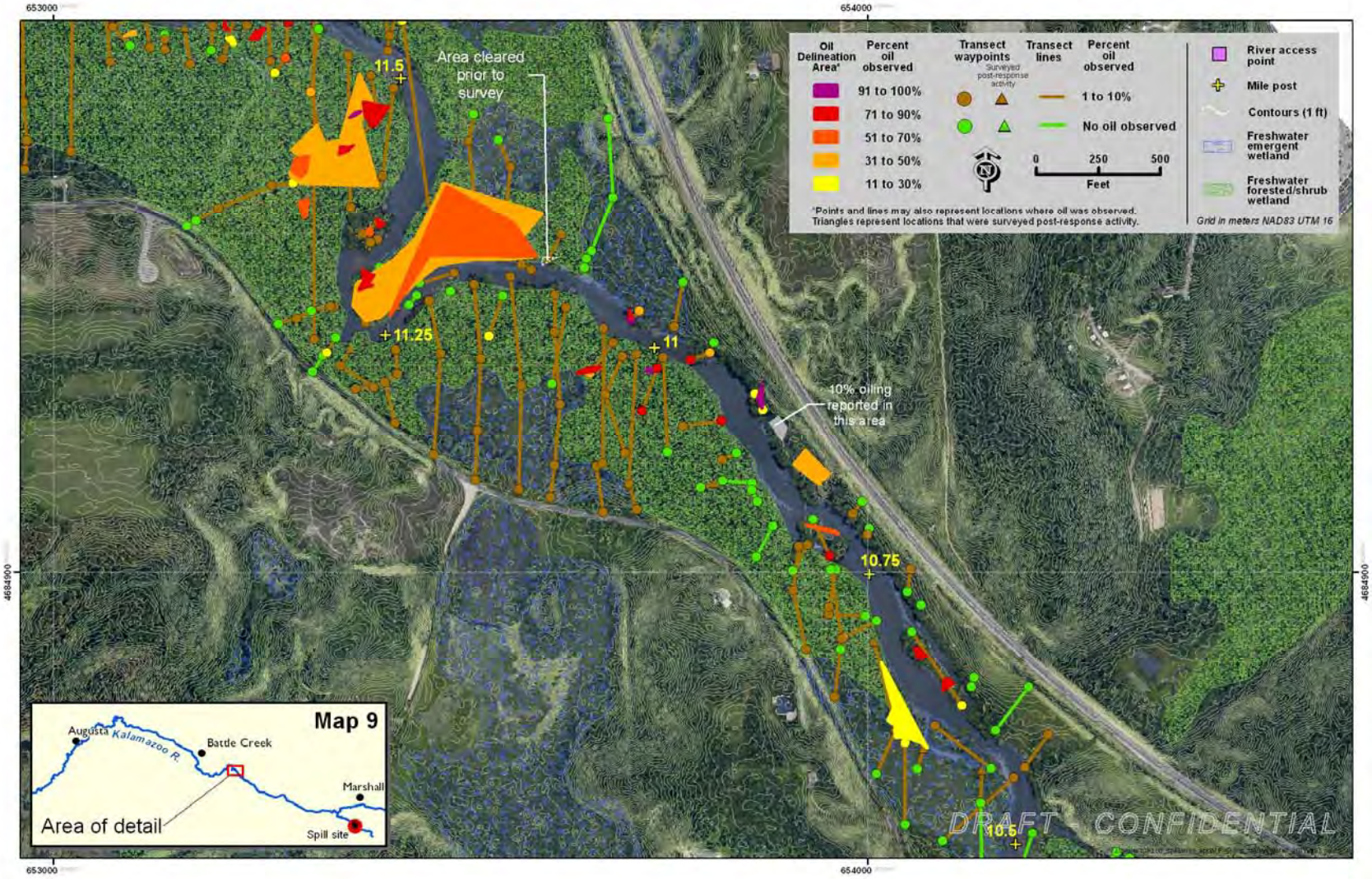

Figure 21. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 10.5–11.5).

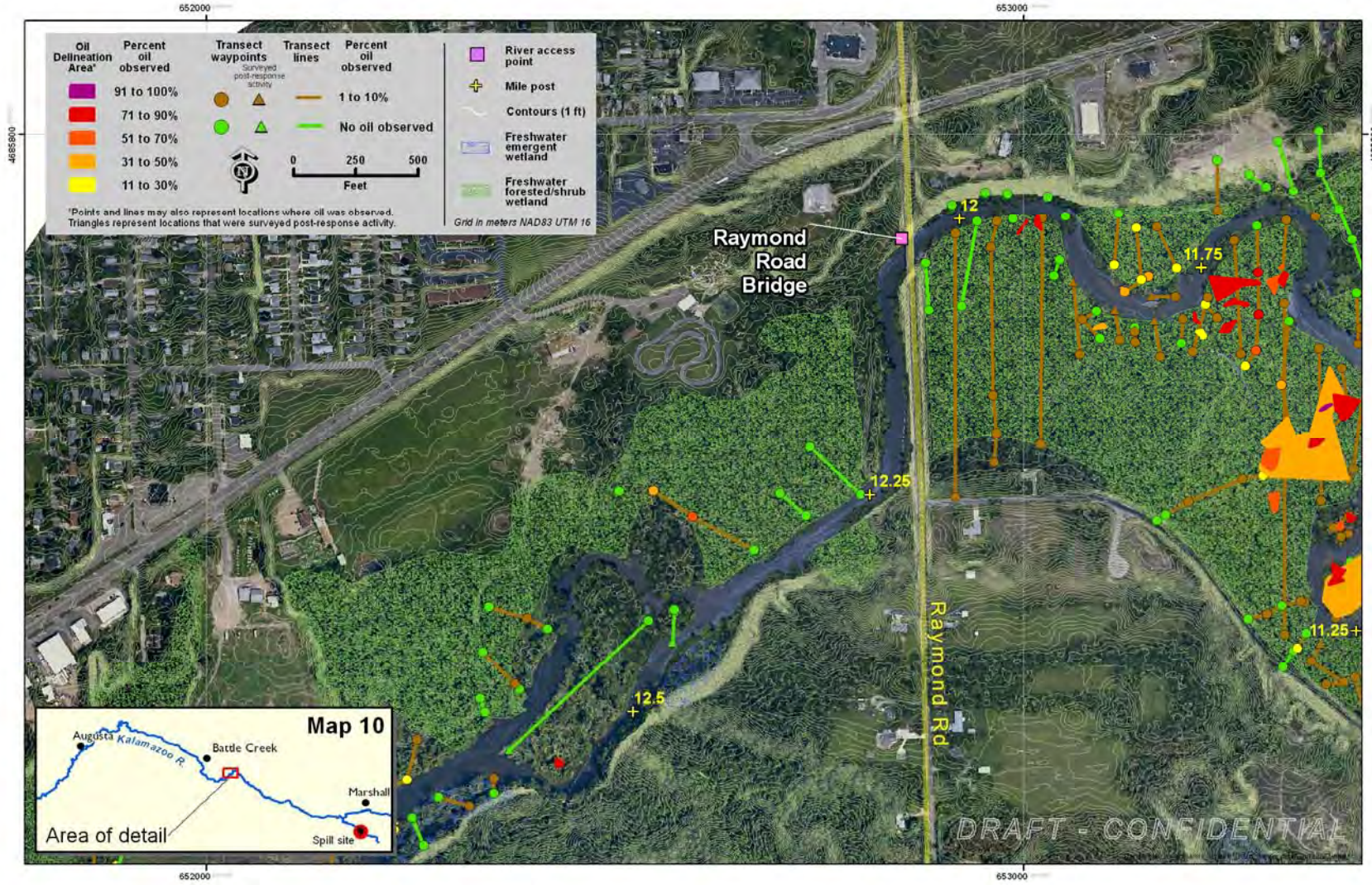

Figure 22. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 11.25–12.5).

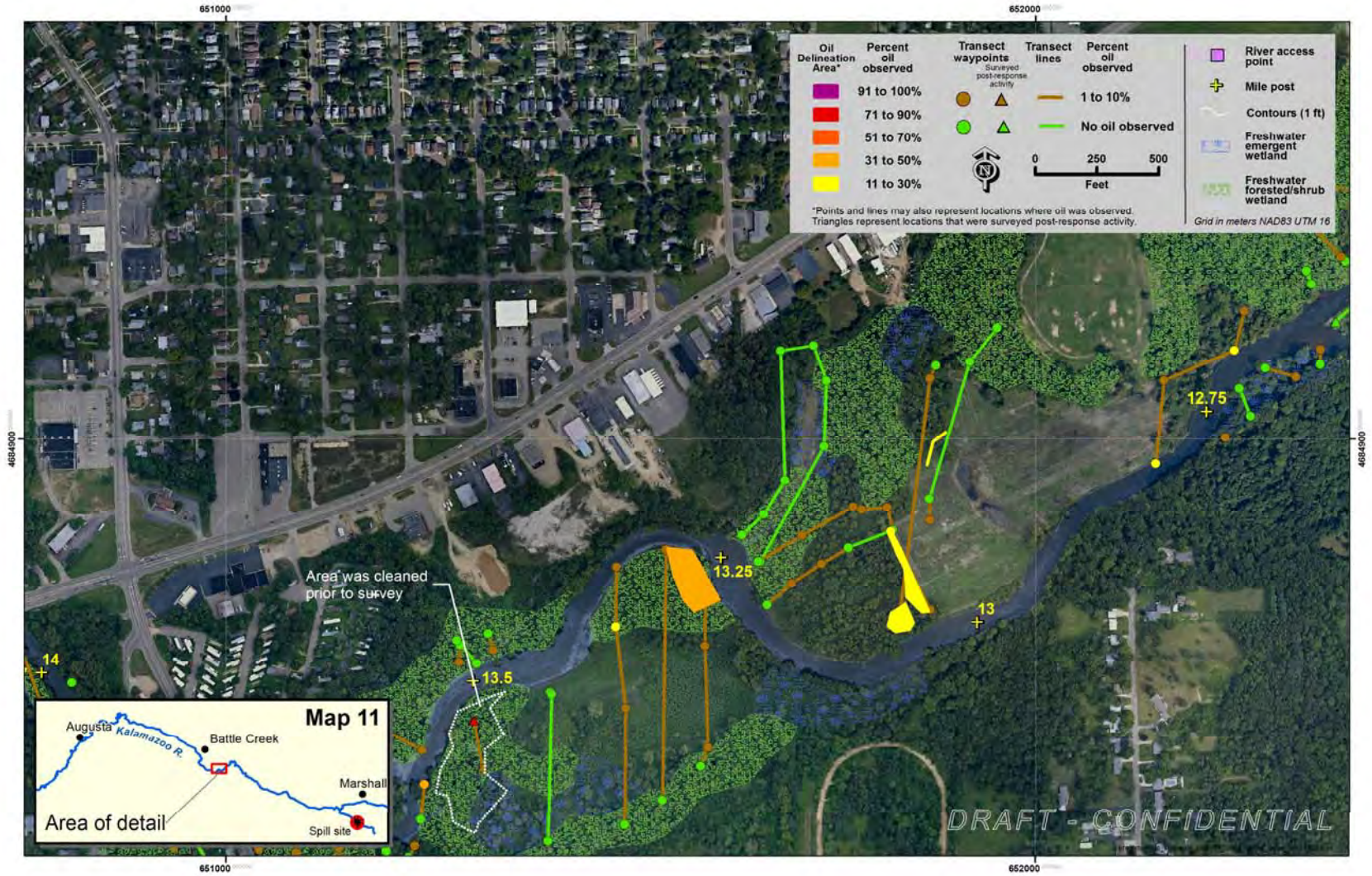

Figure 23. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 12.75–14).

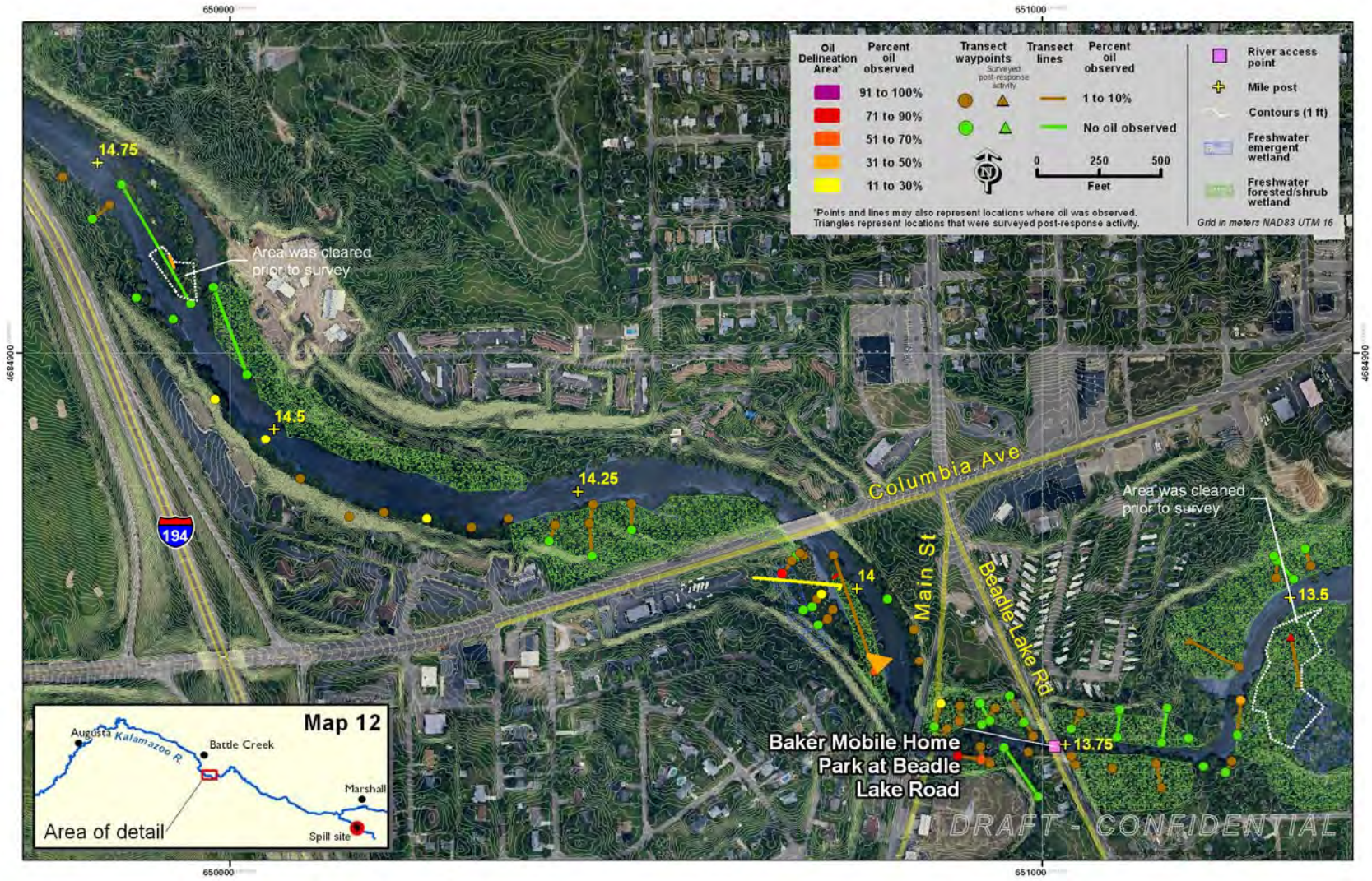

Figure 24. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 13.5–14.75).

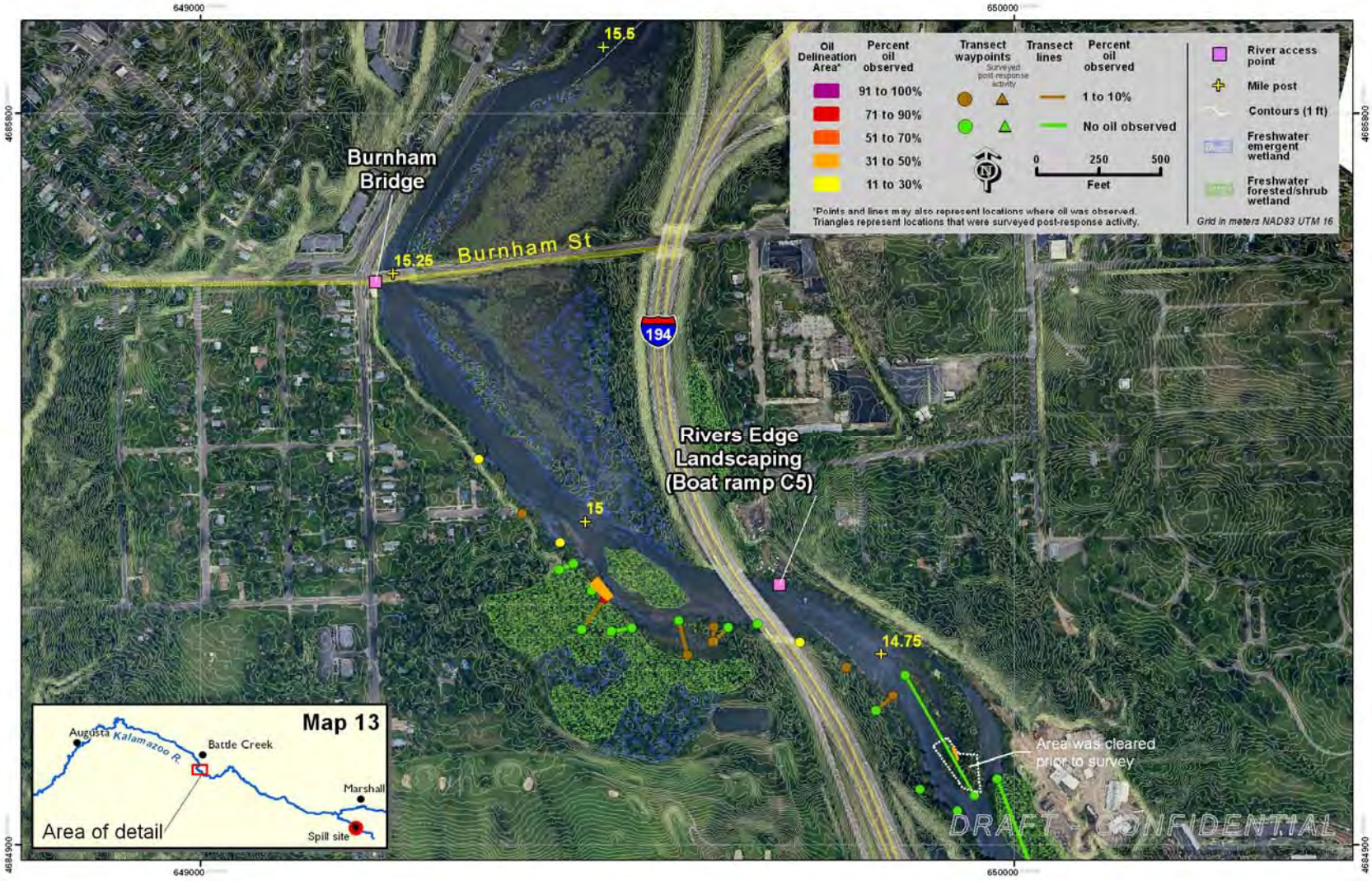

Figure 25. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 14.75–15.5).

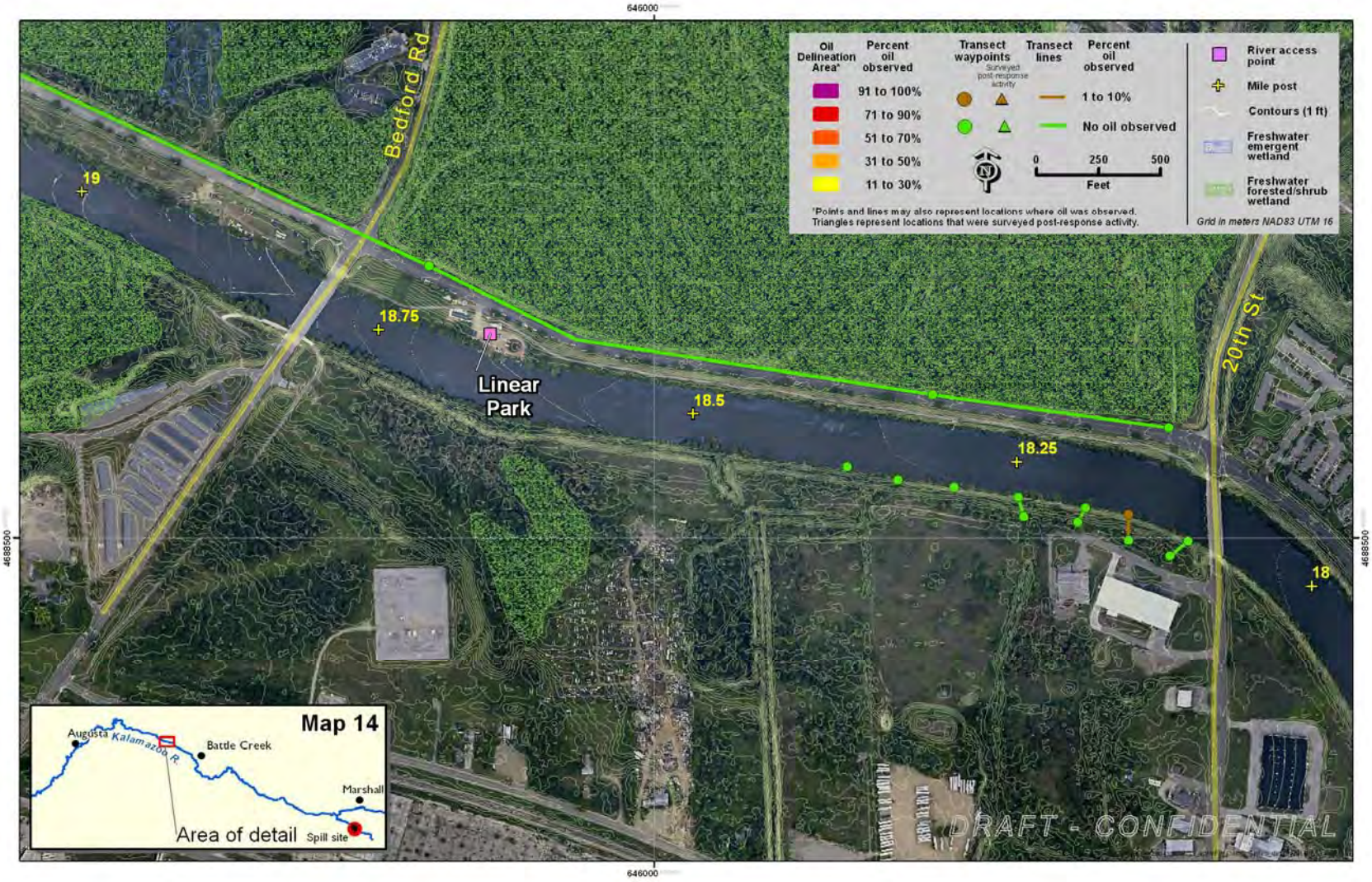

Figure 26. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 18–19).

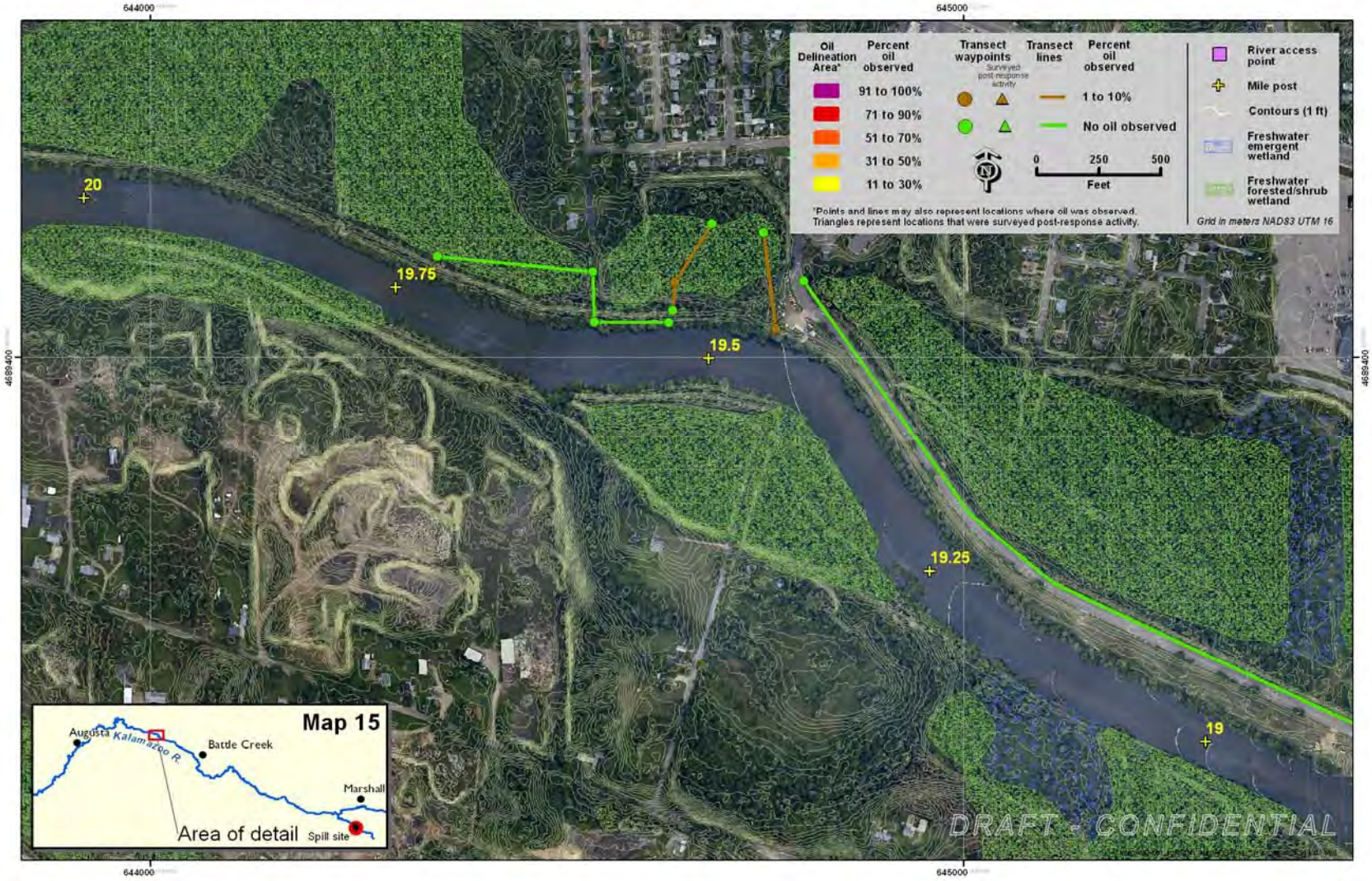

Figure 27. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 19–20).

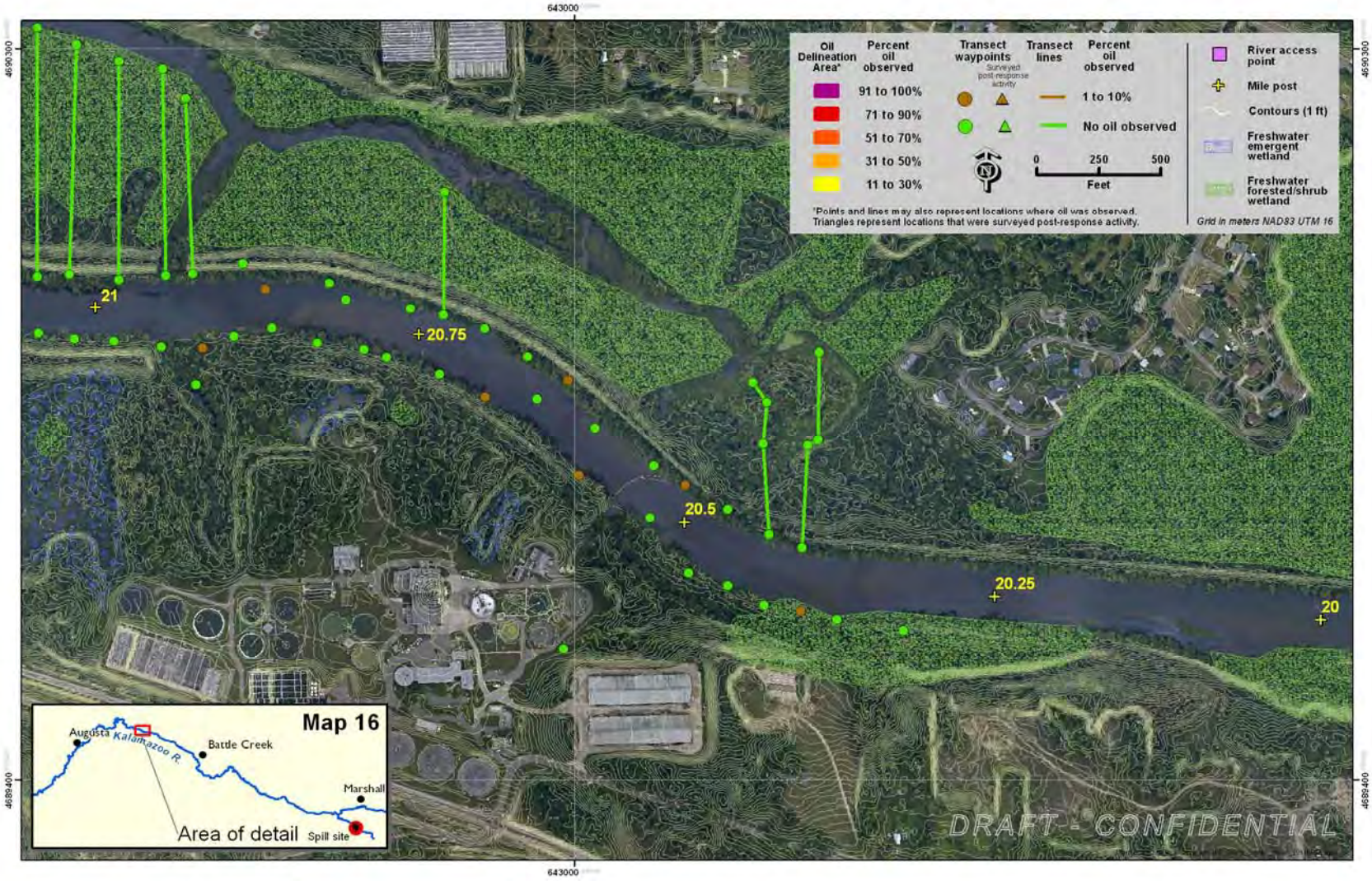

Figure 28. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 20–21).

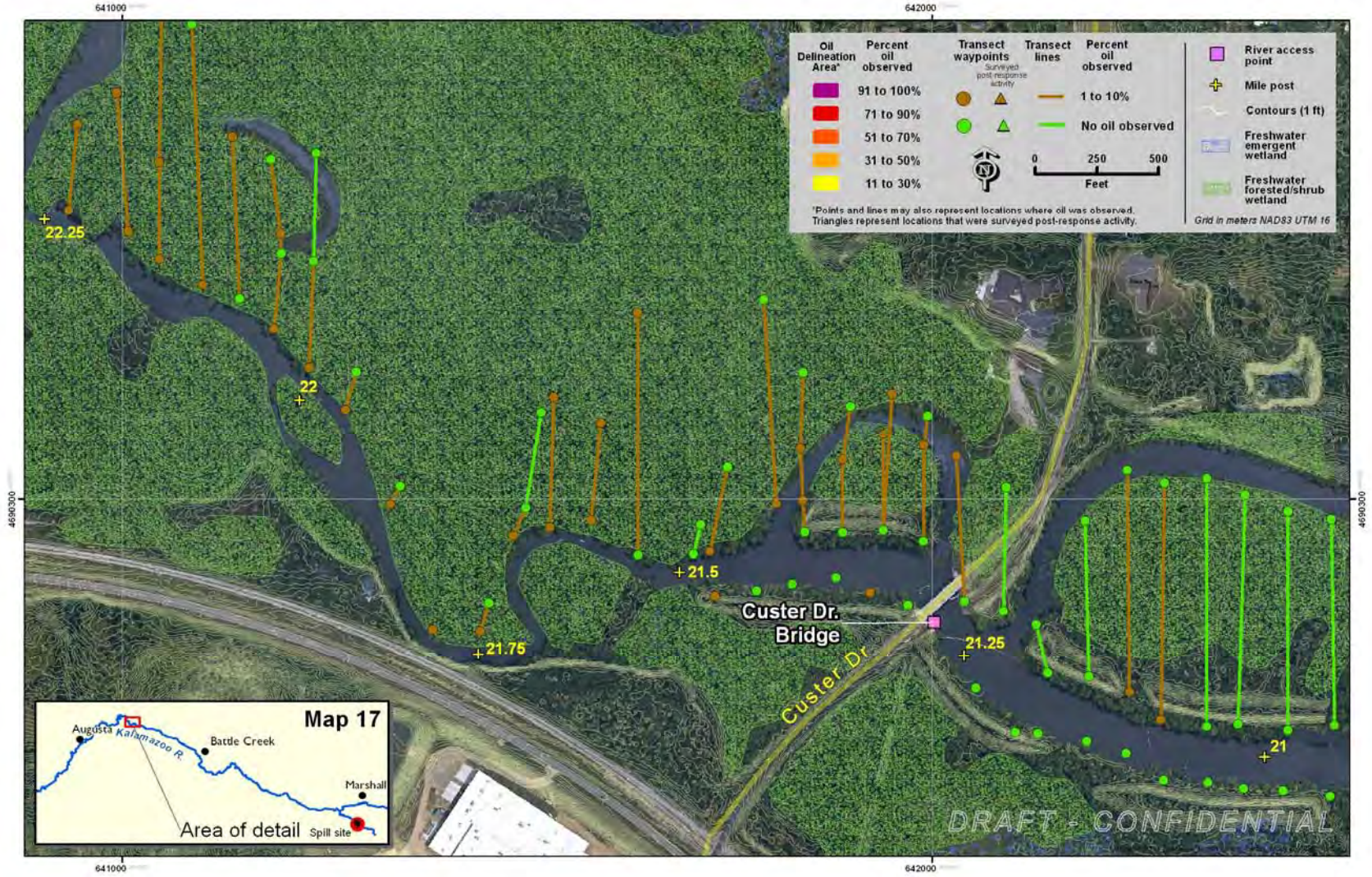

Figure 29. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 21–22.25).

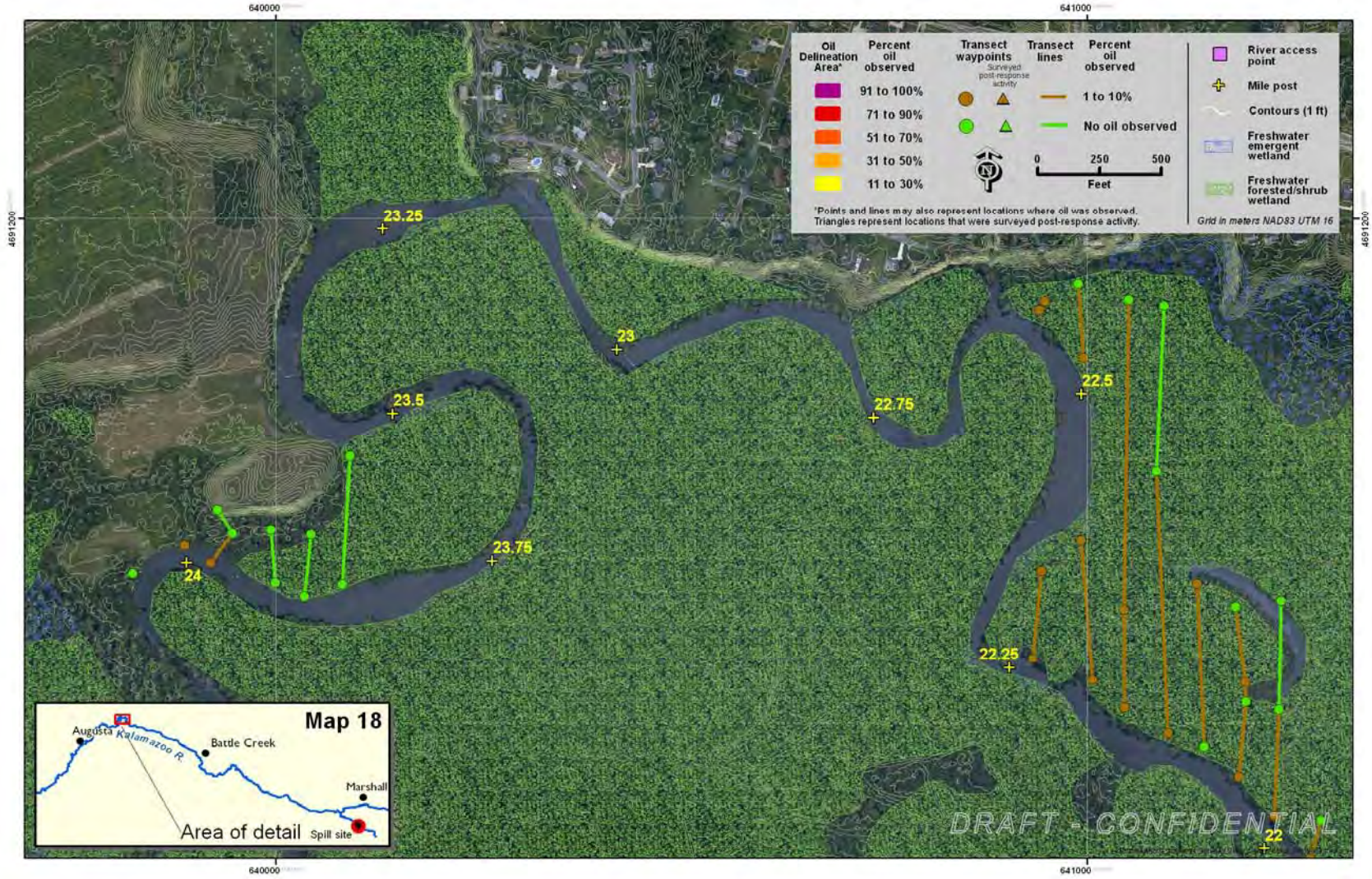

Figure 30. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 22–24).

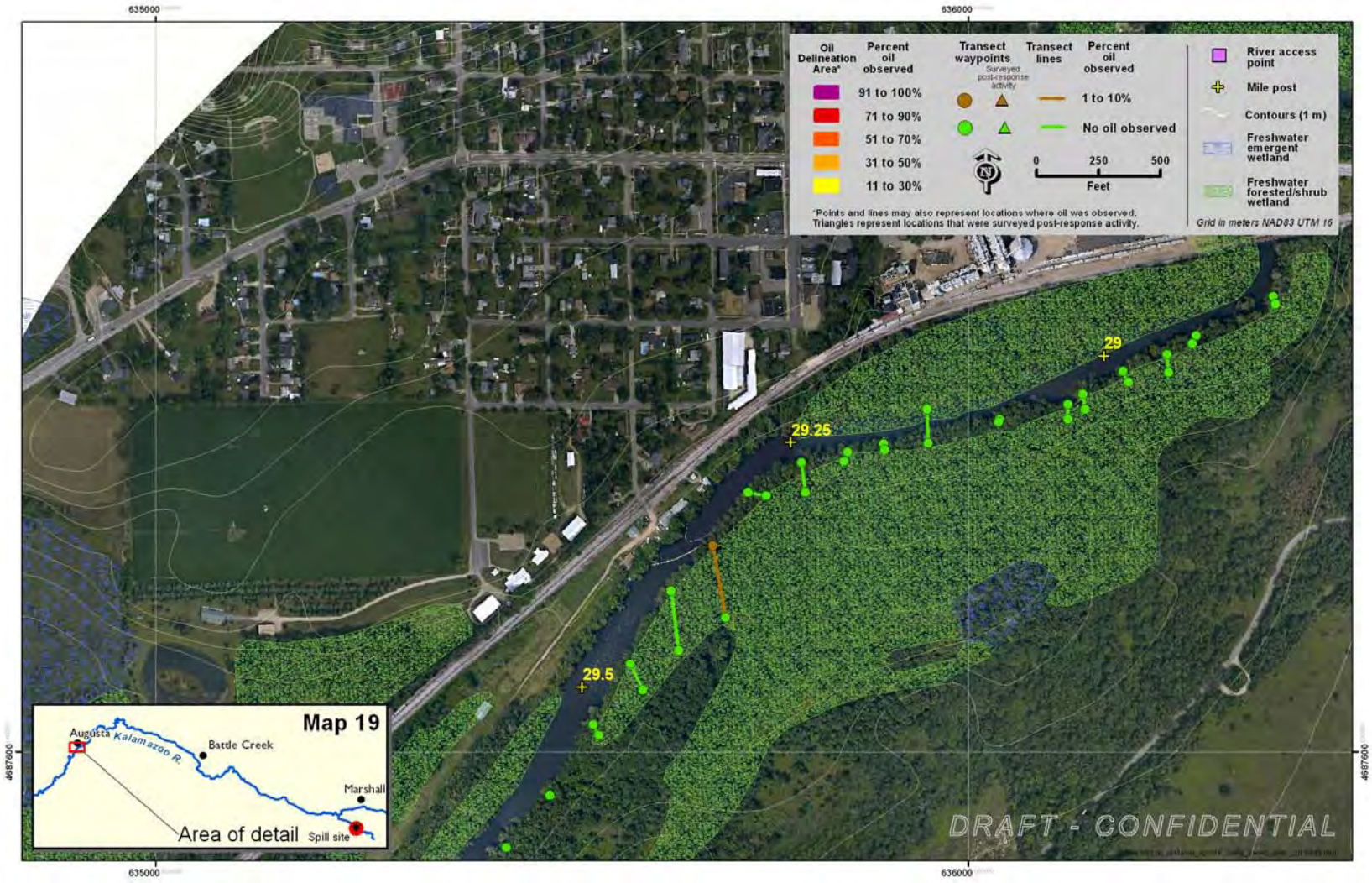

Figure 31. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 29–29.5).

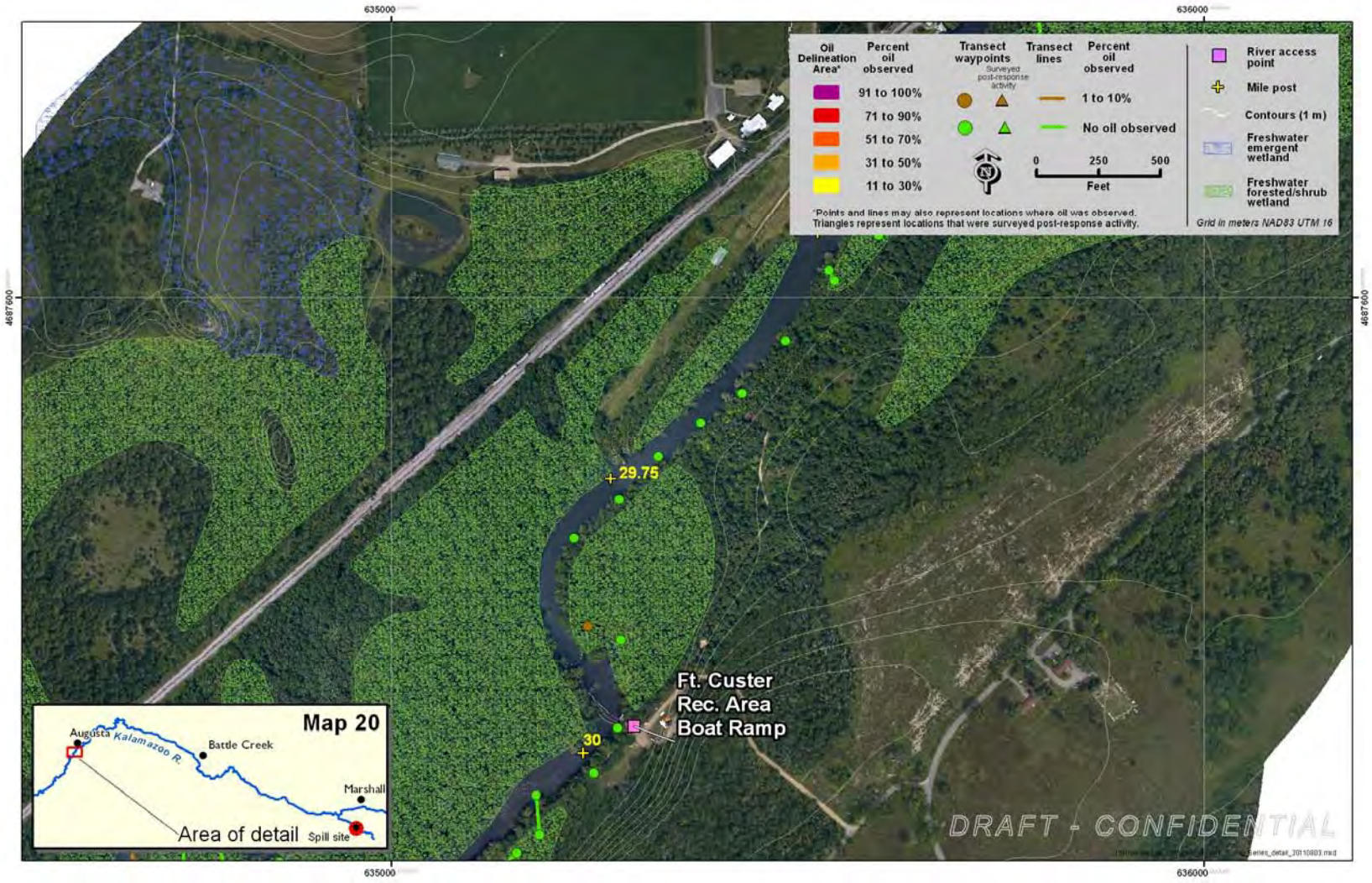

Figure 32. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 29.75–30).

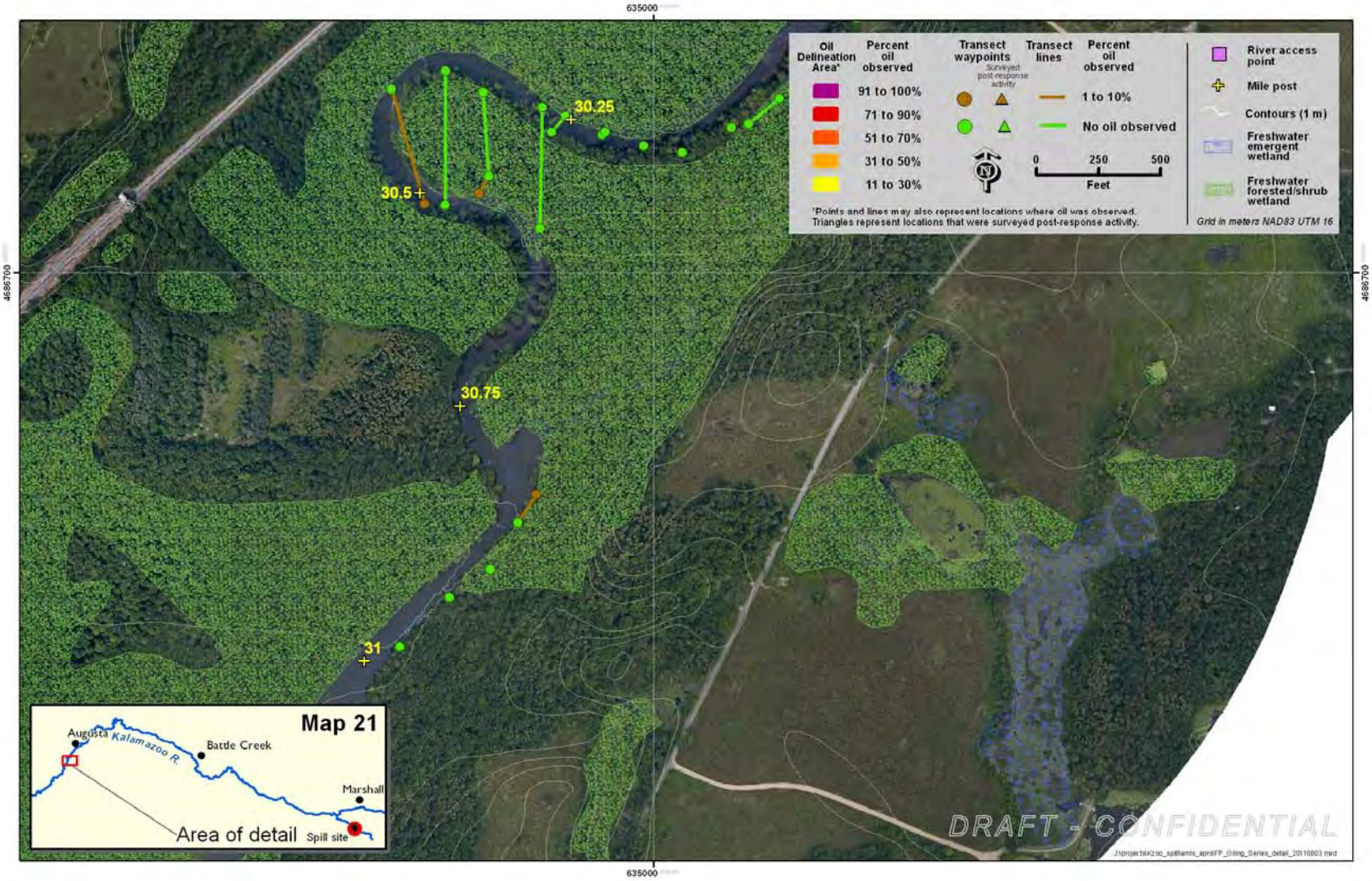

Figure 33. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 30.25–31).

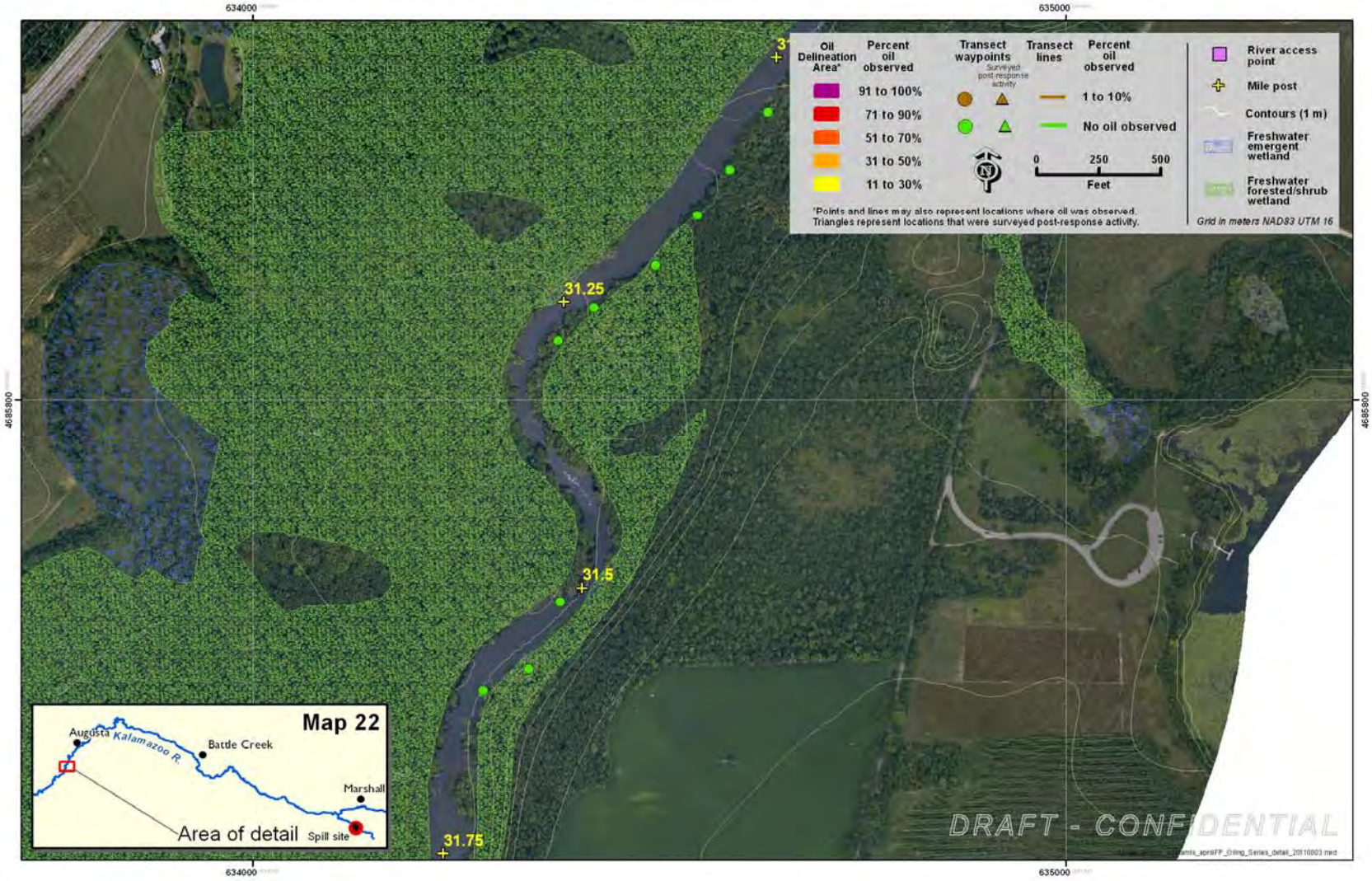

Figure 34. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 31–31.75).

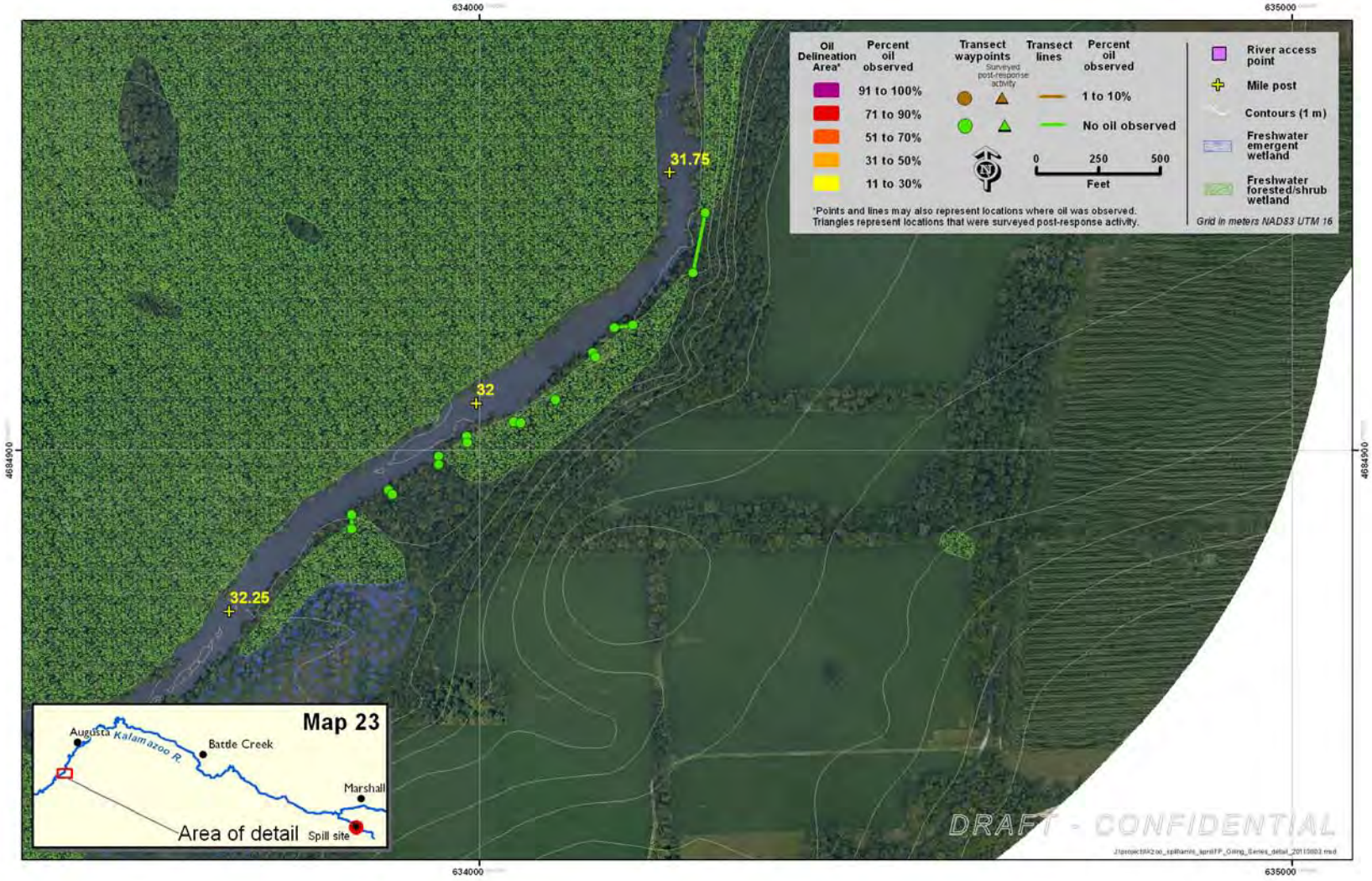

Figure 35. Detailed map showing all transects, waypoints, and ODAs surveyed during the floodplain survey (MP 31.75–32.25).

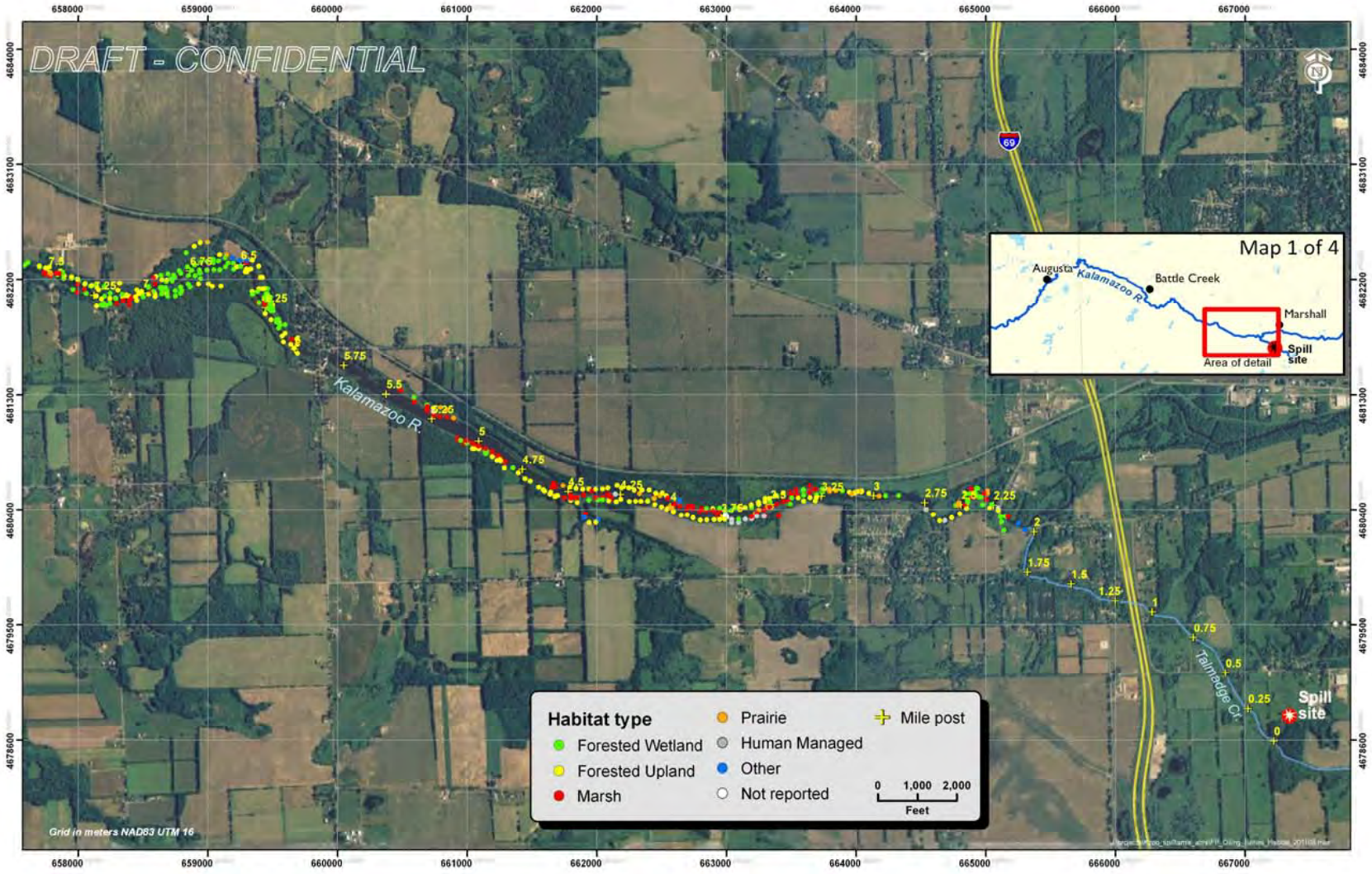

Figure 36. Map showing the habitat types identified at each waypoint during the floodplain survey (MP 0–7.5).

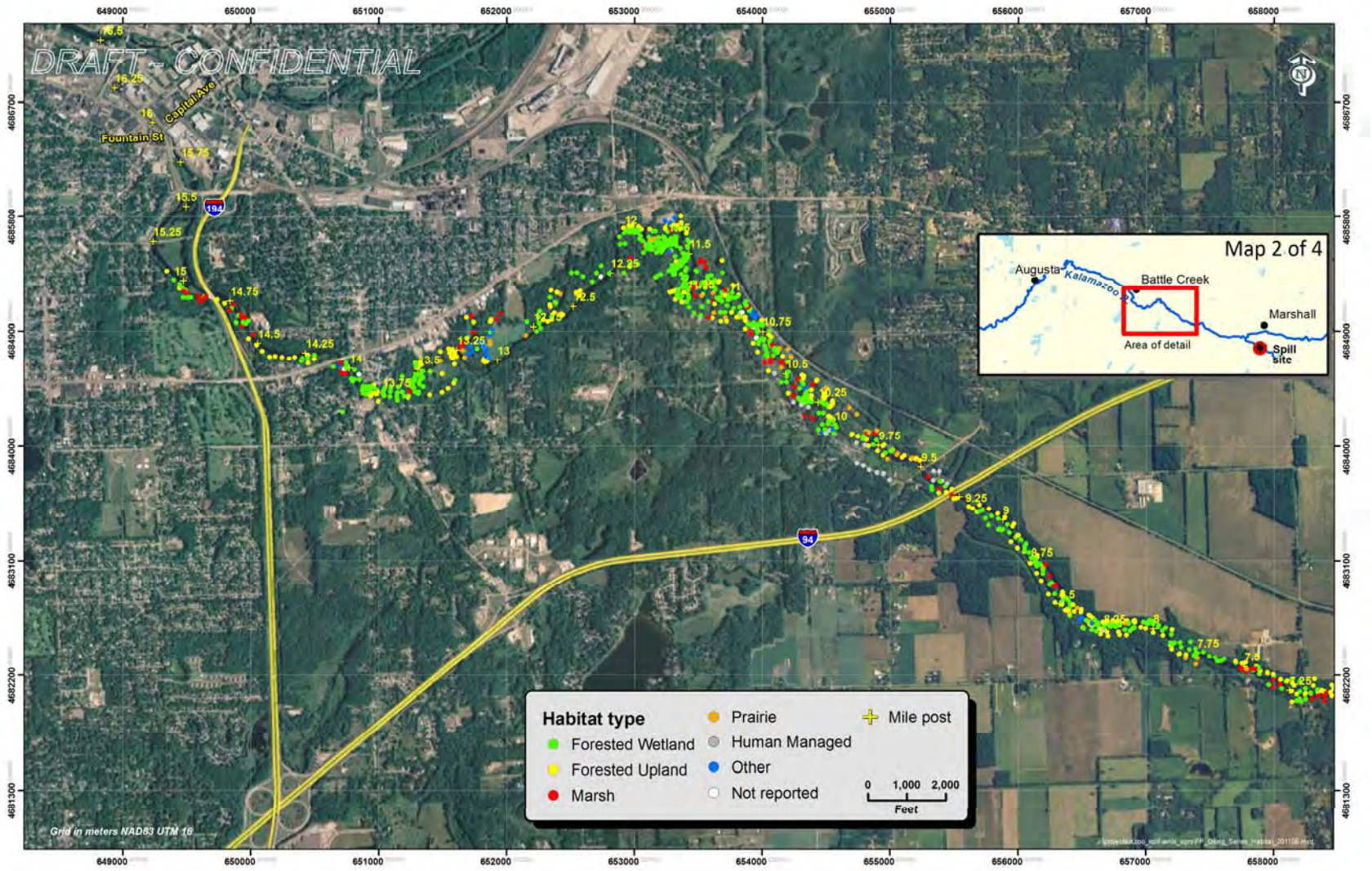

Figure 37. Map showing the habitat types identified at each waypoint during the floodplain survey (MP 7.25–16.5).

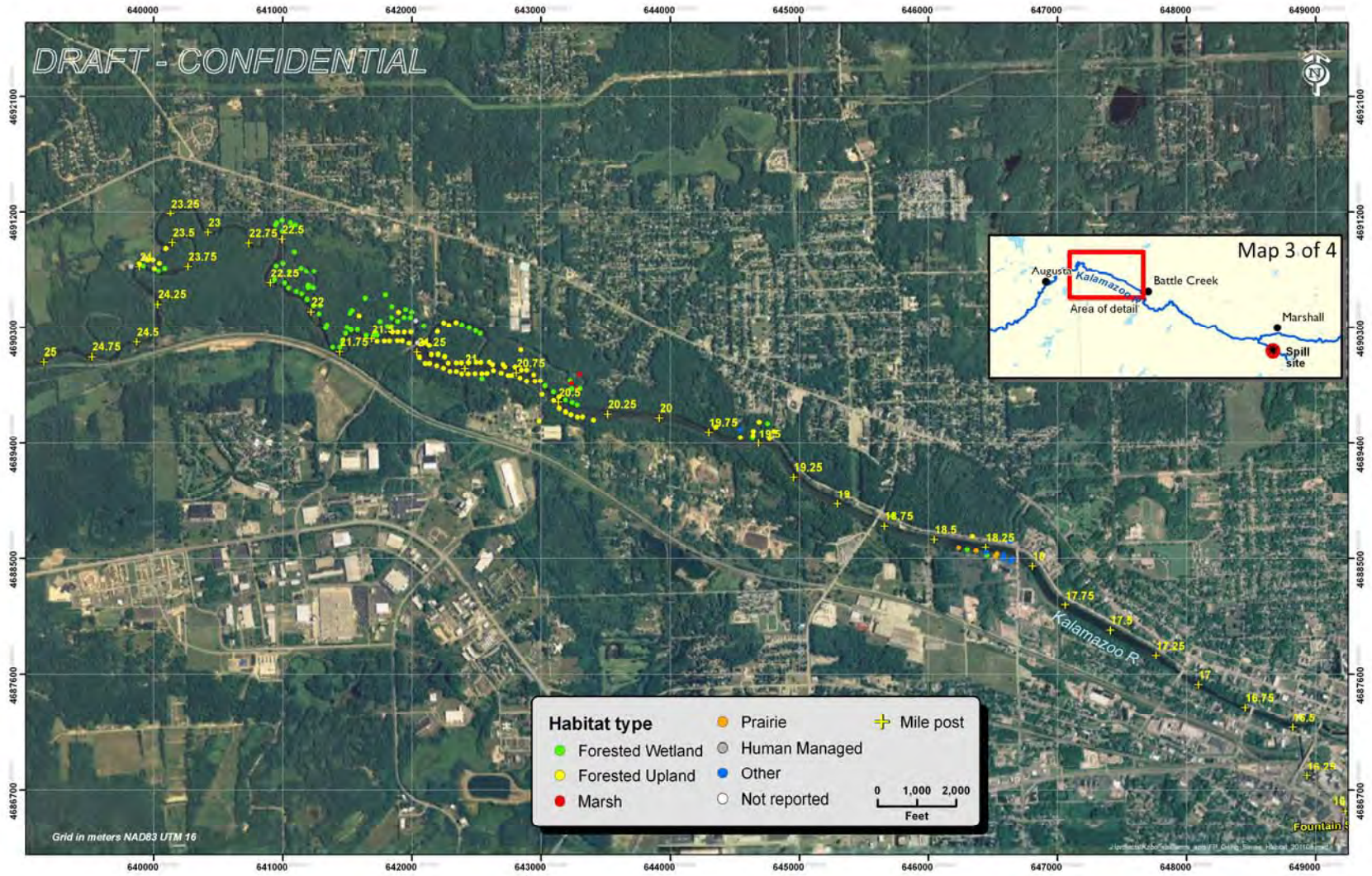

Figure 38. Map showing the habitat types identified at each waypoint during the floodplain survey (MP 16–25).

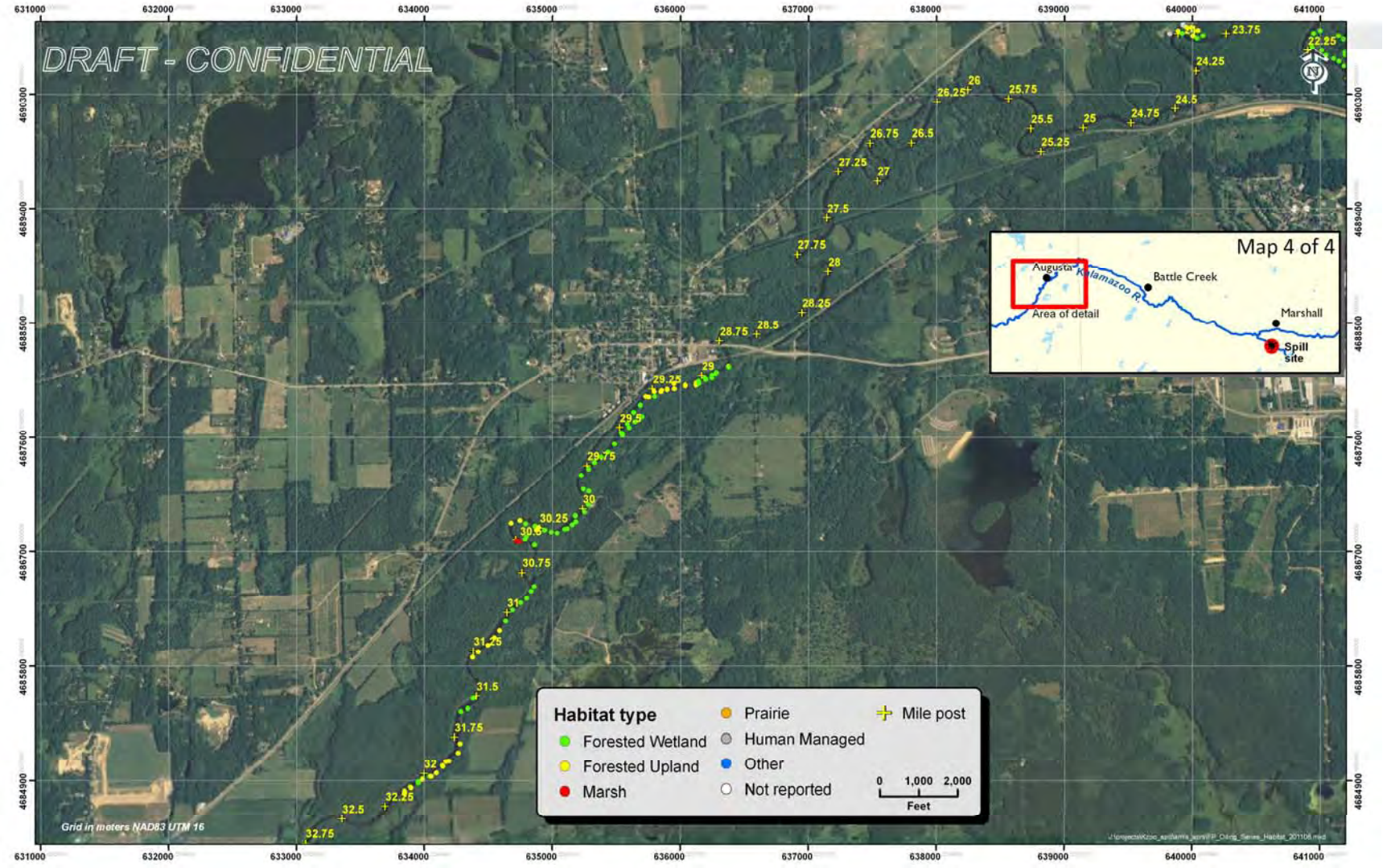

Figure 39. Map showing the habitat types identified at each waypoint during the floodplain survey (MP 22.25–32.75).

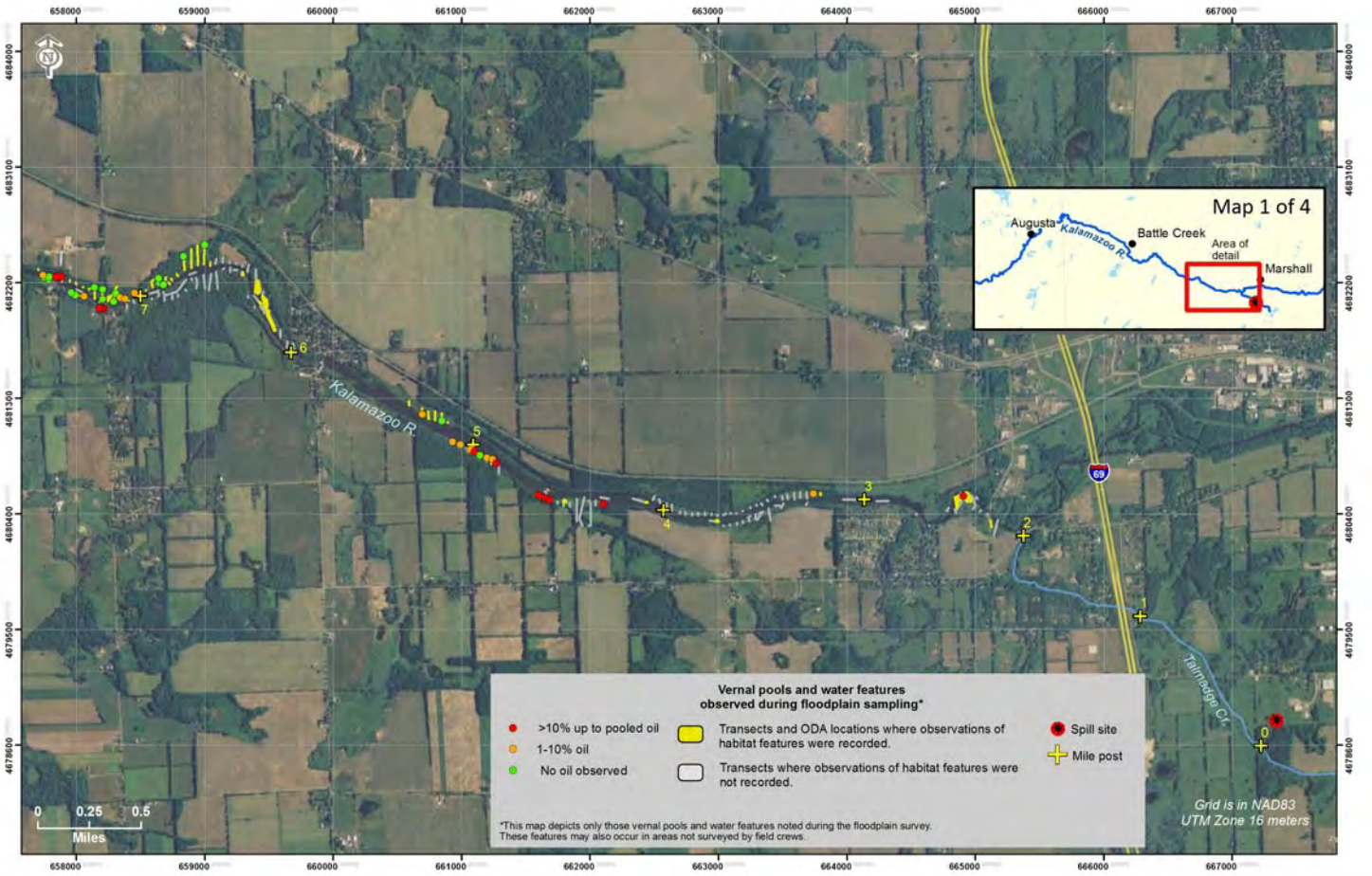

Figure 40. Map showing the waypoint locations where vernal pools and/or water features were identified and the degree of oiling recorded at the corresponding waypoint (MP 0–7.5). (Note: these data were not recorded at all waypoints during the floodplain survey and the degree of oiling was recorded for the waypoint as a whole and not the water feature or vernal pool specifically).

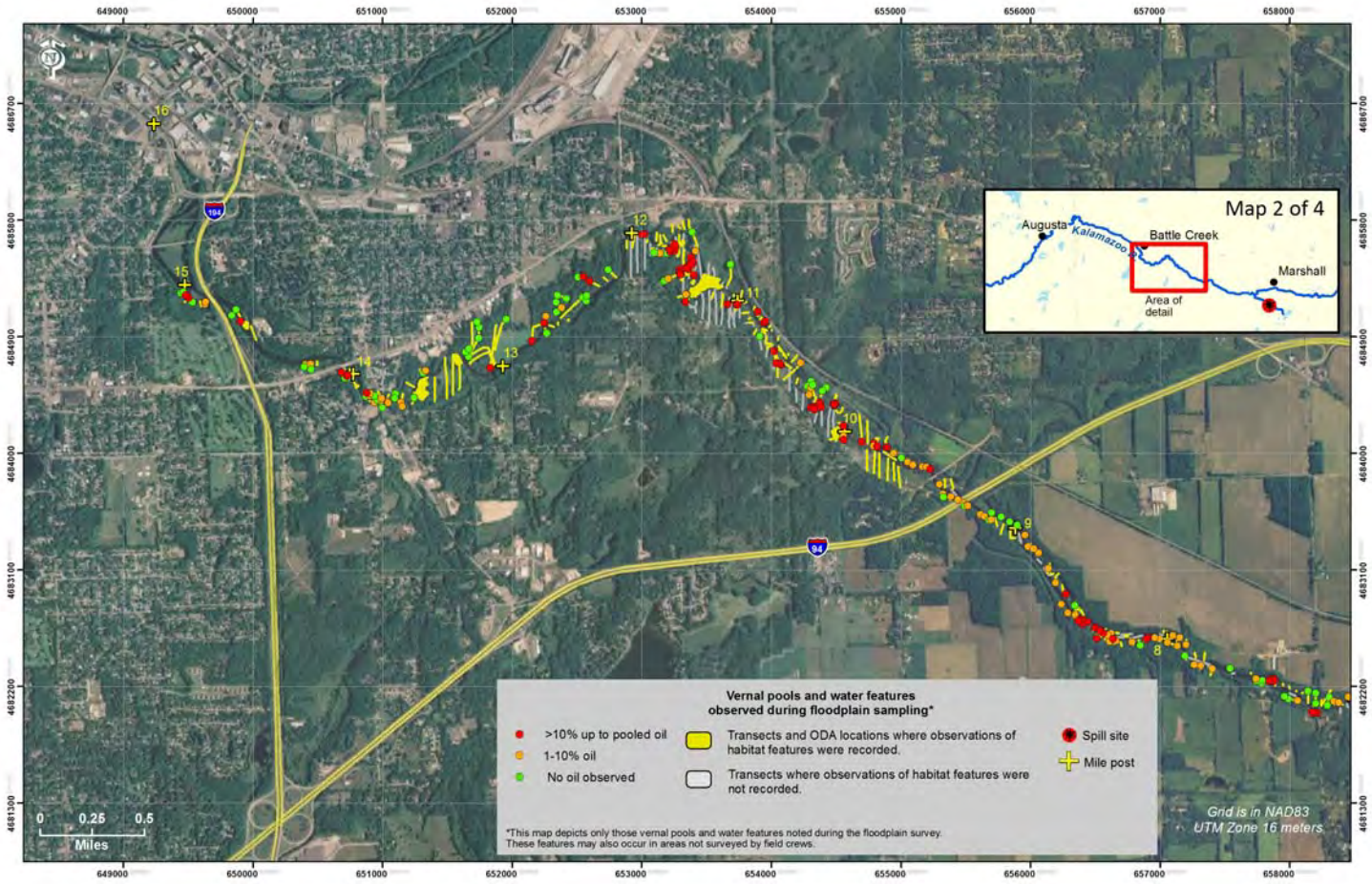

Figure 41. Map showing the waypoint locations where vernal pools and/or water features were identified and the degree of oiling recorded at the corresponding waypoint (MP 7.25–16.5). (Note: these data were not recorded at all waypoints during the floodplain survey and the degree of oiling was recorded for the waypoint as a whole and not the water feature or vernal pool specifically).

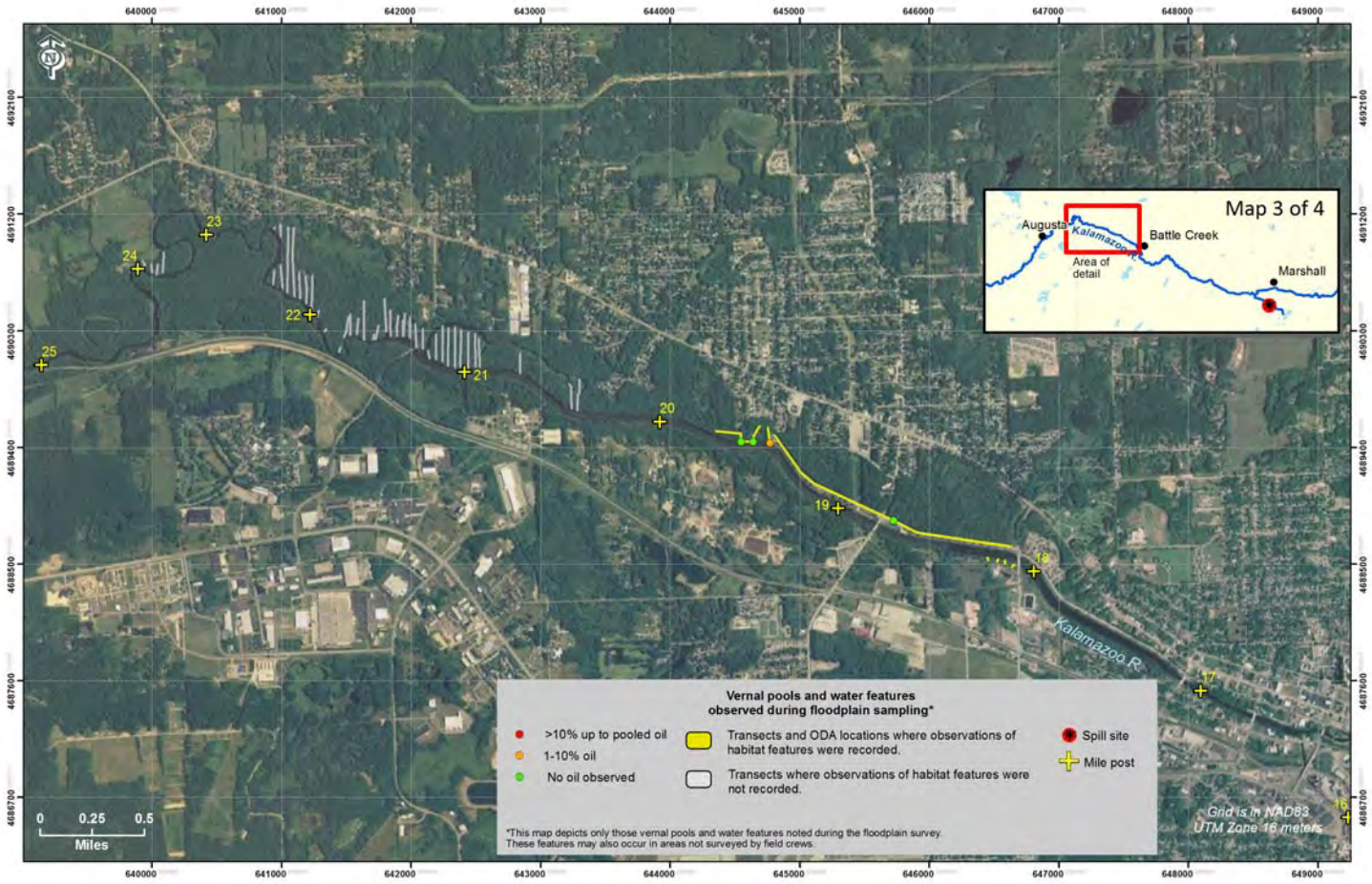

Figure 42. Map showing the waypoint locations where vernal pools and/or water features were identified and the degree of oiling recorded at the corresponding waypoint (MP 16–25). (Note: these data were not recorded at all waypoints during the floodplain survey and the degree of oiling was recorded for the waypoint as a whole and not the water feature or vernal pool specifically).

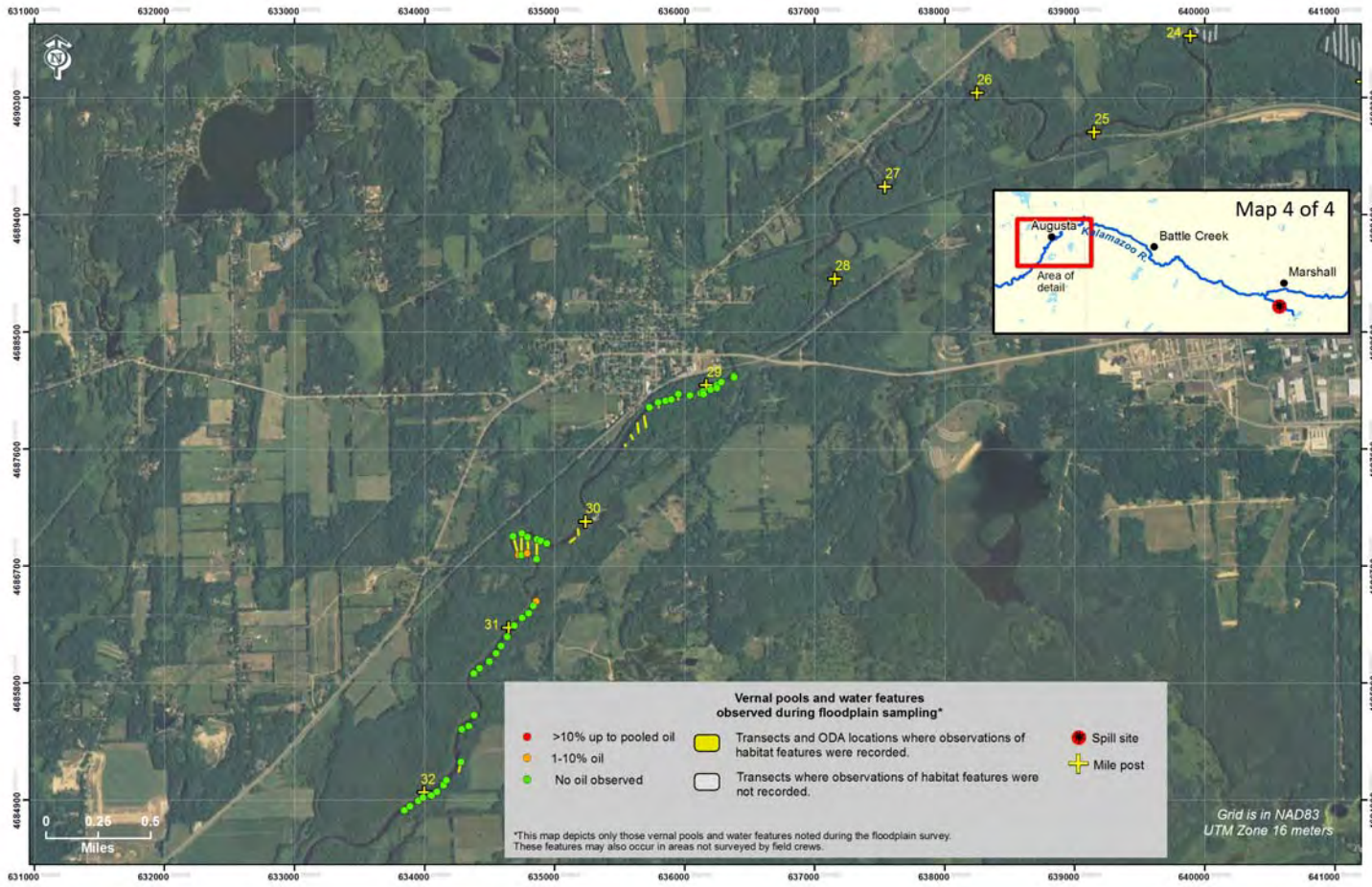

Figure 43. Map showing the waypoint locations where vernal pools and/or water features were identified and the degree of oiling recorded at the corresponding waypoint (MP 22.25–32.75). (Note: these data were not recorded at all waypoints during the floodplain survey and the degree of oiling was recorded for the waypoint as a whole and not the water feature or vernal pool specifically).

A. Floodplain Survey Work Plan

DISCUSSION DRAFT

PROTOCOLS FOR CHARACTERIZING KALAMAZOO RIVER FLOODPLAIN OILING

ENBRIDGE OIL SPILL INCIDENT

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August 18, 2010

1. Introduction

On July 26, 2010, Enbridge Energy, Limited Partnership discovered a release of heavy crude oil (Cold Lake Blend) from line 6B just west of milepost 308 in the vicinity its pump station located in Marshall, Calhoun County, Michigan. Line 6B is a 30-inch, 190,000 barrels per day (bpd) line transporting light synthetics, heavy and medium crude oil from Griffith, IN, to Sarnia, Ontario. The location of the release from Line 6B is located in an undeveloped area in the outskirts of town with coordinates of approximately North ½ Section 2, T3S, R6W, Latitude: 42.2395273 Longitude: -84.9662018. Upon discovery of the release the pipeline was shut down and isolation valves closed, stopping the source of the oil; however, initial estimates are that approximately 19,500 barrels of crude oil may have been released.

The release occurred along Tallmadge Creek approximately 1.5 miles upstream of where the creek enters the Kalamazoo River. The oil flowed down Tallmadge Creek and into the Kalamazoo River. At the time of the spill, recent rains had pushed the Kalamazoo River over its banks in many areas, and as a result the spilled oil entered into the floodplains along the river. Preliminary reconnaissance has confirmed that floodplains along the river downstream of the spill contain oil, and that the oiling is heavy in some areas. Therefore, an assessment of the locations and degree of oiling in the floodplain is required. These protocols focus on a rapid assessment of the locations and degree of oiling in the floodplains and the general floodplain habitat types where the oiling occurs. Subsequent protocols and fieldwork may address more detailed characterization of the habitat in the oiled areas for natural resource damage assessment (NRDA) purposes, if necessary.

2. Objective

The objective of these protocols is to characterize the areal extent and degree of oiling in the floodplains of the Kalamazoo River that have resulted from the Enbridge Pipeline spill and to characterize the general floodplain habitat types in the areas of the spilled oil. Discussed is a procedure that would allow us to map, characterize, and delineate both the habitat types and their extent of exposure to oil.

3. Approach

The floodplain surveys will be conducted on foot by floodplain assessment teams using protocols adapted from standard Shoreline Cleanup and Assessment Technique (SCAT) protocols. Areas requiring the on-the-ground assessment will first be identified using a combination of a

previously conducted shoreline oiling survey, remote sensing data, overflight videos, GIS habitat layers, and field experience of researchers familiar with the river floodplain in this area.

4. Site Selection

The overall scope of the study is the Kalamazoo River floodplain between Talmadge Creek and Morrow Lake. Areas targeted for on-the-ground survey work will those areas that:

- Are likely to have been flooded at the time of the spill. These areas will be identified using maps, remote sensing data, the shoreline survey results, and field experience; and
- Contain at least 3 acres of floodplain habitat (based on aerial photography or GIS analysis).Smaller areas may surveyed after most large areas are surveyed.

The primary focus of the floodplain survey will be in Division C, but some surveys will be done in Division D as well. We anticipated apportioning approximately 80% of the survey level of effort (LOE) to Division C, with the balance apportioned to Division D.

Initial field reconnaissance work indicated that predicting the location and extent of oiling in the floodplain will be difficult based solely on available information (LIDAR, wetland layers from the National Wetland Inventory, shoreline oiling surveys). Initial floodplain work also indicates that surveying all floodplain within Divisions C and D may not be feasible. We are thus implementing a 'sampling' approach that is meant to characterize patterns of oiling across general habitat types and elevations. The 'samples' of river floodplain that we survey will be used to extrapolate to areas not surveyed within each of the Divisions.

Areas of river to be surveyed will be selected randomly in via GIS in Divisions C and D of the Kalamazoo River. A GIS will be used to generate randomly the areas to be sampled as follows. First, the area of interest, beginning at the confluence of Talmadge Creek and the Kalamazoo River and extending downstream to the inlet of Lake Morrow, will be divided into 400 meter wide sections that run from north to south (i.e., 400 meters across from east to west) covering the entire extent of the floodplain on both banks of the river. The 400 meter wide sections will then be identified as either right bank or left bank of the river, as delineated by the centerline of the Kalamazoo River in the National Hydrologic Database (high resolution). This will result in the entire floodplain of the Kalamazoo River in the area of interest being divided into 400 m wide (east to west) sections with borders that run straight north to south, with separate sections on the left bank and on the right bank of the river.

The left bank and right bank 400 m sections of floodplain will then be randomly assigned numbers using a random number generator. Sections for the on-the-ground survey will then be

identified based on the random number assignments, starting with number 1 and proceeding up. Separate numbering will be done for the right bank sections and for the left bank sections so that an equal number of right bank and left bank sections will be sampled.

Within each 400 m wide section identified for field surveying, eight, north–south transects 50 meters apart will then be generated. GPS coordinates of where each transect intersects the riverbank will be provided to the field team. The transects will also be identified on a map that includes land ownership parcels and whether permission has been acquired to go onto the parcels. Survey areas, or individual transects within survey areas, that fall within parcels for which teams do not have permission to enter will be not be surveyed until such permission is obtained.

Field teams are to survey along each of the eight north-south transects in a 400 m wide section until, based on their judgment, they have covered all areas along the transect that likely were under water during the time of the spill. The field teams will consult wetland maps and elevation contours in making this judgment in the field.

After one week of sampling randomly selected floodplain sections with 4 field crews, the data obtained through these surveys will be evaluated to determine the degree to which floodplain oiling is predictable based on other types of information already available for the entire floodplain area (e.g., aerial photography, LIDAR elevation data, shoreline oiling survey, river bends). The evaluation of the initial floodplain oiling data from the first week of surveying in randomly selected areas will be done cooperatively between the Trustees and Enbridge. The Trustees and Enbridge will also review progress to date and determine whether the level of effort being invested in the floodplain survey is appropriate and/or needs to be changed.

5. Characterizing Habitats and Extent of Oiling

General issues:

- Safety is the first priority with all operations during this incident. The team will follow appropriate health and safety procedures related to survey activities.

- The floodplain survey will be conducted by four teams of two members each. When practically feasible, there will be one representative from the Trustees and one from the RP on each team. Teams will access the targeted floodplain habitat areas by either airboat or car. Each team will have a designated leader, who will be responsible for managing the team activities and records.

- The teams will meet with the study coordinator in the morning prior to entering the field to review safety procedures and the protocol. A morning meeting sheet will be signed by each individual.
- Each team will contact the study coordinator around mid-day to provide a quick status report and ensure the team is safe.
- The teams will meet at the end of the day with the study coordinator to download data, review the day, make any suggestions for improving the protocol, receive transect numbers to be completed the following day.
- We plan to spend three weeks intensively surveying floodplain areas. After this initial effort, the data will be reviewed to assess whether further floodplain characterization is needed. The nature and extent of any further surveying will be done at that time.
- Landowner permission for all areas to be surveyed on foot will be obtained by Enbridge prior to the teams conducting the survey in an area.
- As noted above, the primary focus of the floodplain survey will be Division C, with approximately 20% of LOE to be used to characterize Division D.

Survey Details:

- A GIS analyst will lay out north-south transects in each 400 meter survey section, at 50 meter intervals (8 transects per survey area). Coordinates of transect endpoints will be provided to field crews prior to their surveys so that their GPS units can be used to find the start and end points of transects.
- Two approaches have been developed for identifying transects; an initial approach (which will be used until we have enough information to implement the randomized approach), and a randomized approach:
    - Until we have the information available to lay out pre-determined transects, survey teams will select their own survey areas, with each team aiming to complete 250-500 m of river each day.
        - Sites will be selected based on property access (i.e., teams will go where they can).
        - Then, within a given property, areas of particular focus will include those with floodplain habitat and low banks, determined based on LIDAR and visual inspection, that are likely to have been impacted by the spill.

- — Crews will disembark the boat, noting the relevant river mile, and take a GPS waypoint to mark the point of disembarkation, and a north and south facing photograph

- — Survey teams will then mark out four to 10 different transects (depending on what is feasible, considering the number of teams present at the site, the length of river containing floodplain habitat, the amount of area for which private land owner permission has been granted, and the difficulty of terrain) on a map, spaced approximately 50 meters apart. They will then begin to conduct surveys along the transects.

- Once the randomized survey approach is implemented, teams will go to predetermined locations (400 m sections). Note that in the randomization scheme, if a randomly-selected section is located on private property that is still not accessible, it will be skipped. Skipped sections will be surveyed once access is obtained.

- At the beginning of each transect, a photograph of the GPS unit and a north-facing and south-facing photograph will be taken. If so equipped, the track log can also be turned on the hand-held GPS unit, according to the attached SOP (to be received from entrix). Note: We are investigating whether the tables can be adjusted for track logging.

- The survey team will then walk along the transect and observe the presence and degree of oiling in any areas within sight from the transect. Teams are specifically looking for any areas of at least 50 square feet that are more than ‘sporadically’ oiled (see photos and sheets at end of this protocol for definition). Habitat in the floodplain is assumed to be sporadically oiled unless observed to be otherwise.

- The teams should leave the transect to inspect any areas that they suspect could be oiled heavier than sporadic, such as side channels connected to the river. After inspecting these areas (and taking photographs and making appropriate records as described below if the area is more than sporadically oiled), the team will return to the transect at the point where they left it.

- The survey along the transect stops when the team reaches either:

  - the point at which oiling is reduced to ‘no visible oil’
  - an area of greatly reduced habitat quality, such as a housing development or agricultural field; or
  - a point 15’ past the upland edge of the floodplain area (based on visual estimation).

- GPS waypoints will be taken at the river edge, periodic waypoints along the transect to demarcate the transect path taken, the transect end point, and at habitat transitions. At each waypoint, two photographs will be taken, on north-facing, and one south-facing.

- If equipped with a GPS unit that allows it, GPS track logs can be collected in addition to discrete waypoints, for later coordination of photographs and spatial coordinates. Note: We are investigating if the tablets can be adjusted to provide track logs.

- If an area of at least 50 square feet with more than sporadic oiling is observed, the survey team will circumscribe the area by visually identifying and walking around the perimeter of the area, and taking GPS waypoints at key points of direction change. Note that hereafter, 'oiled zone" refers to any area more than sporadically covered in oil.

    - Prior to and after delineating the oiled zone, photos of the GPS unit will be taken.
    - If equipped with GPS units that allow for it, a GPS track log will be used to circumscribe the area.
    - To characterize each oiled zone, team members will assess the degree of oiling within the oiled zone using the standard characterization charts in Appendix A.
    - If the team cannot safely walk around the perimeter of a zone, they will take a waypoint as close to the center of the area as they can reach and estimate the dimensions of the zone area visually.
    - If using back-up hardcopy sheets, separate datasheets will be used to record information about general transect waypoints (which are meant to simply show transect trajectories and habitat changes) and distinct oiled areas.

- For areas along a transect beyond which no visible occurs, only the point on the transect at which the oiling changes from sporadic to no visible oiling will be recorded, and the transect is then complete, rather than attempting to circumscribe the area of no visible oiling.

- In addition to oiling, the following habitat information will also be recorded on datasheets by the survey teams:

    - General vegetation type (forested wetland, forested upland, marsh, prairie, human managed area, etc.)
    - GPS waypoint location and approximate size of any water features of at least approximately 50 square feet, such as vernal pools or small channels
    - Presence of downed trees (that could provide habitat cover for herpetofauna and other wildlife)

- As transects are completed, field teams will note any instances where terrain or vegetation makes it difficult to observe the 25 meters on either side of the transect.
- Field teams will also note if they were impeded from completing the transect, and why (for example, if the upland edge was too steep to climb).

6. Tablets

The following rules and conventions will be followed when entering data into the tablet electronic datasheet in the field (see data management protocol for complete data management instructions):

- Transect I.D. naming convention: <map transect number>L (for left descending side) or <map transect number>R
  - e.g., 124R
- The program does not save automatically. Therefore, hit save after taking every waypoint
- USBs will be provided to each team. Conduct a save mid-day and end-of-day:
  - File that contains survey data on the tablet: C:\users\entrix\KREOS\floodplain.xml
    - Naming convention: <date>_<last name>
    - e.g., 2010_0815_Ritter.xml

7. Equipment

Transportation needs will likely vary daily, but we estimate that three to four airboats will be needed to transport four teams of two to various points along the river. One or two boats may be appropriate on given days, and some teams may be able to drive to sites, but we assume that three boats will be needed to allow maximum team mobility.

Each team will be equipped with an IBM notebook tablet, with electronic datasheets and GPS capabilities to take way points, GPS, camera, Scat Manual, PPE (Appropriate to HASP), pens, and a waterproof field notebook. Paper datasheets will also be carried in the field, as back-up to the tablets. Extra batteries, including computer batteries will be carried.

Once electronic tablets are available, they will be used to take GPS waypoints and pictures and will contain electronic version of the datasheet. Each team will still need a GPS, camera and paper data sheets as backup.

Data management and map production

Each evening cameras, GPS units, and data sheets will be turned in for downloading, and quality control. All data (hard copies of data sheets, GPS data, photos) will be shared with RP representatives by the end of the day.

Trustee and/or RP representatives will produce GIS maps showing the extent area surveyed, and, eventually, the extent of oiling in floodplain habitat will be produced after the survey is completed.

8. Data management and map production

Each evening cameras, GPS units, and data sheets will be turned in for downloading, and quality control. All data (hard copies of data sheets, GPS data, photos) will be shared with RP representatives by the end of the day.

Trustee and/or RP representatives will produce GIS maps showing the extent area surveyed, and, eventually, the extent of oiling in floodplain habitat will be produced after the survey is completed.

Appendix A

The extent of oiling for vegetation and sediments will be used as the standard reference.

Owens, E.H. and G.A. Sergy.Field Guide to the Documentation and Description of Oiled Shorelines. Environmental Canada, March 1994.

33 PERCENT COVER ESTIMATION CHARTS

These charts are aids to help you estimate the percent oil coverage in the area you are observing. The black shading represents oil. Do not spend time trying to get a precise measure of percent cover; the four ranges listed are usually sufficient. The chart below would prove most helpful in oil band situations; the one on the following page is best for discrete oil deposits such as tarballs.

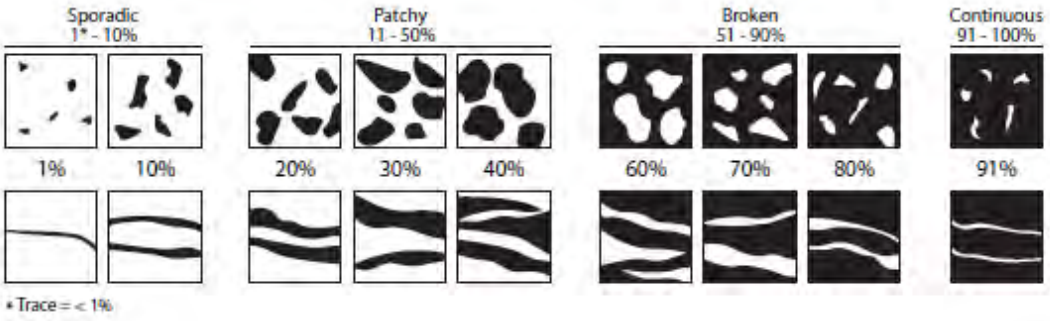
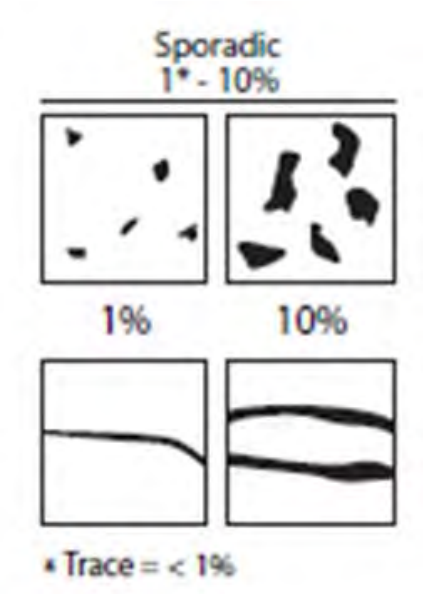


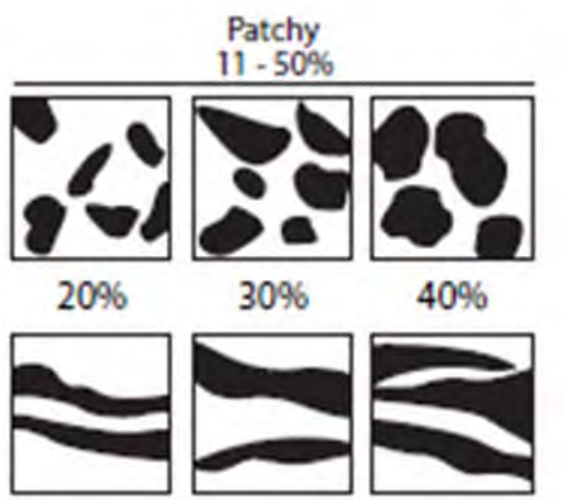
Chart source: Owens, E.H., and G.A. Sergy. Field Guide to the Documentation and Description of Oiled Shorelines. Environment Canada, Edmonton, Alberta, Canada. March 1994. ISBN 0-662-22048-X.

NO VISIBLE OIL

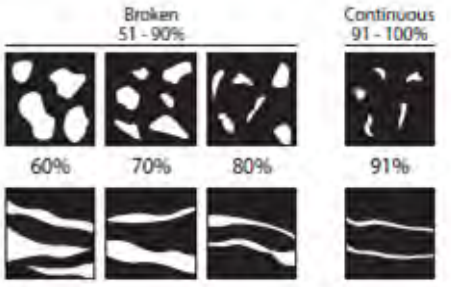
LIGHT (OR SPORADIC) OILING ON MARSH VEGETATION



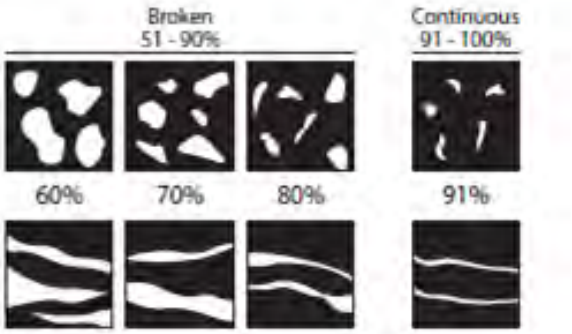
BAND OF PATCHY OIL ON EMERGANT MARSH VEGETATION



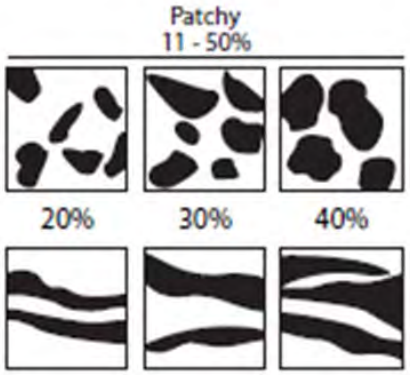
HEAVY OILING OF EMERGENT VEGETATION



HEAVY SEDIMENT OILING



MODERATE OR PATCHY OIL ON SEDIMENTS



Appendix B
Data Sheet

(In preparation)

Floodplain Characterization Data Sheet (Version 5.0) Site _____/______ (Sheet ___ of ___)

River Mile (tenths) ____.____ Bank Side Descending (R/L) ____ Date ___/___/2010 Data Collector/Recorder ________________________________

GPS/Photo Operator ______________ GPS Unit ID ___________ GPS Photo (Y ___, #_______) GPS Start Waypoint ______ Camera ID______________

TRANSECT ID (Rivermile.transect):__________________________OIL DELINEATION AREA ID (A-Z): _________ Time:_________________________

Waypoint # (____) **Habitat type (FU, P, FW, M, H, O):** ________ If O, describe ____
Oiling: Soil visible? (Y___/N___) If Y % oil covered soil (____%) % oil covered herbs (____%) % oil covered shrubs (____%) % oil covered trees (____%)
Features: Pooled oil (>50ft^2)?[1] (Y__/N__) Water feature (>50ft^2)?[2] (Y__/N__) Vernal pool (>50ft^2)?[3] (Y__/N__) Downed tree (>4" DBH)?[4] (Y__/N__) **Skunk Cabbage:** Present? (Y___/N___) If present, healthy___/defoliated____/new shoots_____ (combination ok) **Photos #s** ________________________
Notes: ____

Waypoint # (____) **Habitat type (FU, P, FW, M, H, O):** ________ If O, describe ____
Oiling: Soil visible? (Y___/N___) If Y % oil covered soil (____%) % oil covered herbs (____%) % oil covered shrubs (____%) % oil covered trees (____%)
Features: Pooled oil (>50ft^2)?[1] (Y__/N__) Water feature (>50ft^2)?[2] (Y__/N__) Vernal pool (>50ft^2)?[3] (Y__/N__) Downed tree (>4" DBH)?[4] (Y__/N__) **Skunk Cabbage:** Present? (Y___/N___) If present, healthy___/defoliated____/new shoots_____ (combination ok) **Photos #s** ________________________
Notes: ____

Waypoint # (____) **Habitat type (FU, P, FW, M, H, O):** ________ If O, describe ____
Oiling: Soil visible? (Y___/N___) If Y % oil covered soil (____%) % oil covered herbs (____%) % oil covered shrubs (____%) % oil covered trees (____%)
Features: Pooled oil (>50ft^2)?[1] (Y__/N__) Water feature (>50ft^2)?[2] (Y__/N__) Vernal pool (>50ft^2)?[3] (Y__/N__) Downed tree (>4" DBH)?[4] (Y__/N__) **Skunk Cabbage:** Present? (Y___/N___) If present, healthy___/defoliated____/new shoots_____ (combination ok) **Photos #s** ________________________
Notes: ____

Waypoint # (____) **Habitat type (FU, P, FW, M, H, O):** ________ If O, describe ____
Oiling: Soil visible? (Y___/N___) If Y % oil covered soil (____%) % oil covered herbs (____%) % oil covered shrubs (____%) % oil covered trees (____%)
Features: Pooled oil (>50ft^2)?[1] (Y__/N__) Water feature (>50ft^2)?[2] (Y__/N__) Vernal pool (>50ft^2)?[3] (Y__/N__) Downed tree (>4" DBH)?[4] (Y__/N__) **Skunk Cabbage:** Present? (Y___/N___) If present, healthy___/defoliated____/new shoots_____ (combination ok) **Photos #s** ________________________
Notes: ____

Waypoint # (____) **Habitat type (FU, P, FW, M, H, O):** ________ If O, describe ____
Oiling: Soil visible? (Y___/N___) If Y % oil covered soil (____%) % oil covered herbs (____%) % oil covered shrubs (____%) % oil covered trees (____%)
Features: Pooled oil (>50ft^2)?[1] (Y__/N__) Water feature (>50ft^2)?[2] (Y__/N__) Vernal pool (>50ft^2)?[3] (Y__/N__) Downed tree (>4" DBH)?[4] (Y__/N__) **Skunk Cabbage:** Present? (Y___/N___) If present, healthy___/defoliated____/new shoots_____ (combination ok) **Photos #s** ________________________
Notes: ____

B. Description of Closing Polygons

The ODAs delineated by the field crews required additional GIS processing in order to create closed polygons that could be visualized on a map. This appendix presents notes about how each ODA was drawn as a closed polygon on the map (Table B.1).

Each polygon was assigned a unique identification in the Access database. The ODAs are organized according to their unique identifier (see Unique ODA ID column in Table B.1).

For many ODAs, the waypoints were connected in order and the polygon was closed by connecting the first and last waypoints in the ODA. These are described as “close polygon.”

Some ODAs were delineated in the field in such a way that a closed polygon could not be drawn. These are described as “leave as line.” On the maps, these are represented as linear ODA features.

In some instances, connecting the waypoints in the order they were delineated in the field created irregular patterns or features with crossing lines. It is likely that this happened because of imprecision of the handheld GPS devices, which have an accuracy of approximately 3 m. For these cases, ODAs were drawn as closed polygons by connecting the waypoints to form a perimeter, even if the waypoints were not connected in order and a detailed description was provided.

Table B.1. Decisions for polygon delineations

Unique ODA ID	Decision	Additional notes
10.2L92_A	Close polygon	No additional notes.
10.2R286_A	Close polygon	No additional notes.
10.2R291_B	Close polygon	No additional notes.
10.2R301_C	Extend the polygon to the river – close polygon with a straight line rather than shape of the river because of unknown bank location	Because this was in a bend of the river, the polygon was created from the river edge to the next waypoint.
10.6L137_A	Close polygon	Used the adjacent transect line to complete the polygon.
12.5R59_A	Close polygon	The field notes say that the beginning of polygon is at waypoint 60, waypoint 59 is the start of the transect. Waypoint 59 was removed from the polygon and a new transect was created connecting waypoints 59–60.
12.5R71_B	Leave as line	No additional notes.
12.5R79_C	Close polygon	No additional notes.
13.3L93_A	Leave as line	No additional notes.
14.2L19_A	Extend the polygon to the river – close polygon with a straight line rather than shape of the river because of unknown bank location	No additional notes.
6.8L23_A	Leave as line	No additional notes.
8.5L43_A	Close polygon	No additional notes.
9.6L107_A	Leave as line	No additional notes.
9.6L114_B	Leave as line	No additional notes.
9.9L39_A	Close polygon	No additional notes.
8.5L39_B	Leave as point	No additional notes.
8.5L36_A		No additional notes.
474L_A	Close polygon	No additional notes.

Table B.1. Decisions for polygon delineations (cont.)

Unique ODA ID	Decision	Additional notes
477L_A	Close polygon	No additional notes.
533R_A	Close polygon	This polygon originally had 5 waypoints points. The first 4 make a nice polygon outline, but the 5th did not fit with the rest. In the field "Type" (type of waypoint) it said "End," while others said "Oil Polygon." The 5th point was not included as part of the polygon.
533R_B	Close polygon	No additional notes.
534R_A	Close polygon	No additional notes.
562L_A	Close polygon	No additional notes.
570R_A	Close polygon	No additional notes.
573L_A	Close polygon	No additional notes.
585R_A	Close polygon	Two of the 3 waypoints points had 0% oil recorded. However, it was noted that at this time, field crews were instructed to characterize the entire polygon with 1% oiling value, so the percent oiling was assigned to the first or last waypoint.
602R_A	Close polygon	No additional notes.
726R_A	Keep as line	Could not close the polygon.
901L_A	Close polygon	No additional notes.
901L_B	Keep as line	The field notes suggest that the pooled oil extends 15 ft north of the line; however, this is not enough information to delineate a polygon. Therefore, this ODA was left as a line.
903L_A	Close polygon	No additional notes.
903L_B	Keep as line	The field notes suggest the "Edge of water closes polygon"; however, this is not enough information to close the ODA polygon. Therefore, it was left as a line.
903L_C	Close polygon	No additional notes.
907L_A	Close polygon	The shape of this polygon was unusual; it appears that the polygon shape is irregular because of the imprecision of the GPS units. A polygon was delineated by joining the ODA waypoints in the following order: 1, 2, 4, 3, 1.

Table B.1. Decisions for polygon delineations (cont.)

Unique ODA ID	Decision	Additional notes
909L_A	Keep as line	The field notes reference a small island with oil; however, this is not enough information to create a polygon. Therefore, it was left as a line.
911L_A	Close polygon	No additional notes.
911L_B	Close polygon	The shape of this polygon was unusual; if the waypoints are connected in order, the lines form a criss-cross across a polygon. Linking waypoints 1, 2, 4, 3, 1 forms a perimeter of the points; this is how the polygon was drawn.
913L_A	Close polygon	No additional notes.
913L_B	Close polygon	This polygon overlaps with another polygon, 913L_A. These polygons were left as is.
917L_A	Close polygon	No additional notes.
919L_A	Close polygon	No additional notes.
920L_A	Close polygon	The shape of this polygon was unusual; it appears that the polygon shape is irregular because of the imprecision of the GPS units. Linking waypoints 1, 2, 4, 3, 1 forms a perimeter of the points; this is how the polygon was drawn.
921L_A	Close polygon	The shape of this polygon was unusual; linking the waypoints forms a "Z." It appears that the field crew delineated the top of the polygon, then crossed the polygon and formed the bottom. The polygon was created by joining the waypoints that form the perimeter.
921L_B	Close polygon	No additional notes.
1003L_A	Close polygon	No additional notes.
1005L_A	Close polygon	No additional notes.
505.5L_A	Close polygon	No additional notes.
505.5L_B	Close polygon	No additional notes.
507.5 L_A	Close polygon	No additional notes.
509.5 L_A	Close polygon	No additional notes.

Table B.1. Decisions for polygon delineations (cont.)

Unique ODA ID	Decision	Additional notes
509.5 L_B	Close polygon	No additional notes.
510.5 L_A	Close polygon	Waypoints 6 and 7 cross each other. The polygon was created by connecting waypoint 5 to 6 and waypoint 6 to 8. Waypoint 7 fell within the polygon; therefore, it was not included.
510.5 L_B	Close polygon	No additional notes.
511.5L_A	Close polygon	No additional notes.
511.5L_B	Close polygon	No additional notes.
511.5L_C	Close polygon	Connecting the waypoints in order creates crossing lines; this is because of the imprecision of the GPS units. The polygon was deleted by connecting waypoints 4 and 5.
511.5L_D	Close polygon	Connecting the waypoints in order creates crossing lines between waypoints 1 and 6; this is due to the imprecision of the GPS units. The polygon was drawn by moving the lines to remove the cross.
511.5L_E	Close polygon	No additional notes.
511.5L_F	Close polygon	No additional notes.
512.5L_A	Close polygon	No additional notes.
512.5L_B	Close polygon	No additional notes.
512.5L_C	Close polygon	No additional notes.
515R_A	Close polygon	No additional notes.
518.5 L_A	Close polygon	Connecting the waypoints in order creates crossing lines. The polygon was drawn by connecting the waypoints in the following order: 2, 3, 1, 4, 5, 6.
518R_A	Close polygon	No additional notes.
535L_A	Close polygon	No additional notes.
631L_A	Close polygon	No additional notes.
633R_A	Close polygon	No additional notes.

Table B.1. Decisions for polygon delineations (cont.)

Unique ODA ID	Decision	Additional notes
634R_A	Close polygon	Connecting the waypoints in order creates crossing lines. The polygon was drawn by connecting waypoints 8 and 2; waypoint 1 falls in line between the segments.
635R_A	Close polygon	Connecting the waypoints in order creates crossing lines; this is because of the imprecision of the GPS units. The polygon was drawn by moving the vertex, which eliminated the crossing lines but kept the polygon closed.
681_A	Close polygon	No additional notes.
743L_A	Close polygon	No additional notes.
748L_A	Left as line	No additional notes.
930L_A	Close polygon	Connecting the waypoints in order creates crossing lines. The polygon was drawn by connecting the waypoints on perimeter.
934L_A	Close polygon	No additional notes.
947L_A	Close polygon	No additional notes.

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