ENBRIDGE LINE 6B INCIDENT

KALAMAZOO RIVER BANK EROSION ASSESSMENT AND ACTION PLAN

MARCH 21, 2011

PREVIOUS VERSION DATES:
OCTOBER 7, 2010
OCTOBER 19, 2010
OCTOBER 26, 2010
OCTOBER 28, 2010
DECEMBER 23, 2010

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SUMMARY OF REVISIONS:

10/19/10 Revision: *Erosion areas table and location map (Appendix A) revised as a result of 10/12/10 site assessments by AECOM and JFNew. Detailed plans of stabilization/restoration methods (Appendix C) added.*

10/26/10 Revision: *Erosion areas table and location map (Appendix A) revised as a result of 10/20/10 site assessments by AECOM, JFNew, MDNRE and Tetra Tech and site assessments by Entrix.*

10/28/10 Revision: *Erosion areas table and location map (Appendix A) and Mitigation Plans (Appendix C) revised as a result of 10/27/10 site assessments and review comments by AECOM, JFNew and MDNRE). Added photographs of completed stabilization work (Appendix D).*

12/23/10 Revision: *Added "Background" and expanded "Monitoring" section based on recent monitoring assessments. Erosion areas, tables and figures (Appendix A) revised as a result of 11/18/10-11/20/10 monitoring trip (AECOM, JFNew, MDNRE and Entrix), Reorganized and relabeled appendices. Added summary of monitoring trip #1 (Appendix E).*

BACKGROUND AND SUMMARY OF WORK COMPLETED TO DATE

In October, 2010, AECOM conducted an assessment of bank erosion along the Kalamazoo River. The assessment extended just downstream of Talmadge Creek (milepost 2.0) to Morrow Lake (milepost 38.0). Erosion areas that were identified to be the result of response activities were rated for severity of erosion, using a numerical rating system ranging from category 1 to category 5 with 5 being the most severe. The rating system is described in subsequent section of this report.

The initial sites and their respective ratings were included in the *Kalamazoo River Bank Erosion Assessment and Action Plan* report dated October 19, 2010. Subsequent to that initial assessment and report JFNew was added to the AECOM team to provide additional expertise and experience stabilizing and restoring local river systems. Reassessments and on-going monitoring and stabilization activities has resulted in changes to the initial list of erosion sites and their numeric ratings. This report describes the activities completed to date. The following is a general timeline of the activities:

- Beginning in mid-September 2010, personnel from AECOM and JF New assessed bank erosion within the project area (culminating into the *Bank Erosion Assessment and Action Plan*). The first draft of the *Bank Erosion Assessment and Action Plan* was submitted to the Trustee Group (representatives of several governmental agencies) for review.
- On October 12, 2010, two members of the AECOM team, and two members of the JF New team reassessed the erosion areas together.
- On October 20, 2010, two members of the AECOM team, two members of the JF New team, along with representatives of Enbridge, and the MDNRE visited many of the assessed erosion areas.
- On October 21, 2010, members of the AECOM team, a member of the JF New team, and staff from Entrix held a conference call with the Trustee Group to discuss their review comments. As a result of that call, several items were addressed, including items that the Trustee Group requested to be included in this monitoring plan.
- On October 28, 2010, AECOM staff received review comments of the *Bank Erosion Assessment and Action Plan* from MDNRE staff.
- Upon addressing comments both from the Trustee Group, and MDNRE, a third revision of the *Bank Erosion Assessment and Action Plan* was completed, dated October 28, 2010. As part of that assessment, 78 sites were identified (one with Rating 2, 14 with Rating 3, 53 with Rating 4, and ten with Rating 5).
- As part of the action plan described in the *Bank Erosion Assessment and Action Plan*, it was recommended that stabilization measures be implemented immediately in the most severely eroded areas (category 5 priority rating). Beginning on October 26, 2010, JFNew began construction of the bank stabilization measures in the category 5 priority sites.
- As of the date of this report, all erosion control measures at the ten level 5 rated sites have been completed.
- As part of the action plan described in the *Bank Erosion Assessment and Action Plan*, it was recommended that a monitoring plan be implemented for all sites, Priority Rating 1 to 5. On November 18 to 20, 2010, the first monitoring trip was completed. As a result of the monitoring trip,

the initial ten category 5 sites were re-categorized as category 1, 11 sites were downgraded, 10 sites were upgraded (seven of which were upgraded to a category 5 priority rating), and six new sites were added (two of which were assigned a category 5 priority rating). A stabilization/restoration plan is proposed for the nine additional category 5 priority sites, which is included in Appendix F of this report.

INTRODUCTION AND SCOPE OF ASSESSMENT

At the request of Enbridge, AECOM and JFNew completed field reconnaissance in order to assess erosion along the shoreline and various islands that are located along the Kalamazoo River from Talmadge Creek confluence to Morrow Lake (assessment limits). The intent was to identify areas of erosion along the river in order to support the development of an erosion action plan to mitigate erosion resulting from incident response activities.

It is important to note that in some areas, it was difficult to differentiate erosion associated with the incident response from naturally occurring erosion. To assist, field observations of the Kalamazoo River upstream of the project (from 17 Mile Road to Marshall Avenue in the City of Marshall) were completed to compare the areas within the assessment limit to an area not impacted by the response. Without specific pre-project condition documentation, the assessment of erosion resulting specifically from incident response activities requires some professional judgment.

As a result of continued field assessments, a bank erosion assessment table, location maps of erosion areas, and photo logs (Appendix A) are continually being updated. The table lists the location, extent, and composition of the observed areas of erosion. The erosion areas that are recorded are primarily a result of incident response activities (boat traffic, clean up, etc.).

Flow velocity and overall river morphology were considered in the assessment of natural versus response-related erosion. Bank erosion, sediment transport, and morphology are all part of the natural channel dynamics. In addition, other anthropogenic influences (e.g. watershed land use, dams/reservoirs) likely impact bank erosion, sediment transport, morphology, and flow regimes.

Flow velocity and morphology were considered when:

- Erosion was occurring at an outside bend, it could more likely be the result of flow scour,
- Erosion was occurring on an inside bend or an area with little flow velocity, it could more likely be the result of incident response activities (e.g. boat wave action),
- Erosion appeared to have occurred over a long period of time (years, not months), it could more likely be the result of natural process. Examples:
    - If gravel/roots/bank did not appear to be recently exposed (e.g. had a covering of organic material)
    - Trees were overhanging bank which appear to have been in this condition for a long time period.
- Island specific erosion: as described in this report, historic aerial photos were examined, and indicated that the extent of most islands change over time (i.e. natural erosion and deposition). Aerial photos from various points in time were overlaid. The extent of islands was compared from one point in time

to another point in time (e.g. 1998 aerial versus 2010 just before the incident, versus 2010 just after the incident). Comparisons revealed noticiable dynamics in the extent of some islands, and negligible dynamics in others.

A relative severity rating of each erosion area was made for several criteria. These ratings are given in the context that the erosion is primarily a result of incident response activities.

- Severity of Erosion - Based on visual observations, this is a rating of how much bank material has been lost, impacts on water quality, impacts on riparian quality, etc. (Rating of 0 = not severe, and 5 = most severe). Less severe erosion typically is experienced in areas where the bank is less than two feet high, has a relatively stable slope (less than vertical), and has some vegetation and root mass present. More severe areas may have bank heights greater than two feet, have vertical side slope, and little to no vegetation or root mass.
- Continued Erosion Risk - Based on visual observations, this is a rating of the likelihood that erosion in a specific area will continue, even after incident response activities have ended (Rating of 0 = not likely to continue, and 5 = likely to continue). It is also a function of bank composition. If a bank has little vegetation and root mass, the risk of continued erosion is higher in the future, even without incident response activities. Likewise, an area with significant root mass or established vegetation has a higher likelihood of stabilizing on its own over time. Islands are also particularly susceptible to river flow dynamics and fluvial processes. A preliminary review of historical aerial photography indicates some islands are part of dynamic system where they may appear and disappear over time. This is taken into account for ratings for islands.
- Composite Rating – This rating is a sum of the two ratings above.
- Priority Rating – A Priority Rating was given to each area. They are a function of the composite rating (Composite Rating 0-2 = Priority Rating 1, Composite Rating 3-4 = Priority Rating 2, Composite Rating 5-6 = Priority Rating 3, Composite Rating 7-8 = Priority Rating 4, Composite Rating 9-10 = Priority Rating 5). A rating of 1 is the lowest priority, and 5 is the highest priority.
    - Priority Ratings 1 to 3, based on the individual rating criteria, have evidence that they are generally more minor banks, have more stable side slope, and existing vegetation and/or root mass that they are likely to stabilize over time without mitigation actions.
    - Priority Rating 4 areas have a combination of high severity of erosion but low or moderate risk of continued erosion, have moderate levels or high risk of continued erosion but low to moderate severity of erosion (e.g.an island may be susceptible to erosion, but the severity is low because the banks are only one foot high and may naturally shift over time).
    - Priority Rating 5 areas have a combination of high severity of erosion and a high risk of continued erosion and therefore are particularly susceptible to erosion and could impact the rivers natural functions and water quality.

Appendix B includes photos (taken 9/27/10) of example Rating 5, 4, 3, and 2 erosion areas.

ACTION PLAN

Purpose

The purpose of this plan was to develop an approach to address the bank erosion described in the assessment. A balanced approach that recommends implementation of measures to mitigate further erosion in higher priority areas combined with a monitoring program was recommended. This should mitigate erosion in priority areas while reducing invasive or aggressive measures that may not be needed in areas where banks may stabilize on their own.

This action plan represents an approach based on information obtained through the assessment process. Prior to beginning any mitigation actions, the assessment and this action plan will be presented to stakeholders (MDNRE and/or NRDA Trustees) for concurrence. Should the stakeholder review result in modifications to the assessment, and subsequently this action plan, a revised action plan will be submitted at that time.

Decision Process

Using the information previously described in the Assessment, a decision process was developed to determine which areas require immediate action, which do not require immediate action but should be monitored. This decision process is primarily a function of the Priority Ratings, which are described in the assessment.

It was proposed to provide stabilization/restoration measures immediately to Priority Rating 5 erosion areas because these areas have combination of high severity of erosion and a high risk of continued erosion. They therefore have the highest risk of impacting the river's natural functions, substrate quality, and water quality.

It is proposed to implement a regular monitoring program for the remaining areas (see Action Plan Steps for additional information). This approach balances the need for erosion protection while preventing aggressive stabilization/restoration activities within the river that may not be necessary. The monitoring plan is described further in a subsequent section of this report.

Action Plan Steps

1) Mitigation of Priority Rating 5 Erosion Areas and Other Site-Specific Areas

   Mitigation measures are proposed immediately for Priority Rating 5 erosion areas. Additionally, there are several areas where the erosion impacts and future risks are low, but bank impacts are high. These areas received a low Priority Rating, but impacts to the bank are significant, primarily because they are or were access points for work crews and boats during the incident response activities. The specific site IDs that fall into this category are: 1, 19, 21, 22, 38, 44, 55, 58, and 64. The mitigation measures for these areas would likely be similar to those for the Priority Rating 5 erosion areas. These areas will be mitigated when incident response activities at these access points have ended. The design process would include:

   a. Field measurements of erosion areas

      Using basic equipment (e.g. laser level, measuring tape), key measurements of the target areas will be completed. They include bank height, water depth / drop off at toe, bank length, specific bank composition, and vegetation types present (e.g. grass, brush, and trees).

   b. Develop "Template" design for each area

      A template design approach is proposed to expedite the mitigation measures for these areas. This approach consists of providing general design information, typically in the form of typical cross-sections that can provide a construction contractor base information necessary to bid on and construct the mitigation measures. This information can be supplemented with construction oversight by staff familiar with the intent of the mitigation measures and their design (described in Step 1d).

      Based on information collected to date, it is anticipated that mitigation measures at each of the areas will include one or more of the following:

      - Branch Packing
      - Brush Mattresses
      - Coconut Fiber Rolls
      - Logs and Rootwads
      - Tree revetments
      - Bank shaping (grading), with plantings/live stakes/live facines
      - Stone Toe Protection / Riprap
      - Vegetated Geogrids

      Whenever possible, mitigation measures will be chosen to increase habitat value in addition to stabilize erosion. This may include softening of the bank slope to increase shoreline accessibility to wildlife or placement of woody debris to provide perches for turtles, mink, and birds as well as aquatic habitat for fish and benthos. Vegetation plans will focus on planting of native species and seek to minimize colonization by invasive non-native species.

c. Permitting
The applicable government agencies will be engaged to obtain the necessary permits for the construction work designed, as described in Step 1b. These may include county (both Calhoun and Kalamazoo Counties) soil erosion permits, Michigan Inland Lakes and Streams permit, and Army Corps of Engineers permits. Enbridge currently has County Soil Erosion and Sedimentation Control Permits from both Calhoun County and Kalamazoo County.

d. Construction and Construction Management
Steps 1a through 1c were completed for the original ten Level 5 sites (see Appendix C for design plans). Construction was completed as of 11/18/10. Example photos of the stabilized sites are presented in Appendix D.

e. Monitoring Stabilized Sites
See the "Monitoring Plan" section for a description of monitoring stabilized sites.

2) Monitoring Plan
a. Introduction
The assessments completed to date, were all qualitative assessments based on visual observations made in accordance with the rating system described previously. No specific quantitative field measurements were taken. To be consistent with this method, and in agreement with comments from the Trustee Group, the monitoring will also be conducted following the same process. Visual observations of bank conditions will be documented through written record keeping, photographs, and video recordings.

b. Monitoring Team
At present, the monitoring team includes two staff members from AECOM (Jamie Matus and Jaren Hiller) and two staff members from JF New (Stu Kogge and Brian Majka). All four were involved with the original assessment. The team also includes a MDNRE representative (Michelle DeLong of the MDNRE Kalamazoo District office). In addition, an invitation has been extended to the NRDA Trustee group to participate in any monitoring trip. The Trustee group will be given one week notice prior to any monitoring trip. Using this same team of individuals for each monitoring assessment trip provides for the greatest ability to compare conditions in a consistent manner over time. Ideally, all team members will be part of every monitoring trip. If this cannot be accomplished, then a minimum of one team member from each of the firms and/or agency (AECOM, JFNew and MDNRE) should participate in the monitoring assessments[1]. As a result, there will be consistency in monitoring, and observations during any one trip can be compared objectively with the previous trip.

[1] The MDNRE can waive their attendance during these monitoring assessments with the understanding that photographs and documentation of the assessment will be provided to them for review and comment.

c. Data Collection

i. Erosion Areas - All sites recorded as part of the *Bank Erosion Assessment and Action Plan* will be monitored. Visual observations of each area will be recorded. The features to be observed and recorded will be consistent with the original assessment, and include:

- Estimated length of observed erosion
- Estimated bank Height
- Estimated bank Side Slope
- Bank composition
    - Vegetation type and extent of cover
    - Soil type
- Adjacent channel flow velocity – (proximity of bank to thalweg)
- Location of erosion area relative to channel planform (e.g. outside bend, inside bend, etc)
- Notable changes from previous monitoring trip, such as:
    - Vegetation reestablishment
    - Change in bank slope (steepening or flattening)
    - Sloughing or other significant mass/bank failure
    - Fallen trees
    - Significant changes in water levels and relative change in degree of natural erosion

Photos of each erosion area will be taken for comparison to photos taken during the original assessment, and previous monitoring trips. In addition, video may be recorded at each area during each monitoring trip to assist in comparing the conditions to the previous monitoring trips. In addition, if new bank erosion areas are identified that are the result of incident response activities, they will be recorded and added to the monitoring plan. New sites would be evaluated to determine if incident response activities could be identified as causing the site erosion. In this way, the plan would limit addressing natural erosion that is difficult to quantify because of the dynamic nature of a river system.

ii. Stabilized Erosion Areas

Sites where bank stabilization construction has been completed for the category 5 sites identified in the *Bank Erosion Assessment and Action Plan* will also be monitored as part of the monitoring plan. Monitoring of these sites will include:

- Record description of stabilization techniques,
- Conditions of stabilization, presence of any observable failure,
- Presence of vegetation reestablishment
- Bank conditions adjacent (upstream, downstream, across river) to stabilization to determine if stabilization measures are negatively impacting other banks. If this occurs, and additional stabilization is required, it will be documented and addressed similar to the other erosion areas.

iii. Reference Reach Area

The reference reach of the Kalamazoo River (from 17 Mile Road to Marshall Avenue in the City of Marshall) will also be monitored and recorded similarly to the erosion areas.

Photos of each stabilization area will be taken for comparison to photos taken during the original assessment, and previous monitoring trips. In addition, video may be recorded at each area during each monitoring trip to assist in comparing the conditions to the previous monitoring trips.

d. Monitoring Schedule

The following describes the schedule for monitoring:

- Monitoring is planned for a 12 month period (November, 2010 to November, 2011). Monitoring trips will occur every other month, unless snow and ice cover prevent the ability to complete visual assessments.

e. Monitoring Criteria

The following describes the criteria for monitoring:

- Each area will be monitored for a minimum of a 12 month period.
- Stabilized sites will be monitored for the base monitoring period (November, 2010 to November, 2011). If stabilized areas are damaged and need repair, monitoring will extend for 12 months from the time of the repair. Stabilized areas that are unchanged and/or continue to improve after 12 months of monitoring will be delisted from the assessment.
- If additional sites are added during the base monitoring period, then monitoring for those areas will extend for 12 months from the time they are added.
- If, as a result of a monitoring trip, an erosion area has an increased priority rating (e.g. from a Rating 3 to a Rating 4), then monitoring for that area will extend for 12 months from the time of the increased priority rating.
- Erosion areas that have either an unchanged or decreased priority rating after 12 months of monitoring will be delisted from the assessment.

f. Monitoring Reports

Interim monitoring reports will be completed after each monitoring trip. They will included an update to Priority Ratings, summary of actions taken, and photo log of the trip. If erosion areas are proposed to be stabilized as a result of the trip, proposed stabilization plans will also be included.

When all erosion areas have been delisted, a final report summarizing all activities associated with the monitoring plan will be completed.

The summary of the first monitoring trip is included in Appendix E. The table presented in Appendix A includes both the original priority ratings and the latest ratings subsequent to the 11/20/10 monitoring trip.

SUMMARY AND CONCLUSIONS

Based on field reconnaissance of the Kalamazoo River from September through November 20, 2010, the team has identified locations along and within the river where erosion has likely occurred due to incident response activities. A relative severity rating was assigned to each location based on a number of factors as described in this action plan.

As a result of Enbridge and regulatory agency (MDNRE and EPA) approval of the third revision of the Kalamazoo River Bank Erosion Assessment Action Plan (dated October 28, 2010) the ten priority 5 bank erosion sites have been stabilized. These ten sites were all located downstream of Ceresco Dam between Mile Post 6.25 and MP 25.5.

As a result of the first monitoring trip completed from November 18 through 20, 2010, the initial ten category 5 sites were re-categorized as category 1, 11 sites were downgraded (given lower priority ratings), 10 sites were upgraded (seven of which were upgraded to a category 5 priority rating), and six sites were added (two of which were upgraded to a category 5 priority rating).

It appears, from the monitoring trip that many of the sites, especially those with a base of vegetation and/or root mass, are naturally stabilizing without intervention. Areas with little vegetation and root mass, especially those particularly exposed to wave action from boats (e.g. islands) are continuing to degrade. The frequency of erosion and relative severity dramatically decreases downstream of the confluence with the Battle Creek River, near mile post 16. In order to further monitor and understand erosion along the river, a longer term monitoring plan of erosion areas has begun. Depending upon site conditions, including snow cover and river conditions, AECOM proposes to conduct monitoring trips every other month for a period of one year. The frequency of monitoring may be increased depending upon site conditions observed during each monitoring trip.

APPENDIX A

Assessment Table
Assessment Location Maps
Assessment Photo Log

Unique ID	Approximate River Mile Station	(2) Bank Side	Approximate Length of Impacted Bank (ft)	Approximate Height of Impacted Bank (ft)	Approximate Bank Side Slope	Current Bank Composition	Approximate River Width (ft)	(3) Severity of Erosion Rating	(3) Continued Erosion Risk Rating	(4) Composite Rating	10/28/10 Priority Rating	12/10/10 Priority Rating
1	2.25	LDB	150	2-3	2:1	soil, grass	75	4	3	7	3	4
2	2.30	LDB	250	2-3	V	soil, grass	150	3	2	5	4	3
3	2.35	LDB	150	3	1:1	soil, grass, some trees	125	3	2	5	4	3
4	2.55	Island	250	3	V	soil, shrubs, roots, trees	200	4	3	7	4	4
104	2.65	LDB	150		V	soil, grass	125	4	4	8	4	4
5	2.90	Island	750	1-2	V	soil, grass	225	3	4	7	4	4
6	3.10	Island	1500	1-2	V	soil, grass	225	3	4	7	4	4
7	3.35	RDB	200	1-2	1:1	soil, grass	100	3	3	6	4	3
8	3.55	Island	300	1-2	V	soil, grass clumps/hummocks	225	3	4	7	4	4
9	3.60	Island	300	1-2	V	soil, grass clumps/hummocks, brush	225	3	4	7	4	4
10	3.65	LDB	300	3	V	soil, grass, spotty small trees	225	4	3	7	4	4
11	3.75	Island and LDB	300	1-2	1:1	soil, grass clumps/hummocks	225	3	4	7	4	4
12	4.00	Island	300	2	V	soil, grass clumps/hummocks	200	4	5	9	4	5
13	4.15	Island	1000	1	1:1	soil, grass clumps/hummocks	275	3	4	7	4	4
113	4.20	RDB	300	2	V	soil, brush, some roots	275	4	4	8	4	4
14	4.30	Island	500	1	1:1	soil, grass clumps/hummocks	275	3	4	7	4	4
15	4.40	LDB	1000	1	1:1	soil, grass clumps/hummocks	125	2	3	5	3	3
16	4.60	Two Islands	400	1	1:1	Soil, spotty grass/hummocks	300	3	4	7	4	4
17	4.75	LDB	50	4	2:1	soil, brush/small trees	250	2	2	4	3	2
18	4.85	LDB	350	1-2	V	soil, grass	200	4	3	7	3	4
19	4.95	RDB	100	2	V	soil, grass	300	3	3	6	3	3
20	5.20	LDB	150	3	1:1	soil, grass clumps/hummocks	225	2	2	4	2	2
21	5.35	LDB	100	10	2:1	soil, gravel, grass	300	3	3	6	3	3
22	5.35	LDB	50	10	2:1	gravel, soil	300	3	3	6	3	3
23	5.35	LDB	100	3	2:1	soil, gravel, grass	300	3	2	5	3	3
24	6.00	RDB	500	2	V	half w/ soil, grass, half with soil, roots, tree	100	4	3	7	5	4
25	6.10	RDB	100	4	V	grass, soil, sparse roots, underlain gravel	100	1	1	2	5	1
26	6.25	RDB	100	3	1:1	grass, soil, roots, underlain gravel	200	4	4	8	3	4
27	6.25	Island	1200	1-2	V	soil, grass	200	3	4	7	4	4

Priority Ratings with diagonal hatching are “Other Site-Specific Areas” such as river access/launch

Unique ID	Approximate River Mile Station	(2) Bank Side	Approximate Length of Impacted Bank (ft)	Approximate Height of Impacted Bank (ft)	Approximate Bank Side Slope	Current Bank Composition	Approximate River Width (ft)	(3) Severity of Erosion Rating	(3) Continued Erosion Risk Rating	(4) Composite Rating	10/28/10 Priority Rating	12/10/10 Priority Rating
28	6.55	LDB	300	3	1:1	grass, soil, roots, underlain gravel	200	3	3	6	4	3
29	6.75	Island	100	3-4	V	soil, grass, brush	225	4	5	9	4	5
30	7.00	LDB	200	3-4	V	half w/ soil, grass, half with soil, roots, tree	125	5	4	9	4	5
31	7.35	2 Islands	400	1	V	soil, grass	150	3	2	5	4	3
32	7.40	LDB	200	4	V	soil, grass	175	1	1	2	5	1
33	7.40	RDB	100	2	V	grass, soil, roots, underlain gravel	175	3	4	7	4	4
34	8.25	LDB	100	3	V	grass, soil, roots, underlain gravel	175	4	3	7	4	4
35	8.30	LDB	400	2-4	V	brush, soil, roots, underlain gravel	175	4	2	6	3	3
36	9.00	LDB	50	3	V	brush, soil, roots, underlain gravel	125	4	2	6	4	3
37	9.00	LDB	300	3	V	brush, soil, roots, underlain gravel	125	4	3	7	4	4
38	9.15	RDB	50	5	2:1	rock, soil, roots, underlain gravel	125	2	2	4	4	2
39	9.15	RDB	150	1-2	1:1	grass, soil	125	3	4	7	4	4
40	9.30	RDB	50	2	1:1	brush, rock, soil, roots, underlain gravel	150	3	4	7	3	4
41	9.40	Island	500	1-2	V	soil, grass	175	3	4	7	4	4
42	9.40	RDB	600	2-4	V	soil, grass. Also	125	1	1	2	5	1
43L	9.45	LDB	100	1-2	V	soil, grass	100	3	4	7	4	4
43R	9.45	RDB	100	1-2	V	soil, grass	100	3	4	7		4
44	9.90	LDB	700	3	1:1	soil, grass	100	4	4	8	4	4
45	10.00	Island	200	2	V	soil, grass	150	1	1	2	5	1
145	10.00	LDB	300					4	5	9		5
46	10.00	RDB	150	2	V	soil, grass	150	1	1	2	5	1
47	10.30	LDB	150	2	V	soil, grass	125	1	1	2	5	1
48	10.35	LDB	100	2-3	V	soil, grass, some roots	100	4	4	8	4	4
49	10.35	LDB	100	2-3	V	soil, grass, some roots	100	4	4	8	4	4
50	10.55	LDB	100	2	V	soil, grass, some roots	125	4	4	8	4	4
51	10.80	Island	700	2	1:1	soil, grass	200	3	3	6	4	3
152	11.05	LDB	75	3		soil, grass	75	3	3	6		3
52	11.10	Island	100	2	V	soil, grass, brush	75	5	5	10	4	5
53	11.15	RDB	100	2	V	soil, roots, trees	75	4	3	7	4	4
54	11.25	Island	150	1-2	1:1	soil, grass	100	4	5	9	3	5
55	11.30	LDB	200	2-3	V	grass, soil, roots, trees	100	3	4	7	4	4
156	11.65	RDB	40	2		sandy soil, grass, brush	75	5	5	10		5

Priority Ratings with diagonal hatching are “Other Site-Specific Areas” such as river access/launch

Unique ID	Approximate River Mile Station	(2) Bank Side	Approximate Length of Impacted Bank (ft)	Approximate Height of Impacted Bank (ft)	Approximate Bank Side Slope	Current Bank Composition	Approximate River Width (ft)	(3) Severity of Erosion Rating	(3) Continued Erosion Risk Rating	(4) Composite Rating	10/28/10 Priority Rating	12/10/10 Priority Rating
56	11.70	LDB	150	2	V	soil, grass, some roots	75	1	1	2	5	1
57	11.80	Island	100	1-2	V	soil, grass	75	4	5	9	4	5
58	12.15	RDB	200	4	V	grass, soil, roots, trees	75	5	3	8	4	4
59	12.20	LDB	200	6	0.5:1	soil, grass	75	4	5	9	4	5
160	12.40	Island	25	2-4	V	soil, grass	125	1	1	2	5	1
60	12.45	Island	400	2-3	V	soil, grass	75	4	4	8	4	4
61	12.55	Island	250	2-4	V	soil, grass	75	4	4	8	4	4
161	12.60	LDB	150	4	V	grass, soil, roots, trees	50	4	4	8	4	4
261	12.65	RDB	150	2-3	V	silty loam, grass	100	1	1	2	5	1
62	13.70	LDB	50	2-3	V	grass, soil, roots, trees	75	4	4	8	4	4
63	13.85	RDB	200	1-3	1:1	grass, soil, roots, trees	75	3	3	6	3	3
164	14.65	Island	25	1	V	soil, grass	100	2	2	4		2
64	14.85	RDB	200	2-3	V	grass, soil, roots, trees	150	3	2	5	3	3
165	17.25	Island	40	1-2	1:1	soil, grass	175	1	2	3		2
65	20.10	Island	600	2	V	soil, grass	225	3	3	6	4	3
66	23.40	RDB	100	4	V	sand, soil	75	4	4	8	4	4
67	23.50	LDB	100	2	V	sand, grass, roots	125	4	3	7	4	4
68	25.40	LDB	250	2	V	sand, grass, roots	250	1	1	2	5	1
169	30.30	RDB	70	2		soil, grass, roots, trees	75	3	3	6		3
69	30.50	LDB	200	2	1:1	soil, grass, roots	75	2	2	4	4	2
70	30.80	RDB	400	2	1:1	soil, grass, roots, trees	75	4	4	8	4	4
170	32.80	LDB	300	2		soil, grass, roots, trees	75	3	3	6		3
71	34.50	LDB	100	2	vertical	soil, grass, roots	125	1	1	2	4	1

No actually measurements were taken. All measurements shown in table are estimates based on visual observation only.

Recommendations on islands apply only to bank stabilization. In some cases, entire islands may need restoration/stabilization measures as a result of cleanup work.

(1) Location coordinates are based on locating points from paper aerial maps, not by actual GPS readings

(2) Bank Side: LDB = Left Descending Bank, RDB = Right Descending Bank. Listed as "Island" if impacted bank is located on an island.

(3) Ratings range from 1 to 5 with 1 reflecting the lowest degree of severity or relative impact. Ratings are qualitative.

Priority Ratings with diagonal hatching are “Other Site-Specific Areas” such as river access/launch

BANK EROSION LOCATIONS

KALAMAZOO RIVER - BANK EROSION ASSESSMENT

AECOM

60162778

12/10/10

N

Feet

0 550 1,100

BANK EROSION LOCATIONS

KALAMAZOO RIVER - BANK EROSION ASSESSMENT

AECOM

60162778

12/10/10

BANK EROSION LOCATIONS

KALAMAZOO RIVER - BANK EROSION ASSESSMENT

AECOM

60162778

12/10/10

16.50

16.25

16.00

15.75

River Mile (Typical)

15.50

15.25

Bank Erosion Area ID (Typical)

15.00

64

14.75

164

Bank Erosion Area Location (Typical)

14.50

Priority Rating

- 1
- 2
- 3
- 4
- 5

N

Feet

0 550 1,100

BANK EROSION LOCATIONS

KALAMAZOO RIVER - BANK EROSION ASSESSMENT

AECOM

60162778

12/10/10

20.00
19.75
19.50
19.25
19.00
18.75
18.50
18.25
18.00
17.75
17.50
17.25
17.00
16.75
65
165
River Mile (Typical)
Bank Erosion Area ID (Typical)
Bank Erosion Area Location (Typical)

Priority Rating

- 1
- 2
- 3
- 4
- 5

N

Feet
0 500 1,000

BANK EROSION LOCATIONS

KALAMAZOO RIVER - BANK EROSION ASSESSMENT

AECOM

60162778

12/10/10

BANK EROSION LOCATIONS

KALAMAZOO RIVER - BANK EROSION ASSESSMENT

AECOM

60162778

12/10/10

BANK EROSION LOCATIONS

KALAMAZOO RIVER - BANK EROSION ASSESSMENT

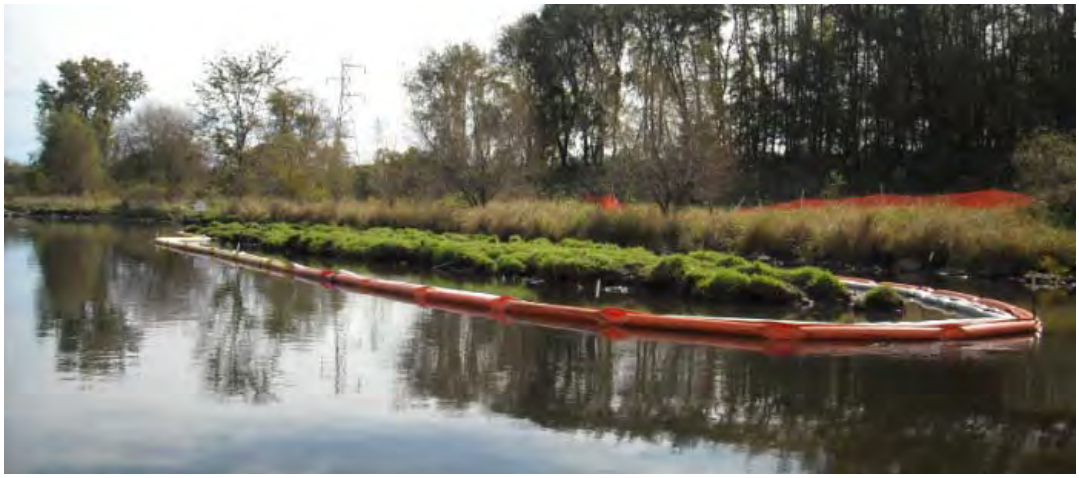
AECOM

60162778

12/10/10

	Site ID	Date Photo Taken
	1	09/27/10
	2	09/27/10
	3	09/27/10

	Site ID	Date Photo Taken
	4	09/27/10
	104	10/12/10
	5	10/12/10

	Site ID	Date Photo Taken
	6	09/27/10
	7	09/27/10
	8	09/27/10

	Site ID	Date Photo Taken
	9	09/27/10
	10	09/27/10
	11	09/27/10

	Site ID	Date Photo Taken
	12	09/27/10
	13	09/27/10
	113	12/12/10

	Site ID	Date Photo Taken
	14	10/12/10
	15	09/27/10
	16	09/27/10

	Site ID	Date Photo Taken
	17	09/27/10
	18	09/27/10
	19	09/27/10

	Site ID	Date Photo Taken
	20	09/27/10
	21	09/27/10
	22	09/27/10

	Site ID	Date Photo Taken
	23	09/27/10
	24	10/12/10
	25	09/27/10

	Site ID	Date Photo Taken
	26	09/27/10
	27	09/25/10
	28	09/27/10

	Site ID	Date Photo Taken
	29	09/27/10
	30	09/27/10
	31	09/27/10

	Site ID	Date Photo Taken
	32	09/27/10
No Photo Available as of 11/05/10	33	09/27/10
	34	09/27/10

	Site ID	Date Photo Taken
	35	09/27/10
	36	09/27/10
	37	09/27/10

	Site ID	Date Photo Taken
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	39	09/27/10
	40	09/27/10

	Site ID	Date Photo Taken
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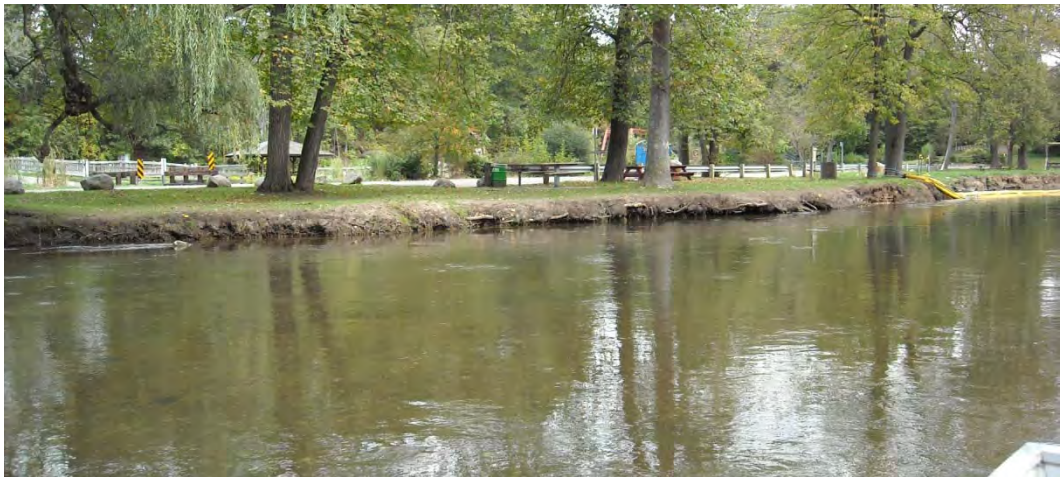
	42	09/27/10
	42	09/27/10

	Site ID	Date Photo Taken
	42	09/27/10
	42	09/27/10
	43	09/27/10

	Site ID	Date Photo Taken
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	44	09/27/10
	44	09/27/10

	Site ID	Date Photo Taken
	45	09/27/10
	46	09/27/10
	47	09/27/10

	Site ID	Date Photo Taken
	48	10/12/10
	49	09/27/10
	50	09/27/10

	Site ID	Date Photo Taken
	51	09/27/10
	52	09/27/10
	53	09/27/10

	Site ID	Date Photo Taken
	54	09/27/10
	55	09/27/10
	56	09/27/10

	Site ID	Date Photo Taken
	57	09/27/10
	58	09/27/10
	59	09/27/10

	Site ID	Date Photo Taken
	60	09/27/10
	160	10/20/10
	61	09/27/10