# Appendices

# St. Louis River Area of Concern Implementation Framework: Roadmap to Delisting

**July 15, 2013**

*Photo by Dave Witt/Aero-Environmental Consulting; courtesy Duluth Seaway Port Authority*


Minnesota
Pollution
Control
Agency

WISCONSIN
DEPT. OF NATURAL RESOURCES

Minnesota
DEPARTMENT OF
NATURAL RESOURCES

NAH-GAH-CHI-WA-NONG
FOND DU LAC
RESERVATION

PROTECT, RESTORE AND ENHANCE
ST. LOUIS RIVER
ALLIANCE

Great Lakes
RESTORATION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CLEAN
WATER
LAND &
LEGACY
AMENDMENT

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# Stakeholder Involvement Plan

## St. Louis River Area of Concern Implementation Framework

### Introduction

This stakeholder involvement plan (SIP) defines the methods for involving stakeholders in the St. Louis River Area of Concern (AOC) in the development of the Implementation Framework for Delisting the AOC. Funding for development of the Implementation Framework is from a U.S. EPA-administered Great Lakes Restoration Initiative (GLRI) grant awarded to the Minnesota Pollution Control Agency.

A desired outcome of the Implementation Framework (the Framework) is that it enables groups other than the state regulatory agencies to act to improve the AOC in a more coordinated, cooperative, and directed manner to contribute to delisting and restoration efforts. Therefore, the Framework must be accepted by stakeholders and developed in a manner such that they feel a sense of ownership of this important plan.

Because of the complexity of issues to be addressed in this project, a key element for success is educating and informing stakeholders early on about how the project will proceed and what primary work products will look like. In addition, given the knowledge and experience of the stakeholders in this AOC, the plan must involve stakeholder groups in meaningful ways throughout the project. This SIP was developed considering the ultimate goal: acceptance of the Framework to move forward to delisting the AOC.

### Key Stakeholder Groups for Framework Development

The primary stakeholder groups to be involved with development of the Framework include existing stakeholder groups and groups formed specifically for this project as described below and depicted in Figures 1 through 3. Oversight of the project and future implementation through the GLRI federal partners is depicted in Figures 1 and 3.

#### Existing Primary Stakeholder Groups

There is a long list of stakeholders involved in work in the St. Louis River AOC. Included in these stakeholders are several successfully functioning groups that have been working on issues in the AOC. This SIP takes advantage of these groups and their regularly scheduled meetings to inform stakeholders throughout the project. These groups, as shown in Figure 1, are:

- **Implementation Framework Partners (IFP)** – Staff members of state and tribal agencies responsible for oversight, direction, and coordination of AOC activities and programs.
  - Current coordinators and their affiliations are:
    - Marc Hershfield, Minnesota Pollution Control Agency (MPCA)
    - Tracey Ledder, Wisconsin Department of Natural Resources (WDNR)
    - Rick Gitar, Fond du Lac Band of Lake Superior Chippewa (FDL)

- John Lindgren, Minnesota Department of Natural Resources (MDNR)
- Julene Boe, St. Louis River Alliance[a]

- **St. Louis River Alliance (SLRA)** - The SLRA is a local nonprofit organization that "is working to oversee activities and practices that are helping to restore, protect and enhance the St. Louis River"[1]. SLRA has evolved from the Citizen Advisory Committee that was formed to assist Minnesota and Wisconsin state agencies in developing the remedial action plan for the AOC. Members of SLRA are active in all of the groups mentioned above. SLRA receives funding alternating yearly between MPCA and WDNR to assist in coordinating bi-state activities for the AOC. SLRA's mission is[1]:
  - Coordinating community efforts
  - Increasing public awareness
  - Focusing on the St. Louis River Area of Concern
  - Helping to implement the St. Louis River Area of Concern Remedial Action Plan

  - **SLRA Habitat Work Group (HWG)** – A diverse group of stakeholders focused on habitat issues for fish and wildlife in the watershed. Members include local, state, county, and federal agency representatives, researchers, citizens, and local conservation group representatives. The former SLRA Sediment Work Group has been incorporated into the HWG. Main roles of the Habitat Work Group are[2]:
    - Developing, coordinating, and tracking of habitat, remediation to restoration (R2R), and contaminated sediments projects
    - Providing two-way communication forum for project managers and agencies
    - Providing a forum for project planning and strategizing (needs assessment, helping the AOC coordinators)
    - Acting as an information resource (sharing funding opportunities)
    - Networking
    - Making recommendations and advising the states and tribes

- **Harbor Technical Advisory Committee (HTAC)**[3] – The HTAC is a committee of the Metropolitan Interstate Council (MIC). The MIC provides guidance and leadership on transportation and land use planning issues in the Duluth-Superior metropolitan planning area. The MIC was created in 1975 under a joint agreement between the Arrowhead Regional Development Commission (ARDC) in Duluth, Minnesota and the Northwest Regional Planning Commission (NWRPC) in Spooner, Wisconsin. The thirty voting members of the HTAC represent a wide range of harbor stakeholders including business owners, environmental groups and local, state and federal officials who are directly concerned with the planning, programming and implementation of issues pertaining to the harbors of Duluth and Superior.

[a] Citizen representative

- The HTAC's mission is to:
  - Provide a forum for the discussion of issues and concerns pertaining to the Duluth-Superior harbor
  - Promote the harbor's economic and environmental importance to the community
  - Provide sound planning and management recommendations to the MIC

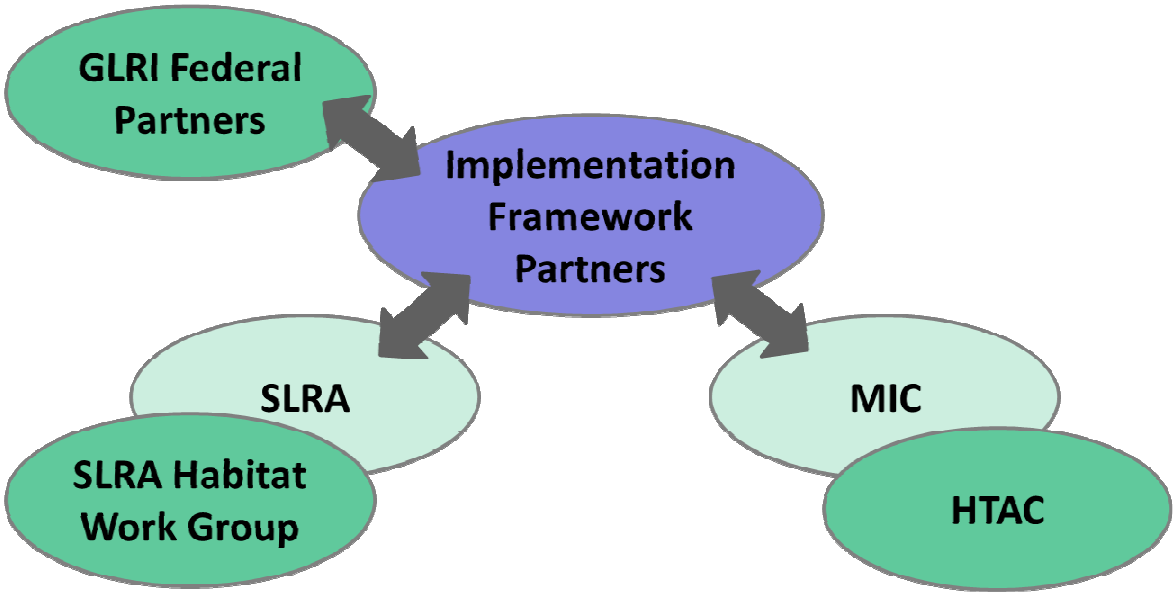


**Figure 1: Existing Stakeholder Groups**

## Additional Groups Formed for this Project

In addition to the primary stakeholder groups described above, a scientific advisory group and groups dealing with beneficial use impairments (BUIs) will be formed for this project. These groups will be tasked with development of and/or review of project work products.

- **BUI Teams** – Members of the Implementation Framework Partners, HWG, HTAC, SLRA, and other strategic partners will be asked to contribute to the project as members of groups dealing with issues regarding specific BUIs or sets of related BUIs, as depicted in Figure 2. BUI teams will be formed as follows:

  - Aesthetics and beaches
    - Degradation of aesthetics
    - Beach closings/body contact

  - Sediment-related impairments
    - Fish consumption advisories
    - Fish tumors and deformities
    - Restrictions on dredging
    - Degradation of benthos
  - Fish and wildlife
    - Degraded fish and wildlife populations
    - Loss of fish and wildlife habitat
  - Water quality
    - Excessive loading of nutrients and sediment

- **Scientific Advisory Group (SAG)** – Potential members will be identified by the Implementation Framework Partners and invited by MPCA. The group will serve as a resource for review and input on important technical project work products, as shown in Figure 3.

- **Implementation Leadership Team (ILT)** – Potential members will be identified and invited by the Implementation Framework Partners. A broad group of local and state business, community, and conservation leaders will be engaged. This team will be ambassadors for the efforts to move the Area of Concern to delisting and will assist in identifying and becoming champions for the vision.

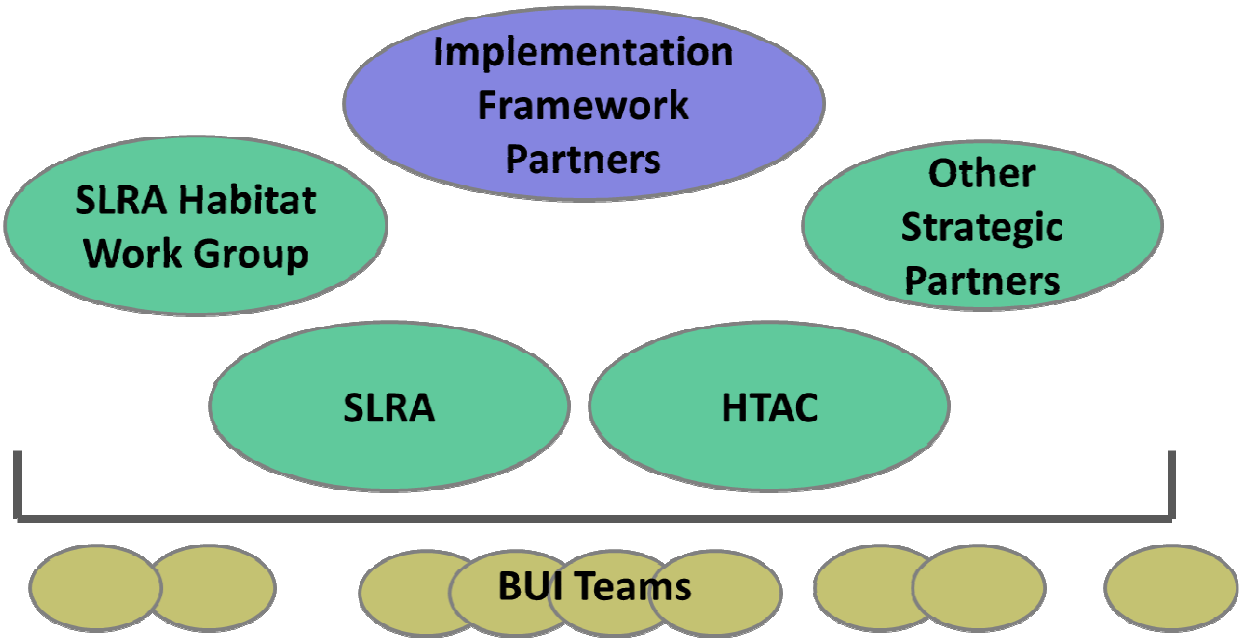


**Figure 2: Formation of BUI Teams from Existing Stakeholder Groups and Strategic Partners**

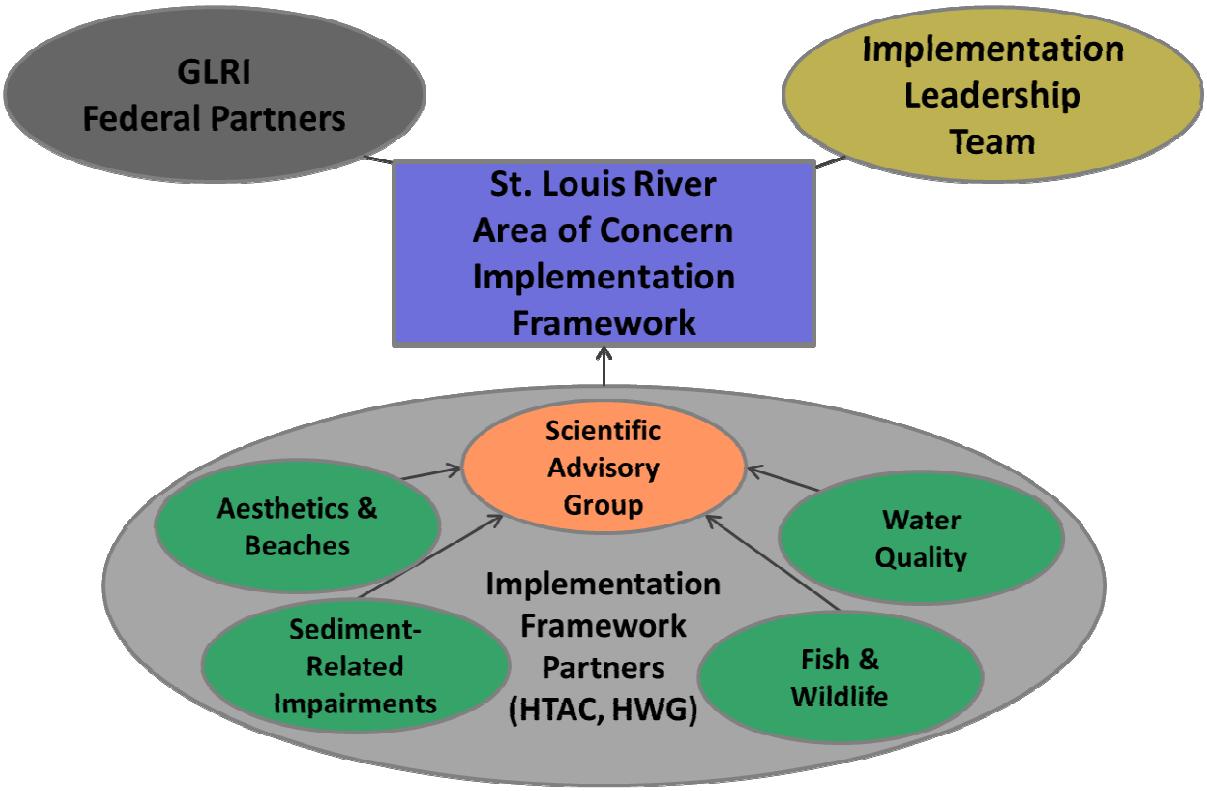


**Figure 3: Stakeholder Groups for Development of the Implementation Framework**

## Key Points of Input and Methods of Involvement

Stakeholders will be informed of project progress and involved in development of project elements at specific points during the project. Important project elements are listed in Table 1, along with the methods of involving the stakeholder groups. These methods are:

- **Inform** through presentations at regularly scheduled meetings.
- **Solicit comment** on project elements after providing documents for review or presentations at regularly scheduled meetings. Comments will be considered for incorporation into final versions.
- **Direct input** will be requested to develop project elements at task-specific workshops or meetings.
- **Review and approve** provided documents for incorporation into final project deliverables.

## Table 1: Methods of Involvement of Stakeholders with Project Elements

| Project Element | Method of Involvement | | | |
|---|---|---|---|---|
| | **Inform** | **Solicit Comment** | **Direct Input** | **Review and Approve*** |
| Stage II RAP Table of Contents | | | | Implementation Framework Partners |
| Descriptions of BUI blueprints, R2R template**, and System of measureable indicators | HWG<br>HTAC<br>BUI Teams | **MPCA, WDNR, MDNR, EPA, FDL, USFWS, MLT | | Implementation Framework Partners |
| Selected measureable indicators | HWG | Scientific Advisory Group | | Implementation Framework Partners |
| Source/stressor assessment | BUI Teams | Scientific Advisory Group | | |
| BUI current conditions | BUI Teams | Scientific Advisory Group | | |
| Prioritization scheme metrics | HWG | | Implementation Framework Partners | |
| IDing potential actions/R2R projects | | | BUI Teams<br>Implementation Framework Partners | |
| Prioritized list of actions/R2R projects | | BUI Teams | | Implementation Framework Partners |
| Draft BUI Blueprints | HWG[1]<br>HTAC[1] | BUI Teams<br>Scientific Advisory Group<br>Implementation leadership Team | | Implementation Framework Partners |
| Preliminary Delisting Roadmap | HWG<br>HTAC | Scientific Advisory Group<br>Implementation leadership Team | | Implementation Framework Partners |

[1]Overview of blueprints to be presented
*Final review and approval of the Implementation Framework will be by the WDNR and MPCA.

## Schedule

The projected schedule of stakeholder meetings for the points of involvement in Table 1 is shown below on the overall project schedule. This schedule is subject to adjustment as necessary as the project proceeds. Descriptions of each meeting are provided in the "Stakeholder Meeting Key" following the schedule.

| | Task | 2011 | | | | | | 2012 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| 1 | **Measureable Indicators, BUI Bluepints, and Delisting Roadmap** | | | | | | | | | | | | |
| | *Develop System of Measureable Indicators* | | | 2. IF Partners, HWG, HTAC | | | | | | | | | |
| | *Develop BUI Blueprints* | 1. IF Parters, HWG | | | | 3. BUI SAG | 4. SAG | | 6. ILT | 7. HWG, HTAC | 8. SAG | 9. SAG, ILT, HWG | |
| | *Develop Delisting Roadmap* | | | | | | | | | | | | 10. HTAC, ILT |
| | *Compile Elements of Draft Stage II RAP* | IF Partners | | | | | | | | | | | |
| 2 | **Prioritize Action Items/R2R Projects and Create R2R Templates** | | | | | | | | | | | | |
| | *Develop Prioritization Scheme* | | | | | | 5. IF Partners | | | | | | |
| | *Prioritize Action Items/R2R Projects* | | | | | | | | | | | | |
| 3 | **Develop Project Description and Concept Plans** | | | | | | | | | | | | |
| | *Develop Project Descriptions and Concept Plans* | | | | | | | | | | | | |

### Stakeholder Meeting Key:

1. Outline of BUI blueprints, R2R Template and Measureable Indicators Descriptions presented to Implementation Framework Partners for review and approval; presented to HWG
2. System of measureable indicators presented to Implementation Framework Partners for review and approval; Project update presented to HTAC and HWG
3. BUI Teams groups convene and begin tasks; Scientific Advisory Group meets and reviews source/stressor assessment and measureable indicators
4. SAG meets to provide comments on source/stressor models
5. Prioritization scheme workshop with Implementation Framework Partners to define prioritization metrics and approach

6. ILT convenes
7. BUI Teams finish work; Present project update to HWG and HTAC
8. Present draft BUI blueprints to SAG for review
9. SAG meets to provide comments on draft BUI Blueprints; Present draft BUI blueprints to Implementation Leadership Team; Present project update to HWG
10. Present project update to HTAC; present preliminary delisting roadmap to ILT

## Roles and Responsibilities

LimnoTech and the Implementation Framework Partners will share roles for stakeholder involvement throughout the project. Roles and responsibilities for each are described below.

Implementation Framework Partners (MPCA, WDNR, MDNR, FDL, SLRA)

- Formation of scientific advisory group, BUI teams, and implementation leadership team
- Responsible for facilitating and coordinating Implementation Framework Groups as follows:
    - Aesthetics and beaches – Julene Boe
    - Sediment-related impairments – Tracey Ledder
        - Dredging subgroup - Marc Hershfield
    - Fish and wildlife – Rick Gitar and John Lindgren
    - Water quality – Marc Hershfield
    - Leadership Team – Nelson French and Nancy Larson
- Presentation of project updates at HTAC, HWG, SAG, and ILT meetings – shared with LimnoTech as appropriate

LimnoTech

- Preparation of work products for presentation at Implementation Framework group meetings
- Presentation of project updates at Implementation Framework group meetings
    - Selected HTAC, HWG, and ILT meetings TBD as project progresses
    - Others as determined by the IFP
- Facilitation of task-specific meetings and workshops
    - Kickoff meeting for BUI Teams and SAG
    - Other BUI Team meetings TBD as project progresses
    - Prioritization scheme workshop with IFP
    - SAG meetings

SLRA

- Minutes for Implementation Framework Partners meetings

## References

1. St. Louis River Alliance website: http://www.stlouisriver.org/about2.html
2. Habitat Work Group Meeting Minutes, March 10, 2011
3. Duluth Superior Metropolitan Council website: http://www.dsmic.org/default.asp?PageID=190

# Appendix B: BUI and SAG Team Membership List

# Appendix B: Team Members and SAG Membership List

| Group | Name | Affiliation |
|---|---|---|
| **Aesthetics and Beaches** | Brandon Kohlts | Western Lake Superior Sanitary District |
| | Brian Becker | Douglas County Health Dept |
| | Brittany Story | MPCA |
| | Cynthia Hakala | Minnesota Department of Health |
| | Jenny Thoreson | City of Superior, Environmental Service Division |
| | Julene Boe* | SLRA |
| | Kari Jacobson-Hedin | Fond du Lac Band of Lake Superior Chippewa |
| | Marie Zhuikov | SLRA |
| **Fish and Wildlife** | Dan Weber | US Department of Agriculture |
| | Daryl Peterson | Minnesota Land Trust |
| | Fred Strand | WDNR |
| | Joel Hoffman | USEPA Mid-Continent Ecology Division |
| | John Lindgren* | MDNR |
| | Joshua Bailley | Audubon Minnesota |
| | Nancy Larson | WDNR |
| | Martha Minchak | Minnesota DNR |
| | Pat Collins | US Fish and Wildlife Service |
| | Rich Staffon | MDNR |
| | Rick Gitar* | Fond du Lac Band of Lake Superior Chippewa |
| | Shon Schooler | Lake Superior NERR |
| | Ted Angradi | US EPA MED Lab |
| **Sediment-Related Impairments** | Carri Lohse-Hanson | MPCA |
| | David Bolgrien | USEPA Mid-Continent Ecology Division |
| | Dan Breneman | NRRI-UMD |
| | Doug Beckwith | MPCA |
| | Guy Partch | Barr Engineering |
| | J Howard McCormick | Habitat Workgroup |
| | Lisa Neitzel | Habitat Workgroup Surge Communication |
| | Lorena Rios | UW-Superior |
| | Patricia McCann | Minnesota Department of Health |
| | Rick Gitar | Fond du Lac Band of Lake Superior Chippewa |
| | Ruth Oppedahl | UWS Extension |
| | Todd Fryzek | S.E.H |
| | Tracey Ledder* | WDNR |
| | Zachary Jorgenson | USFWS |
| **Dredging Subgroup of Sediment-Related Impairments** | Andy McDonald | MIC |
| | Gene Clark | WI SeaGrant |
| | Jim Sharrow | Port Authority |
| | Joe Graham | WDNR |
| | Marc Hershfield* | MPCA |
| | Steve Brossart | USACE |
| | Ted R. Smith | AMI Consultants |
| | Ted Smith | Marine Tech |

| Group | Name | Affiliation |
|---|---|---|
| **Water Quality** | Brent Bellinger | USEPA Mid-Continent Ecology Division |
| | Chris Kleist | City of Duluth |
| | Christine Ostern | Douglas County |
| | Diane Nelson | City of Superior |
| | Jane Anklam | Western WI Land Trust |
| | Joel Hoffman | USEPA Mid-Continent Ecology Division |
| | Kari Hedin | Fond du Lac Band of Lake Superior Chippewa |
| | Marc Hershfield* | MPCA |
| | Rich Axler | NRRI |
| | Tim Tuominen | WLSSD |
| **Scientific Advisory Group** | Carl Richards | USEPA Mid-Continent Ecology Division |
| | Dave Warburton | USFWS |
| | Gerald Niemi | NRRI-UMD Center for Water and the Environment |
| | Lucinda Johnson | NRRI-UMD Center for Water and the Environment |
| | Mary Balcer | UWS- Lake Superior Research Institute |
| | Matt TenEyck | UWS |
| | Nancy Schuldt | Fond du Lac Band of Lake Superior Chippewa |
| | Ralph Garono | Lake Superior NERR-NOAA |
| | Val Brady | NRRI-UMD Center for Water and the Environment |
| **Other Implementation Framework Partners** | Nancy Larson** | WDNR |
| | Nelson French** | MPCA |
| | Lisa Angelos | MDNR |
| | Cherie Hagen | WDNR |
| | Gini Breidenbach | LimnoTech |
| | Hans Holmberg | LimnoTech |
| | Joe Depinto | LimnoTech |

*Team Leader

**Scientific Advisory Group Liaison

*Confirmed membership as of 12/2/2011*

# Appendix C: BUI Team Charge

# St. Louis River Area of Concern
# BUI Team Charge
## for Implementation Framework Development

***BUI Team Objective:*** *Provide recommendations to the Area of Concern Coordinators on blueprint(s) for BUI removal.*

A BUI Blueprint will be developed for each BUI based on existing data and information. The blueprint will define the actions necessary to achieve removal of the BUI. Each blueprint is anticipated to consist of the components identified in the table below. An annotated BUI Blueprint Outline is provided as Attachment 1. A graphical depiction of the BUI Blueprint development process is provided in Figure 1.

BUI Teams will assist in developing the blueprint components identified in the Table 1.

**Table 1: BUI Blueprint Components**

| BUI Blueprint Component | Developer |
|---|---|
| **Summary Statement** | **BUI Team Responsibility** |
| | |
| Source/Stressor Model | Provided by LimnoTech |
| Measureable Indicators | |
| Historic Conditions | |
| Current Conditions* | |
| Information Gaps | |
| | |
| **Permitting and Regulatory Process** | **BUI Team Responsibilities** |
| **Sequential List of Prioritized Actions to Achieve BUI Removal** | |
| **Resources Needed** | |
| **Anticipated Timeline for Achieving BUI Removal** | |
| **Costs** | |
| | |
| Ongoing Monitoring Needs | Provided by LimnoTech |

*To be refined by BUI Teams

BUI Teams are being asked to complete their primary tasks between **November 15, 2011 and March 15, 2012,** interim completion dates for each task are provided as guidance. The frequency of meetings during this period will be determined by the BUI Team Leader with the group. Review of the compiled Draft BUI Blueprints will be requested of the BUI Teams in late March or April, 2012.

The BUI Team Scope of Work on the following pages provides details on the specific tasks requested of each BUI Team.

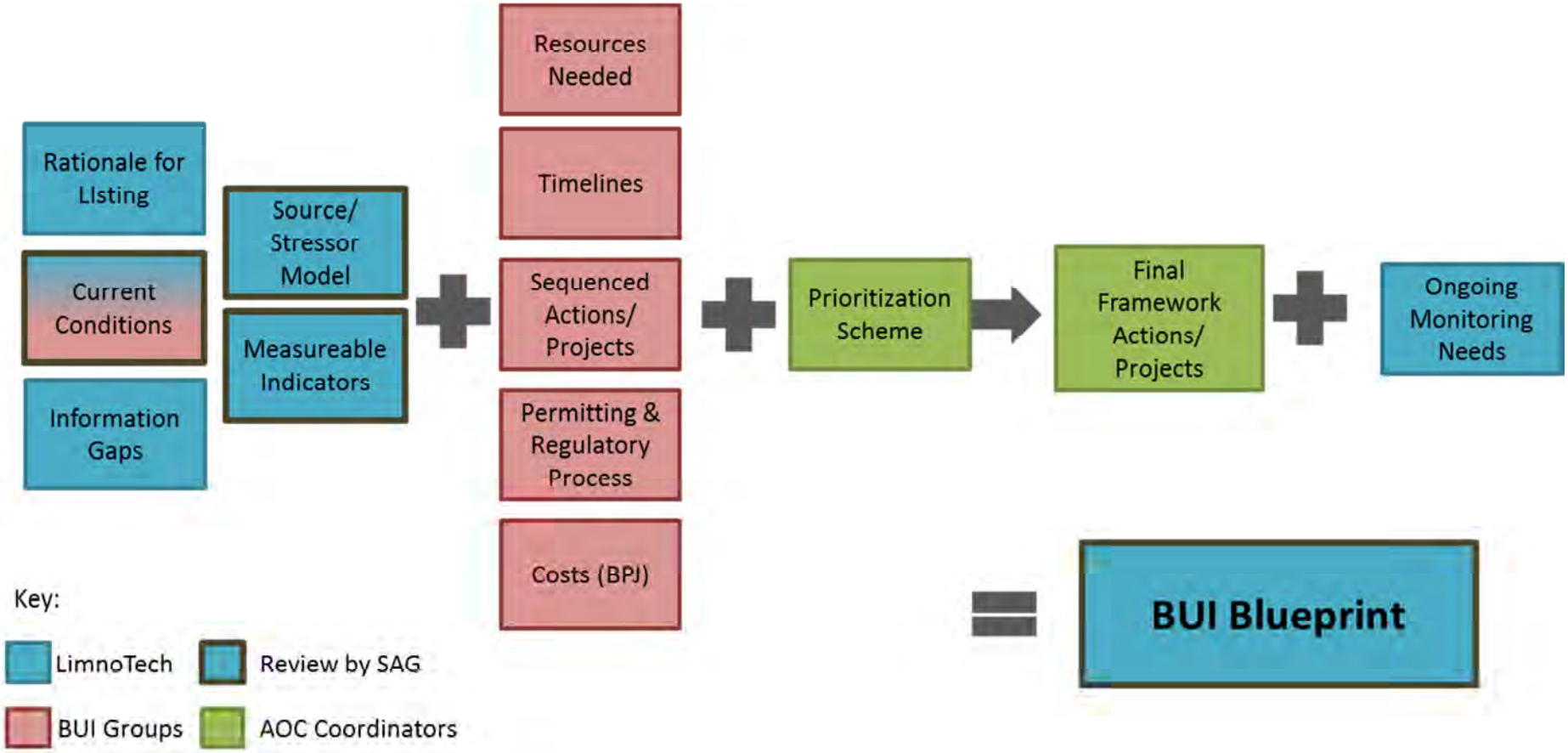


**Figure 1: BUI Blueprint Development Process**

# BUI Team Scope of Work

## Task 1: Attend St. Louis River AOC Implementation Framework Kickoff Meeting

- Objective: Understand the objective of the Implementation Framework, the components of the Implementation Framework (including the BUI Blueprint), and the process for developing it.
- Action Items:
  - BUI Team will attend a Kickoff Meeting where AOC Coordinators and their contractor (LimnoTech) will provide the BUI Teams with relevant information.
  - Share questions/concerns at the meeting.
- Task Completion Date: BUI Team Kickoff Meeting to be held on Tuesday, November 15, 2011 from 9:30am to 12:00pm

## Task 2: Review Original Basis for Listing and Concerns as Set Forth in Existing RAP Documents

- Objective: Understand rationale for listing the BUI and original concerns as outlined in the 1992 Stage I RAP, 1995 RAP Update, and 2001 RAP Update. This task is important to focus the team in on the issues that existed in the AOC at the time of listing. All BUI Teams will be provided access to these documents.
- Action Items:
  - AOC Coordinators and LimnoTech will provide BUI Team with the *Rationale for Listing* summary for each BUI at the Kickoff Meeting.
  - BUI Team will review the *Rationale for Listing* and RAP documents (as desired) prior to a scheduled team meeting to discuss the information and share questions/concerns at that meeting.
  - BUI Team may suggest refinements to the *Rationale for Listing*, if needed.
- Task Completion Date: December 15, 2011

## Task 3: Develop Timeline of Actions That Have Been Taken Since 1992 that Affect Each BUI

- Objective: Inventory projects or activities from 1992, when the Stage I RAP was written, to the present that have contributed to progress towards BUI delisting. Part of this inventory will serve as the basis for an update report on the 43 Recommendations made in the 2001 RAP Update. This report is being developed by the St. Louis River Alliance (SLRA). A bibliography of research conducted in the St. Louis River AOC is available for reference.
- Action Items:
  - BUI Team: Brainstorm to inventory important projects, actions, and regulatory changes that have occurred since 1992 to create a timeline of actions contributing to BUI delisting efforts. Template to be supplied by LimnoTech.

  - BUI Team: Complete SLRA questionnaire "Stage II Remedial Action Plan BUI Progress Since 2001"
- Task Completion Date: December 15, 2011

## Task 4: Finalize Measureable Indicators

- Objective: Finalize measureable indicators based on understanding of the basis for and utility of the BUI *Source/Stressor Models* and the final delisting targets.
- Action Items:
  - AOC Coordinators and LimnoTech will describe the BUI *Source/Stressor Models,* final delisting targets, and measureable indicators and explain their basis and utility at the Kickoff Meeting.
  - BUI Team will review the BUI *Source/Stressor Model*s, final delisting targets, and measureable indicators.
  - BUI Team will use the BUI *Source/Stressor Models* to:
    - Understand measureable indicators for each BUI
    - Understand common indicators among BUIs
    - Understand sources for each BUI and common sources among BUIs
    - Identify remaining sources to be addressed
    - Assist in prioritizing actions
  - BUI Team will propose changes to the BUI measureable indicators, if needed.
- Task Completion Date: December 31, 2011

## Task 5: Finalize Current Conditions Summaries for Each BUI

- Objective: Become familiar with the most recent datasets available, understand assessments of the data related to measureable indicators, and identify needs for additional data and analysis.
- Action Items:
  - AOC Coordinators and LimnoTech will provide the BUI Team with the *Current Conditions* summary for each BUI. These summaries will identify the most recent available datasets and will summarize existing assessments of the data.
  - BUI Teams will:
    - review the *Current Conditions* summary
    - identify other important datasets that should be incorporated
    - identify additional analyses needed to support their efforts
    - determine who will perform the additional analyses for the group and conduct the analyses
    - incorporate analyses into a revised *Current Conditions* summary
- Task Completion Date: January 31, 2011

## Task 6: Determine Actions to be taken to Remove Each BUI

- Objective: Define action items (monitoring programs, analyses, etc) and remediation, restoration, or remediation to restoration (R2R) projects needed to address identified information gaps and existing sources for each BUI.
- Action Items:
  - BUI Team will define action items and projects needed to delist each BUI.
  - BUI Team will define the following for each set of action items and projects:
    - Sequencing of action items/projects
    - Parties responsible for implementation
    - Important regulatory process and permitting considerations
    - Resources needed
    - Cost estimates (BPJ)
    - Estimated timeline for BUI removal, including implementation time frame and attenuation phase (if appropriate)
- Task Completion Date: February 28, 2012

## Task 7: Complete BUI Blueprint Template

- Objective: Document BUI Team recommendations for each BUI in a BUI Blueprint Template for inclusion in the Stage II RAP.
- Action items:
  - AOC Coordinators and LimnoTech will provide the BUI Team with a BUI Blueprint Template based on the BUI Blueprint Outline in Attachment 1.
  - BUI Team will complete the following sections of the BUI Blueprint Template:
    - Summary Statement
    - Sequential List of Prioritized Actions to Achieve BUI Removal
    - Permitting and Regulatory Process
    - Resources Needed
    - Anticipated Timeline for Achieving BUI Removal
    - Costs
- Task Completion Date: March 15, 2011

# Attachment 1: BUI Blueprint Outline

Definition: A blueprint will be developed for each BUI based on existing data and information. The blueprint will define the actions necessary to achieve delisting of the BUI. Each blueprint is anticipated to consist of the following primary components, which are also depicted in Figure A-1:

- Summary Statement
  - A summary documenting the BUI Team process, including important decisions affecting the outcome of the process.
- Source/Stressor Model
  - This section will be developed from a review of findings from existing research and monitoring in the AOC. The source/stressor model will identify the primary sources of each system stressor and identify the relationships between the sources and the nine BUIs. This model will assist in identifying applicable indicators and priority actions that affect multiple BUIs. It should be noted that in practice, this model would be termed a "conceptual model" to indicate its use for planning and educational purposes versus a calibrated, verified model.
- Measureable Indicators Specific to the BUI
  - The set of BUI-specific indicators will be presented with rationale for their selection. See system of measureable indicators for more information.
- Rationale for Listing
  - Historical conditions of stressors and sources will be described based on information from past AOC reports and literature. The statement will focus on the original basis for listing the BUI. As possible based on available information, the historic conditions for each of the measureable indicators will be described.
- Statement of Current Conditions
  - Current conditions of stressors and sources will be described based on the most recent available assessments of monitoring and research data. As possible based on available information, the current conditions for each of the measureable indicators will be described.

- Information Gaps
  - Information gaps on historic conditions, current conditions, and stressors and sources will be described. The information gaps identified will be described for inclusion in the list of action items for prioritization.
- Sequential List of Prioritized Actions to Achieve BUI Removal
  - The sequential list of prioritized actions will be developed from several sources including: action items defined to address any identified information gaps; action items and R2R projects identified by stakeholder groups; applicable projects already described in existing AOC plans (e.g., harbor plans, city plans, SLR Habitat Plan). Priority will be assigned to the actions based on a prioritization scheme developed with stakeholder input. Prioritization may consider factors such as: direct improvement in beneficial use; direct improvement in indicators; cost; implementability/proven technology; landowner willingness; dependence on other projects; willing and able project leader; ability to fund; restoration potential; geographic location; ancillary or multiple benefits such as recreational use, etc.
- Permitting and Regulatory Process
  - Listing of important regulatory process steps and permits that may be required to implement the actions to achieve BUI removal
- Resources Needed
  - Identified partners, landowners, potential funding resources, etc that may be required to implement identified action items/R2R Projects
- Anticipated Timeline for Achieving BUI Removal
  - Anticipated timelines for removing the BUI will be developed based on the conceptual model of stressors and sources and the prioritized actions. The timeline will include the sequence of actions to be conducted, including remediation and restoration efforts, as well as attenuation timeframes required to achieve delisting targets.
- Costs
  - General cost estimates for implementing the identified action items/R2R projects. These costs will be rough cost estimates developed using best professional judgment and

information on-hand. Costs may be presented in the form of relative categories such as $, $$, $$$.

- Ongoing Monitoring Needs
  - Monitoring needs related to ongoing tracking of measureable indicators will be defined.

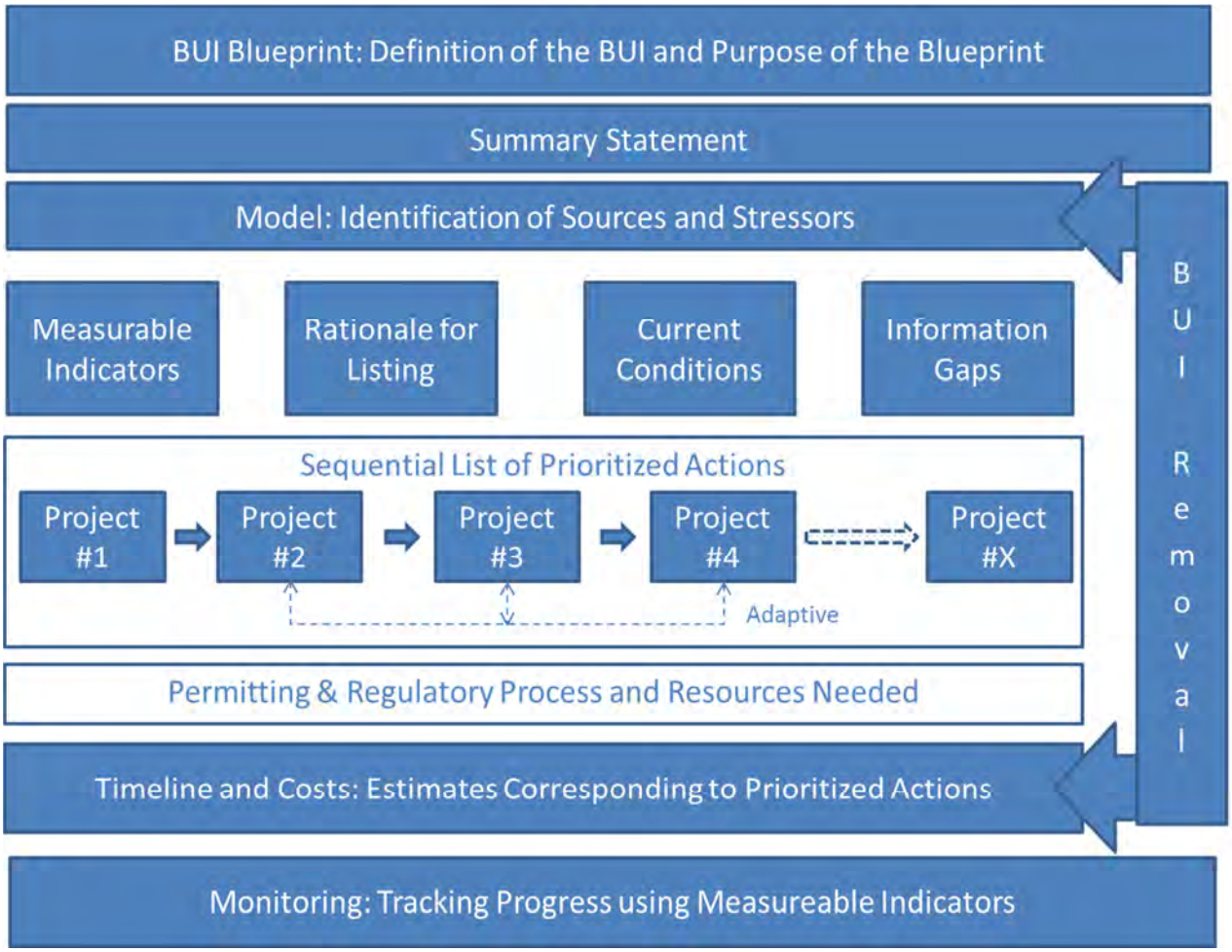


**Figure A-1: Graphical Depiction of BUI Blueprint Contents**

# Appendix D: BUI Blueprints

# Appendix D: BUI Blueprints

# Introduction

The Blueprints for all nine BUIs in the SLRAOC are presented in this Appendix. The following BUIs and their reference numbers are as follow:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

Each section is formatted such that each BUI Blueprint is a standalone section containing all the necessary elements for that BUI Blueprint. Consequently, some repetition in the major components and association descriptions among the nine BUI Blueprints exists throughout this appendix. The major components to each BUI Blueprint are described below.

## Description of BUI Blueprint Components

- **Summary Statement** - A summary documenting the BUI Team process, including important decisions regarding BUI delisting target interpretation and removal strategies.
- **Source/Stressor Model** - The source/stressor model, developed based on existing research and monitoring in the AOC, identifies the primary sources of each system stressor and the relationships between the sources and the nine BUIs. The intent of the conceptual model was to assist in identifying applicable BUI indicators, legacy sources that remain, and priority actions that affect multiple BUIs.
- **Measureable Indicators Specific to the BUI –** This includes the set of BUI-specific indicators, including status indicators and other measureable indicators that were selected by the BUI Team to measure BUI condition. Indicators were selected to provide measurable objectives for the 2008 final delisting targets.
- **Rationale for Listing** - Historical conditions of stressors and sources are described in this section based on information from the Stage I RAP. The statement focuses on the original basis for listing the BUI.
- **Statement of Current Conditions** - Current conditions of stressors and sources and measurable indicators are described based on the most recent available assessments of monitoring and research data, as reviewed and compiled by the BUI Team.
- **Information Gaps** - Information gaps on historic conditions, current conditions, stressors and sources, and measurable indicators are listed. Projects to address identified information gaps are included in the prioritized list of actions.
- **Sequential List of Prioritized Actions to Achieve BUI Removal** - The sequential list of prioritized actions was developed by BUI Teams based on several sources including action items defined to

address any identified information gaps; priority R2R projects identified by stakeholder groups; and applicable projects already described in existing AOC plans (e.g., Lower St. Louis River Habitat Plan). Priority was assigned by each BUI Team.

- **Permitting and Regulatory Process** - Listing of important regulatory process steps and permits that may be required to implement the actions to achieve BUI removal.
- **Resources Needed** - Identified partners, landowners, potential funding resources, etc., that may be required to implement identified action items/R2R Projects.
- **Anticipated Timeline for Achieving BUI Removal** - Anticipated timelines for removing the BUI are given based on BUI Team understanding.
- **Costs** - General cost estimates for implementing the identified action items. The costs are rough estimates developed using best professional judgment and information on-hand.

# BUI 1 Blueprint: Fish Consumption Advisories

This section contains the BUI Blueprint for Fish Consumption Advisories. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below followed by a Summary Statement for this BUI developed by the Team.

## BUI Team membership

- Tracey Ledder, WDNR
- Ruth Oppedahl, UW-Extension
- David Bolgrien, USEPA Mid-Continent Ecology Lab
- Patricia McCann, MDH
- Carri Lohse-Hanson, MPCA
- Mark Briggs, MDNR
- Guy Partch, Barr Engineering
- Todd Fryzek, SEH
- Howard McCormick, SLRA Habitat Workgroup

## BUI Team Summary Statement

We agree that the target includes two interrelated but essentially separate means of looking at this BUI: 1) there are no AOC-specific fish consumption advisories issued for the St. Louis River by WI or MN, and 2) tissue concentrations of contaminants of concern from representative samples of resident fish are not significantly higher than regional background concentrations. We agree that the two contaminants of concern are mercury and PCBs, as those are the reasons for the consumption advisories (both States' advisories indicate that following advice for mercury and/or PCBs will essentially also avoid other contaminants that are potentially bioaccumulated).

What is "regional background"? For PCBs, comparison of fish tissue concentrations in the St. Louis River above Cloquet to those below may be a study we would like to perform, taking into consideration fish size, age and species. The atmospheric deposition should be the same, the legacy sediment PCB contamination should be below Cloquet. Not enough fish tissue samples are currently available to statistically compare.

The mercury situation is more complex, because of mercury cycling and differing mercury sensitivities to different habitats as well as sources of air deposition and upstream mining. A preliminary data comparison by Bruce Monson, MPCA, looked at fish tissue mercury data from northeast MN compared to that of the upper St. Louis River and St. Louis River estuary. The Estuary appears to be significantly higher in mercury. However, this data analysis did not include WI data. Northern WI has several small, rural lakes with fish consumption advisories that are more stringent than those of the St. Louis River (indicating that those lakes have fish that are higher in mercury). If all of the fish tissue concentration data from MN and WI were combined, what would be the conclusion? How do we get such a data analysis?

Major recommendations include more rigorous study of fish tissue concentrations to try to understand if the St. Louis River is indeed higher in mercury and PCB concentrations, and why. Other ongoing projects such as the EPA contaminant TMDL for the AOC should assist with this by defining sources and their relative contributions (all partners agree that mercury is a priority for this TMDL). A future study should follow collection guidelines from the State agencies working with consumption advisories.

Other actions recommended include continuation of remediation of areas of mercury and PCB sediment contamination, which due to the mixed nature of contamination will address other objectives as well. There is, therefore, a need to better understand bioaccumulation potential in the estuary; if legacy sediment contamination is an issue, to make remediation decisions; and to continue collections for private homeowners and industry that remove sources of mercury and PCBs.

## Rationale for Listing: Fish Consumption Advisories

The issuance of sport fish consumption advisories for the St. Louis River was one of the primary reasons for the designation of the river as an AOC. The IJC listing criteria call for listing when contaminant levels in fish or wildlife exceed standards, objectives, or guidelines, and when public health advisories are in effect for human consumption of fish or wildlife. Both of these conditions led to the fish consumption BUI, as summarized below.

**Stage I RAP Rationale for Listing**

Fish samples taken from the St. Louis River and Lake Superior exceed standards established by Minnesota and Wisconsin for the unrestricted consumption of sport fish. The two states issue consumption advisories for various population groups based on fish species and size classes. Advisories are collectively issued for the presence of mercury and polychlorinated biphenyls. Fish tissue residues of mercury and polychlorinated biphenyls also exceed the 0.5 mg/kg and 0.1 mg/kg standards established in the 1978 Great Lakes Water Quality Agreement for the protection of aquatic life and fish-consuming birds.

Sampling efforts carried out by Wisconsin and Minnesota between 1978 and 1988 documented the presence of heavy metals (i.e., mercury) and chlorinated organic compounds (e.g., PCBs) in fish tissue. Levels of mercury and PCBs in fish tissue in the St. Louis River exceeded specific objectives established in Annex 1 of the 1978 Great Lakes Water Quality Agreement, 0.5 mg/kg for mercury and 0.1 mg/kg for PCBs, as shown in Table BUI 1-1: Dioxin (TCDD) was also detected in three fish tissue samples, including a concentration in carp tissue of 8.2 pg/g; however, there is no dioxin objective in Annex 1. Carp and turtle tissue from the Nemadjii River also contained dioxin.

At the time the Stage I RAP was written, fish consumption advisories were issued for the St. Louis River and Lake Superior in both Wisconsin and Minnesota, as shown in Table BUI 1-2.

### Table BUI 1-1: Fish tissue residue concentrations reported in Stage I RAP.

| Pollutant | Annex 1 fish tissue standard | Fish species | Concentration |
|---|---|---|---|
| **Mercury** | 0.5 mg/kg | All | 0.02 mg/kg – 1.4 mg/kg |
| | | Walleye >18" long | 0.31 mg/kg – 1.4 mg/kg |
| **PCB** | 0.1 mg/kg | All | Up to 3.6 mg/kg |
| | | White sucker | 0.45 mg/kg average |
| | | Short head redhorse | 0.33 mg/kg average |
| | | Walleye | 1.34 mg/kg average |
| | | Northern pike (skin-on fillet) | 0.45 mg/kg average |
| **Dioxin (TCDD)** | n/a | Carp | 8.2 pg/g |

### Table BUI 1-2: Fish consumption advisories at time of Stage I RAP.

| State | Location | Pollutant | Fish Species |
|---|---|---|---|
| **Wisconsin** | St. Louis River including Superior Harbor | Mercury | Walleye |
| | Lake Superior | PCBs | Lake Trout |
| | Lake Superior | Chlordane | Siscowett* |
| **Minnesota** | St. Louis River | Mercury | Sport fish |
| | Lake Superior | Mercury | Sport fish |

*Identified as a likely lake-wide problem not related to source loading from the St. Louis River

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 1 .3. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

### Table BUI 1-3: Timeline of Actions: Fish Consumption Advisories.

| Year | Action |
|---|---|
| Major Actions Pre-1992 | |
| 1969 | FDA establishes 0.5 ppm as the maximum safe limit of mercury in fish. |
| 1970 | Mercury pulp and paper slimicide registration canceled in the U.S. |
| 1972 | Federal law bans mercury in antifouling paints for marine use. |
| 1991 | Registration for mercury preservative in paint canceled and withdrawn in the U.S. |
| 1992 | BUI Listed in Stage I Remedial Action Plan |
| | Minnesota Statute 115A.932 prohibits placing mercury waste in solid waste or wastewater. |
| | Minnesota Statute 115A.9561 requires recycling of PCB ballasts and mercury switches in appliances. |
| | Minnesota Statute 116.92 requires manufacturers to label mercury bearing devices sold in Minnesota. |
| 1993 | Minnesota Statute 325E.125 bans sale of mercury batteries. |
| | Honeywell Corporation starts a take-back program for thermostats in Minnesota. |
| | Registration for mercury fungicide for snow mold control withdrawn in the U.S. |
| 1994 | |
| 1995 | Western Lake Superior Sanitary District (WLSSD) elemental mercury collection brings in 217 pounds of mercury waste. |
| 1996 | WLSSD's Merc Alert program collected 175 pounds of mercury batteries between 1993 and 1996. |
| 1997 | WLSSD *Blueprint for Mercury Elimination* published; the *Blueprint* provides advice to wastewater treatment plant operators on how to reduce mercury in their wastewater system. |
| | Wisconsin Mercury Source Book published; the source book is a guide to communities for reducing mercury from 19 sectors. |

| Year | Action |
|---|---|
| | Minnesota law prohibits the use of mercury and other poisonous metals for use in embalming dead human bodies. |
| | National Thermostat Recycling Corporation begins US-wide thermostat take back program. |
| | Minnesota law offers $50 bounty for each dairy mercury manometer recovered. |
| | Superior, WI initiates community mercury source reduction / pollution prevention program. Organizes "Lake Superior Toxic Reduction Committee." Using Wisconsin Department of Natural Resources (WDNR) and Environmental Protection Agency (EPA) funding, they organize five workshops given between 1998 and 2001. |
| | WI Hg Sourcebook: A Guide to Help Your Community Identify and Reduce Releases of Elemental Hg. |
| 1998 | Last two medical waste incinerators in Minnesota portion of the basin shut down. |
| | Minnesota Rules Chapter 7052 ("the GLI") promulgated with new water quality standard for mercury (1.7 ng/L in the basin, 6.9 ng/L in the rest of Minnesota). |
| | Superior compiles database and library of pollution prevention projects in Lake Superior basin or relevant to basin industry. |
| | Superior sponsors Lake Superior basin mercury-reduction community networking meeting – participation from WLSSD, OMOE, Marquette MI, WDNR, MPCA, EPA, other WI communities. |
| 1999 | Beginning of thermometer swap program run by MPCA and WLSSD that results in over 3,000 nonmercury thermometers swapped for mercury thermometers in the Duluth area. |
| | MPCA completes Lake Superior/Duluth-Superior Harbor Toxics Loading Study, which estimates the load of toxic chemicals to Lake Superior from the St. Louis River system; study indicates more mercury is coming into the harbor than is reaching the Lake. |
| | Superior surveys household hazardous waste collection availability in communities basin-wide; community barriers and opportunities for pollution prevention (P2) – helps form basis of 1999 workshop. |
| | EPA grant allows Northwestern Wisconsin Regional Planning Commission to collect fluorescent bulbs in Lake Superior counties at no charge and expands collection program advertising. |
| | State mercury grant pays for collection programs in several WI communities, including in Lake Superior basin. |
| 2000 | WLSSD stops burning solid waste; sludge incineration continues with alternative fuels. |
| | City of Duluth bans mercury fever thermometers. |
| 2001 | City of Superior, WI and State of Minnesota ban mercury thermometers. |
| | EPA approves a low-level detection method for mercury in wastewater (Method 1631). |
| | Fond du Lac Reservation holds a workshop on Mercury and the Tribal Health Care Sector. |
| | WLSSD sludge incineration stops. |
| | WLSSD mercury in sludge levels drop from 4.5 ppm in 1990 to 0.9 ppm (80% decrease); effluent drops from 0.58 ppb to 0.005 ppb (99% reduction). |
| | Mercury Shakedown: Northwest WI Mercury Free Schools project initiated. |
| | Wisconsin issues statewide fish consumption advisories for mercury in inland waters (includes walleye in St. Louis River and Lake Superior). |

| Year | Action |
|---|---|
| 2002 | City of Duluth bans additional mercury bearing products. |
| | St. Louis River Total Maximum Daily Load (TMDL) group inventories mercury reduction projects in NE Minnesota and NW Wisconsin and drafts a gaps analysis. |
| | Superior and Murphy Oil USA receive EPA grant to do mercury audit at refinery. |
| 2003 | |
| 2004 | |
| 2005 | |
| 2006 | |
| 2007 | Minnesota Statewide Mercury TMDL approved by US EPA |
| 2008 | |
| 2009 | Implementation Plan established for Minnesota Statewide Mercury TMDL |
| 2010 | St. Louis River Toxics TMDL study initiated |
| 2011 | Stryker Bay cleanup completed |
| 2025 | Implementation of strategies for Minnesota Statewide Mercury TMDL to be complete |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 1-1) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Fish Consumption Advisories

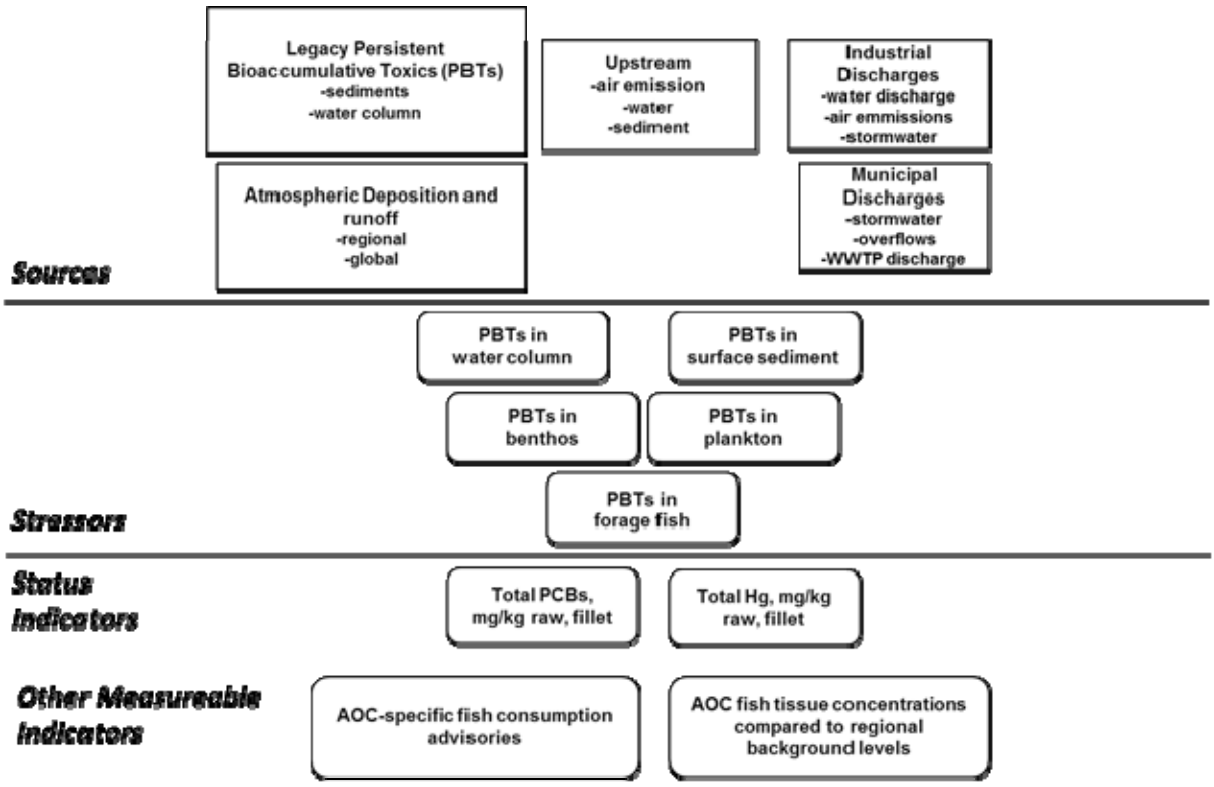


**Figure BUI1-.1: Source stressor model for the BUI Fish Consumption Advisories.**

Table BUI 1-4 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing and may be local or persist beyond the boundaries of the SLRAOC.

### Table BUI 1-4: Description of Source Types.

| Source | Description |
|---|---|
| **Legacy Persistent Bioaccumulative Toxics (PBTs) in Water Column and Sediments** | Historical discharges of mercury and PCBs to the St. Louis River that occurred from municipal and industrial operations |
| **Atmospheric Deposition** | Deposition from regional and global-scale atmospheric transport of air emissions and runoff to waterways |
| **Industrial Discharges** | Permitted industrial water discharges within the AOC |
| | Permitted industrial air discharges within the AOC |
| | Permitted industrial stormwater discharges within the AOC |
| **Municipal Discharges** | Municipal WWTP discharges to the AOC |
| | Municipal overflows from WWTPs and their collection systems within the AOC |
| | Stormwater runoff from regulated municipal separate storm sewer systems (MS4s) and construction in the AOC; this includes both sewered and un-sewered urban runoff |
| **Upstream** | Contaminants in air, water and sediment transported into the AOC from areas upstream of the AOC boundary (including mining) |

### Description of Stressors:

Persistent bioaccumulative toxics (PBTs) bioaccumulate in the food chain and pose a risk to human and ecosystem health. Due to the presence of fish consumption advisories in both Minnesota and Wisconsin based on the concentrations of mercury and PCBs in fish tissue, PCBs and mercury are the PBTs of interest in the AOC. Mercury is transformed microbially into methylmercury, the toxic, bioaccumulative form of the metal.

Legacy contaminants refer to past operations, while industrial and municipal discharges refer to current, regulated sources. Note that the timeline created for this BUI includes many regulations and actions limiting discharge of mercury and PCBs. Therefore, the largest concern is atmospheric deposition (local and regional and global) and legacy sediment contamination.

## Final Delisting Target: Fish Consumption Advisories

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (MPCA, 2009) is:

> *There are no Area of Concern-specific fish consumption advisories issued for the St. Louis River by the State of Minnesota or the State of Wisconsin. Tissue concentrations of contaminants of concern in representative samples of resident fish are not significantly elevated from regional background samples.*

## Measureable Indicators: Fish Consumption Advisories

The BUI Team has identified indicators of stress that can be measured to assess the status of this BUI. These qualitative and quantitative metrics provide the basis for measuring progress towards delisting a BUI. The status indicators and other measurable indicators for this BUI are presented in Tables BUI 1-5 and BUI 1-9. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily, imperative information.

### Table BUI 1-5: Status Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Total PCBs, fish tissue** | mg/kg raw, skin on fillet | See Table BUI 1-6 |
| **Total Hg, fish tissue** | mg/kg raw, skin on fillet | See Tables BUI 1-7 and BUI 1-8 |

### Table BUI 1-6: PCB fish consumption advisory concentrations(mg/kg raw, skin on fillets*).

| Advisory Group (meal rates) | Minnesota & Wisconsin (GLFATF, 1993) |
|---|---|
| **Unrestricted (225/ yr)** | <= 0.05 |
| **1/ week** | >0.05 – 0.22 |
| **1/ month** | >0.22 – 0.95 |
| **6/ year** | >0.95 – 1.89 |
| **Do not eat** | >1.89 |

*The exceptions to this sample type are as follow: the skin will be removed from black bullhead, brown bullhead, yellow bullhead, channel catfish, flathead catfish and burbot, but still remain untrimmed. Sturgeon would be analyzed as a skin-off cross-section (steak). Smelt should be gutted and the head removed. (Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory 1993).

### Table BUI 1-7: Mercury fish consumption advisory concentrations for women not planning to become pregnant and men(mg/kg raw, skin on fillets*).

| Advisory Group (meal rates) | Minnesota & Wisconsin (MN DOH, 2008) |
|---|---|
| **Unrestricted (225/ yr)** | <=0.16 |
| **1/ week** | >0.16 – 0.65 |
| **1/ month** | >0.65 – 2.8 |

*The exceptions to this sample type are as follow: the skin will be removed from black bullhead, brown bullhead, yellow bullhead, channel catfish, flathead catfish and burbot, but still remain untrimmed. Sturgeon would be analyzed as a skin-off cross-section (steak). Smelt should be gutted and the head removed. (Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory 1993)

### Table BUI 1 -8: Mercury fish consumption advisory concentrations for pregnant women, women who may become pregnant, and children under 15 yrs (mg/kg raw, skin on fillets*).

| Advisory Group (meal rates) | Minnesota & Wisconsin (GLC FAWG, 2007) |
|---|---|
| **Unrestricted (225/ yr)** | <= 0.05 |
| **1/ week** | >0.05 – 0.22 |
| **1/ month** | >0.22 – 0.95 |
| **Do not eat** | >0.95 |

*The exceptions to this sample type are as follow: the skin will be removed from black bullhead, brown bullhead, yellow bullhead, channel catfish, flathead catfish and burbot, but still remain untrimmed. Sturgeon would be analyzed as a skin-off cross-section (steak). Smelt should be gutted and the head removed. (Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory 1993)

### Table BUI 1 – 9: Other Measureable Indicators:

| Indicator | Measurement Basis | Target |
|---|---|---|
| **AOC-specific fish consumption advisories** | | None for **X** years or consecutive sampling periods[1] |
| **AOC fish tissue levels** | µg/kg dry weight or mg/kg dry weight | Statistically similar to or less than regional background levels for **X** years or consecutive sampling periods[1] |

[1]Period of time or number of consecutive sampling periods for target to be determined; "regional" must be defined for each parameter

## Current Conditions: Fish Consumption Advisories

The status of assessment of this BUI is reflected in TableBUI 1 -.10 and is based on the most recently available research and monitoring data compiled and reviewed for this BUI Blueprint.

### Table BUI 1 -10: BUI Current Conditions Status Check:

| Check | Yes/No/Unknown | Notes |
|---|---|---|
| **Data for status indicators available?** | Yes | |
| **Data for status indicators assessed?** | No | Comparison to regional fish tissue contaminant levels must be conducted |
| **Status indicator targets set?** | No | "Regional" must be defined for PCBs and for mercury and associated regional background fish tissue contaminant concentrations determined |
| **Status indicator targets met?** | Unknown | |

## Description of Most Recent Data Sets for Indicators:

### Total Mercury and Total PCBS in Fish Tissue

Fish tissue contaminant data used to develop fish consumption advice in Minnesota and Wisconsin is available from each state. Fish tissue results for St. Louis River locations upstream of the AOC are available from a recent study conducted by the Minnesota Department of Natural Resources (DNR) Fisheries Section. Both sets of data are described below.

### AOC

Fish tissue samples are collected in a variety of locations within and outside the AOC by both Minnesota and Wisconsin parties for development of fish consumption advice. Sampling locations vary from year to year. The dataset used for updating the recent consumption advice is a combined dataset from both the Minnesota DOH and Wisconsin DNR, and consists of contaminant data for fish collected throughout the AOC. Advice for Lake Superior is similarly examined using a combined dataset from sampling locations in the open waters of Lake Superior. Monitoring of contaminants in fish has been conducted since the 1970s. Fish tissue contaminant data included in this summary were obtained from Wisconsin DNR and Minnesota DOH and are presented for 2001 to 2006 (more recent fish tissue sampling has been conducted, but results are not yet available).

### Upstream St. Louis River

Fish tissue contaminant data for PCBs and mercury are available for areas upstream of the AOC and were provided by the Minnesota DOH. Data presented below were collected from 2000 through 2005 and cover locations from Fond du Lac upstream through river mile 175.

### Fish Consumption Advisories

Fish consumption advisories for Lake Superior and the St. Louis River are jointly determined by the Minnesota Department of Health and the Wisconsin DNR and Department of Health Services. The process for developing advisories for Lake Superior and border waters of Minnesota and Wisconsin is as follows:

- Minnesota and Wisconsin DNR collect fish samples for contaminant analysis. Sampling locations are selected where angling is popular, at known or suspected pollution sources, or where fish contamination trends are being tracked. Mercury is found in most fish. Within the St. Louis River AOC, PCBs and mercury are the primary contaminants and vary by species. Both Minnesota's and Wisconsin's goal for sampling the St. Louis River is every five years, depending on the timing of fisheries surveys in the area.
- A shared Minnesota-Wisconsin dataset combining mercury and PCB fish contaminant data has been created for the St. Louis River from below the Fond du Lac dam out to the mouth. This dataset also considers species that move in and out of the area. In general, at least two years of data are included out to a ten-year period.

- Fish consumption advisories are developed as a collaborative effort between the Minnesota Departments of Health, DNR, and Pollution Control Agency, and Wisconsin Departments of Health Services and DNR.

Wisconsin and Minnesota use the same protocols for determining the appropriate updates to fish consumption advice. Development of fish consumption advice is not a step-by-step procedure; advice is developed based on fish tissue contaminant levels and additional factors (e.g., fishing regulations).

Key elements related to development of fish consumption advice are as follow:

- Key advisory documents:
  - Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory (GLFATF, 1993).
  - Protocol for Mercury-based Fish Consumption Advice: an Addendum to the 1993 "Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory" (GLC FAWG, 2007).
- Advisories for presence of mercury and PCBs
  - Based on contaminant resulting in most conservative sensitive population advice.
  - If mercury and PCBs result in same advice, the default is PCBs.
  - Fish tissue contaminant levels triggering consumption advice are shown in Tables BUI 1 - 11 through BUI 1 -13.
- Tissue sample specifications
  - A species-based protocol is used as indicated in Table BUI 1 - 14.
  - Whole fish samples are never used for issuing consumption advisories.

### Table BUI 1 - 11: PCB fish consumption advisory concentrations (mg/kg raw, fillets*).

| Advisory Group (meal rates) | Minnesota& Wisconsin (GLFATF, 1993) |
|---|---|
| **Unrestricted (225/ yr)** | <= 0.05 |
| **1/ week** | >0.05 – 0.22 |
| **1/ month** | >0.22 – 0.95 |
| **6/ year** | >0.95 – 1.89 |
| **Do not eat** | >1.89 |

*The exceptions to this sample type are as follow: the skin will be removed from black bullhead, brown bullhead, yellow bullhead, channel catfish, flathead catfish and burbot, but still remain untrimmed. Smelt should be gutted and the head removed. (Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory 1993)

### Table BUI 1 - 12: Mercury fish consumption advisory concentrations for women not planning to become pregnant and men(mg/kg raw, fillets*).

| Advisory Group (meal rates) | Minnesota& Wisconsin (MDOH, 2008) |
|---|---|
| **Unrestricted (225/ yr)** | <=0.16 |
| **1/ week** | >0.16 – 0.65 |
| **1/ month** | >0.65 – 2.8 |

*The exceptions to this sample type are as follow: the skin will be removed from black bullhead, brown bullhead, yellow bullhead, channel catfish, flathead catfish and burbot, but still remain untrimmed. Smelt should be gutted and the head removed. (Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory 1993)

### Table BUI 1 - 13: Mercury fish consumption advisory concentrations for pregnant women, women who may become pregnant and children under 15 yrs (mg/kg raw, fillets*).

| Advisory Group (meal rates) | Minnesota & Wisconsin (GLC FAWG, 2007) |
|---|---|
| **Unrestricted (225/ yr)** | <= 0.05 |
| **1/ week** | >0.05 – 0.22 |
| **1/ month** | >0.22 – 0.95 |
| **Do not eat** | >0.95 |

*The exceptions to this sample type are as follow: the skin will be removed from black bullhead, brown bullhead, yellow bullhead, channel catfish, flathead catfish and burbot, but still remain untrimmed. Smelt should be gutted and the head removed. (Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory 1993)

### Table BUI 1 - 14: Tissue sample specifications (1993 Great Lakes Protocol).

| Fish Species | Tissue Contamination Sample |
|---|---|
| **Species without scales** | Raw, skin-off fillet* |
| **All other species** | Raw, scaled, skin-on fillet* |

*Fillet includes all flesh from the back of the head to the tail and from the top of the back down to and including the belly flap area of the fish. Sturgeon may be analyzed as a skin-off cross-section (steak).

## Current Conditions for Status Indicators:

### Total Mercury and Total PCBS in Fish Tissue

Available fish tissue contaminant data for the AOC and upstream St. Louis River are described in the following sections.

### AOC

A summary of the fish tissue data collected from sites in the St. Louis River below Cloquet is given in TableBUI 1 - 15. Fish tissue data from Lake Superior are not presented, as the locations of fish collected in Lake Superior vary widely and are generally not located within the AOC.

### TableBUI 1 - 15: Minnesota and Wisconsin fish contamination database fish sampling data for the St. Louis River below Cloquet (MDOH, 2011 and WDNR, 2011).

| Parameter | Years | No. Samples* | Area Sampled | Fish Length Range | Range of Concentrations |
|---|---|---|---|---|---|
| **Mercury** | 2000-2002 | 47 | Above Fond du Lac (below Cloquet) | 7.7 – 26.6” | 0.15-0.77 ppm |
| | 2001-2006 | 55 | Below Fond du Lac | 13.7 – 30.5” | 0.07-1.7 ppm |
| **PCBs** | 2000-2002 | 10 | Above Fond du Lac (below Cloquet) | 14.3 – 26.6” | <0.01-0.040 ppm |
| | 2001-2006 | 40 | Below Fond du Lac | 14 – 30.5” | ND-3.3 ppm |

ND= non-detect, detection level not specified
*In some instances, average concentrations from multiple fish were reported in the data. This count refers to number of reported results; therefore, the given range of concentrations includes these averages.

## Upstream St. Louis River

Fish tissue contaminant data from the Minnesota DOH database for areas upstream of Cloquet on the St. Louis River include contaminant results from 201 fish collected between 2000 and 2005. These data are summarized in Table BUI 1 - 16 and include data from the Minnesota DNR St. Louis River Study (MDNR 2006). Data from that study include a total of 105 fish collected at river miles 40, 51, 53, 67, 72, 79, 115, 133, and 175.

### Table BUI 1 - 16: Fish tissue concentrations in the St. Louis River above Cloquet (MDOH, 2011).

| Parameter | Years | No. Samples* | Area Sampled | Fish Length Range | Range of Concentrations |
|---|---|---|---|---|---|
| **Mercury** | 2000-2005 | 155 | Above Cloquet | 4.9 – 31” | 0.09-0.88 ppm |
| **PCBs** | 2000-2005 | 36 | Above Cloquet | 13.6 – 31” | <0.01-0.053 ppm |

*In some instances, average concentrations from multiple fish were reported in the data. This count refers to number of reported results; therefore the given range of concentrations includes these averages.

## Fish Consumption Advisories

Current fish consumption advisories for Lake Superior and the St. Louis River below Fond du Lac Dam issued by the States of Minnesota and Wisconsin are provided in Tables BUI 1 - 17 through BUI 1 - 19. Minnesota consumption advice for the St. Louis River above Fond du Lac Dam is provided in Table BUI 1 -20. Consumption advice for the St. Louis River is more stringent than Minnesota and Wisconsin statewide safe eating guidelines for larger walleye due to mercury and for carp and larger catfish due to PCBs. For Lake Superior, consumption advice is more stringent than statewide safe eating guidelines for

larger lake trout due to mercury and PCBs, larger Siscowet due to PCBs, and walleye due to mercury (personal communication, Candy Schrank, WDNR).

### Table BUI 1 - 17: Lake Superior and St. Louis River (below Fond du Lac Dam) consumption advice.

| Species | Eat no more than 1 meal/week | Eat no more than 1 meal/month | Eat no more than 1 meal every 2 months | Do Not Eat |
|---|---|---|---|---|
| **Brown trout, Chubs, Coho salmon, Lake herring, Lake whitefish, Rainbow trout** | All sizes | | | |
| **Chinook salmon** | Under 30” | Over 30” | | |
| **Lake trout** | Under 22” | 22” - 37 | Over 37” | |
| **Lake sturgeon** | | Over 50” | | |
| **Siscowet Lake Trout** | | Under 29” | 29” - 36” | Over 36” |
| **Walleye and Burbot** | See Tables 8 and 9 | | | |

Current as of January 2012

### Table BUI 1 -18: St. Louis River and Superior Harbor fish consumption advice for women of childbearing years, nursing mothers, and all children under 15.

| Species | Eat no more than 1 meal/week | Eat no more than 1 meal/month | Eat no more than 1 meal every 2 months | Do Not Eat |
|---|---|---|---|---|
| **Panfish and Bullheads** | All sizes | | | |
| **Walleye** | | <20” | | >20” |
| **Pike, Bass, Catfish, Carp, Burbot, all other species** | | All sizes | | |
| **Muskies** | | | | All sizes |

Current as of January 2012

### Table BUI 1- 19: St. Louis River and Superior Harbor fish consumption advice for women beyond childbearing years and men.

| Species | Eat no more than 1 meal/week | Eat no more than 1 meal/month | Eat no more than 1 meal every 2 months | Do Not Eat |
|---|---|---|---|---|
| **Panfish and Bullheads** | | *--Unrestricted--* | | |
| **Walleye** | <20” | >20” | | |
| **Pike, Bass** | All sizes | | | |
| **Channel Catfish** | <18” | >18” | | |
| **Carp** | | All sizes | | |
| **Burbot and all other species** | All sizes | | | |
| **Muskies** | | All sizes | | |

Current as of January 2012

### Table BUI 1 - 20: Minnesota fish consumption advisories for the St. Louis River above Fond du Lac Dam for women of childbearing years, nursing mothers, and all children under 15.

| Area | Species | Eat no more than 1 meal/week | Eat no more than 1 meal/month | Eat no more than 1 meal every 2 months | Do Not Eat |
|---|---|---|---|---|---|
| **Above Cloquet** | **Channel Catfish** | | All sizes | | |
| | **Northern Pike** | | All sizes | | |
| | **Redhorse Sucker** | | All sizes | | |
| | **Rock Bass** | All sizes | | | |
| | **Smallmouth Bass** | | All sizes | | |
| | **Walleye** | | All sizes | | |
| | **White Sucker** | | All sizes | | |
| **Cloquet to Fond du Lac Dam** | **Carp** | | All sizes | | |
| | **Channel Catfish** | | All sizes | | |
| | **Smallmouth Bass** | | All sizes | | |
| | **Walleye** | | All sizes | | |
| | **White Sucker** | | All sizes | | |

Current as of January 2012

## Information Gaps: Fish Consumption Advisories

Fish sampling is conducted every two to five years. However, new data are not yet available because of the time that it takes for sample processing, analysis and verification. Fish tissue contaminant data exist

for Minnesota from 2009 and 2010 that have not yet been analyzed for purposes of issuing consumption advice.

For comparison to delisting targets, regional fish tissue contaminant background levels must be determined for both PCBs and mercury. A different geographic area may be appropriate for each parameter.

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions included in this list include those selected to address data and information gaps, monitoring and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table BUI 1 - 21 followed by a supplementary table key.

## Table BUI 1 - 21: Sequential List of Prioritized Actions: Fish Consumption Advisories.

| Project Sequence | Project Title | Description of Action and Rationale | Location Indicate waterbody, site name, or other geographic reference | Type of Action Enter number(s) from table key, separated by commas | BUI(s) Involved Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration Enter "Ongoing" for actions that will continue over time | Estimated cost See key above and enter appropriate "$" level based on best professional judgment | Permitting Requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Remediate Contaminated sediments | Continue remediation of contaminated sediments. Most contain a mix of contaminants. This will also remove Hg and PCBs. | St. Louis river estuary | 8 | 1, 2, 3, 4, 5, 7, 9 | Fish tissue concentration | Legacy sediment contaminants (local discharge and historic deposition) | | on going | $$$$$ | | |
| 2 | Study mercury and PCB bioavailability | Need to understand what other factors are driving Hg and PCB accumulation in fish, organic carbon, bacteria etc. How do these contaminants move/pathways in this estuary? | St. Louis river estuary | research | 1 | Fish tissue concentration | Legacy sediment contaminants (local discharge and historic deposition) | | | $$$ | | Coordinate study with local partners for staff and lab space |
| 3 | Current Conditions study of fish tissue PCB vs regional background | Study PCBs --compare fish tissue concentrations in the estuary to fish above the paper mill in Cloquet as regional background. | St. Louis River, upper watershed and lower estuary | 2 | 1 | Fish tissue concentration | | | 1 year | $$ | Check on how fish sampling works when partnering with state agencies. | Coordinate data gathering/sampling with MDH and WDNR consumption advisory staff and fish type and size guidance. Could they use AOC study fish tissue samples? Data need to meet state QC requirements. |
| 4 | Current Conditions study of fish tissue Hg vs regional background | Study Mercury - Identify a background region for Hg. Mines contribute to local source of mercury, wetlands and sulfate contribute to Hg methylation, so may not be able to use above/below Cloquet like we would for PCBs. | St. Louis River Estuary vs Bad River, no industrial past, or Rainy River--had history of paper mills (MNDNR has older data on fish tissue at Rainy). | 2 | 1 | Fish tissue concentration | | | 1 year | $$ | Check on how fish sampling works when partnering with state agencies. | Coordinate data gathering/sampling with MDH and WDNR consumption advisory staff and fish type and size guidance. Could they use AOC study fish tissue samples? Data need to meet state QC requirements. |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting Requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | Recovery monitoring of fish tissue concentrations | Monitor fish tissue concentrations (ongoing) after remediation in AOC. How does fish tissue concentration change over time? At a certain point, the designation of the SLR can change from AOC to "Area of Recovery". Could regular state fish tissue sampling inform this monitoring need? | St. Louis River Estuary | 2 | 1 | Fish tissue concentration | Legacy sediment contaminants (local discharge and historic deposition) | Ongoing post remedial actions | 10 years? | $ - $$/year | Check on how fish sampling works when partnering with state agencies. | |
| 6 | Continue removal of local sources | Continue local efforts to reduce local sources (thermometer collection, dentist collection of amalgams, preventing PCB spills etc.) As recommended in Barr Engineering, SLRP, 2003. | St. Louis River and Nemadji River watersheds | 14 | 1 | | Municipal and industrial current sources | ongoing | | $ - $$/year | | Work with and support entities already doing collection efforts |

## Key for Sequential List of Prioritized Actions

Reference numbers for "Type of Action":

1. Monitoring program development
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = <$5M

Reference numbers for BUIs:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Fish Consumption Advisories

Numerous regional and local efforts have contributed to the reduction in sources of PCB and mercury. However, mercury in fish tissue is a very complex issue. Currently, MPCA and WDNR are working with the Fond du Lac Tribe on an EPA-funded TMDL project to model mercury and other toxics related to 303d-listed waters in the St. Louis River watershed. One outcome of this exercise should be a better understanding of the comparative sources of mercury, global, regional and local. One question specifically related to the AOC is whether or not legacy contaminated sediments are still playing a large role in fish tissue concentrations of PCBs and mercury, and thus causing AOC-specific advisories. Mining activities in the upper watershed are an ongoing source of mercury and sulfate that contributes to methylation of mercury and thus bioaccumulation.

## Ongoing Monitoring Needs: Fish Consumption Advisories

Continued monitoring of mercury and possibly PCB concentrations in fish tissue will be required for human health, as both have a global as well as local source. Continued consideration of bioaccumulative contaminants is important to remediation and restoration project decisions.

## Future Issues or Concerns: Fish Consumption Advisories

Whether or not the current Fish Consumption Advisories are the result of legacy sediment contamination that will be remediated within the AOC, as product sources of mercury and PCBs are removed, there are still ongoing watershed (mining) and global sources of mercury that will continue to impact the region.

## References: Fish Consumption Advisories

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Great Lakes Consortium; Fish Advisory Working Group (GLC FAWG) 2007. A Protocol for Mercury-based Fish Consumption Advice: An addendum to the 1993 "Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory". http://www.dhs.wisconsin.gov/eh/fish/FishFS/2007Hg_Add_Final_05_07.pdf . Accessed 10/25/11.

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Wisconsin Department of Natural Resources (WDNR). December 2003. Consensus-Based Sediment Quality Guidelines; Recommendations for Use & Application Interim Guidance. Developed by the Contaminated Sediment Standing Team. WT-732 2003

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# BUI 2 Blueprint: Degraded Fish and Wildlife Populations

This section contains the BUI Blueprint for Degraded Fish and Wildlife Populations. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below, followed by a Summary Statement for this BUI developed by the Team.

## BUI Team Membership

- John Lindgren, MDNR
- Rick Gitar, Fond du Lac Band of Lake Superior Chippewa
- Ted Angradi, U.S. EPA Mid-Continent Ecology Division
- Joshua Bailley, Duluth Audubon Society
- Pat Collins, US Fish and Wildlife Service
- Joel Hoffman, U.S. EPA Mid-Continent Ecology Division
- Nancy Larson, WDNR
- Martha Minchak, MDNR
- Daryl Peterson, Minnesota Land Trust
- Shon Schooler, Lake Superior NERR
- Rich Staffon, MDNR
- Fred Strand, WDNR
- Dan Weber, US Department of Agriculture

## BUI Team Summary Statement

The team focused on the task of transforming the baseline information contained in the Lower St. Louis River Habitat Plan (Habitat Plan) into the BUI Blueprint format of the St. Louis River AOC implementation Framework. The Habitat Plan identifies 37 conservation targets in six broad categories. Conservation targets, which define critical elements of biological diversity, were defined as all of the aquatic habitats and plant communities of the Lower St. Louis River and surrounding uplands. The Habitat Plan identifies five major threats to the conservation targets (habitat loss, sedimentation, exotic species introduction, exposure to contaminated sediments and degradation of water quality), which correspond to the 'sources' in the source/stressor model. It should be noted that, other than "excess sedimentation due to non-point runoff," the sources and stressors identified for this blueprint were the same as those in the fish and wildlife habitat blueprint. That is understandable, since fish and wildlife populations depend on the habitat in which they live. Because the Habitat Plan Implementation Strategies (projects) did not contain projects directly targeting the rehabilitation of native fish and wildlife populations, the team identified specific species-related accomplishments as well as additional projects and outcomes for inclusion in the Blueprint's "Sequential List of Prioritized Actions."

The team acknowledged that impacts to the conservation targets by sources (threats) and resulting stressors have been reduced since the passing of the Clean Water Act and the establishment of the Western Lake Superior Sanitary District (WLSSD) in 1979. Local resource professionals have observed

slow but steady improvements to the habitat quality of the conservation targets. Improved habitat quality, coupled with agency-supported species rehabilitation programs and downstream migration from unimpaired reaches of the St. Louis River, has resulted in the re-establishment of most species that were considered native to the Estuary. Similar to the Habitat Blueprint, the team acknowledged that there is a strong need to identify and monitor status and other measureable indicators that can quantifiably define progress towards delisting this BUI. If the status indicators were quantified, it is likely that the populations BUI is relatively close to being in a state of recovery. However, even though most native fish and wildlife species are present, the absolute productivity of the system relative to the abundance of fish and wildlife populations is likely far less now than historically.

## Rationale for Listing: Degraded Fish and Wildlife Populations

The IJC listing criteria call for listing an impaired beneficial use when fish and wildlife management programs have identified degraded fish or wildlife populations due to a cause within the watershed and when toxicity of sediment-associated contaminants at a site is significantly higher than controls. It is difficult to completely characterize the state of fish and wildlife populations because of the diverse and dynamic nature of the system and the lack of comprehensive data on historical use of the area by various species. However, a number of threats to the system have been identified, with some evidence suggesting impacts. Organic pollution, exotic species, and physical habitat loss were all identified as contributing to degraded fish and wildlife populations, as summarized below.

There was little specific information in the Stage I RAP that definitively linked fish and wildlife population information to particular causes of decline or recovery. However, some evidence was presented suggesting impacts to fish and wildlife from a variety of sources. The Stage I RAP indicated that prior to 1979, fish populations were degraded and fish kills were common. Improvements in wastewater treatment led to some recovery of fish populations. However, the proliferation of exotic species, most notably the ruffe, adversely affected fish populations in the AOC. In addition, habitat loss due to dam construction and development also had an impact on fish and wildlife populations. Table BUI 2 - 1 summarizes some of the impacts and their potential causes, as identified in the Stage I RAP.

**Stage I RAP Rationale for Listing**

During the period of severe organic pollution before 1979, fish populations were degraded and fish kills were common. Fish populations have been recovering from that era because of improvements in wastewater treatment. However, fish populations are now adversely affected by the proliferation of the ruffe, an exotic species first found in the AOC in 1987. Other exotics threaten fish populations. The potential effects of toxic substances on fish population health in the AOC is largely unknown. Continuing loss of physical habitat also threatens populations. The loss of wetland habitat and the infestation of the exotic plant, purple loosestrife, have the potential to cause declining fish and wildlife populations. Little population data are available for wildlife with the exception of colonial nesting birds in the AOC. Populations of the common tern and the piping plover (threatened and endangered species) have declined, probably due to a combination of local and regional factors.

### Table BUI 2 - 1: Potential fish and wildlife impacts and possible causes identified in Stage I RAP.

| Impact | Possible Cause |
|---|---|
| **Stranding and mortality of spawning walleye adults and eggs** | Operation of Fond du Lac dam and rock fish weir below the dam. |
| **Declining lake sturgeon populations**<br>• **No spawning lake sturgeon in the St. Louis River** | Historic water quality issues, overharvesting, dam construction. |
| **Population of ruffe surpasses populations of native fish**<br>• **Ruffe were the most abundant fish species in 1991 trawls** | Introduction of ruffe via ballast water discharge. Population expands with associated impacts to native fish populations |
| **Purple loosestrife crowding out native vegetation and possibly eliminating access to fish spawning grounds** | Exotic species competing with native wetland plants. |
| **Envirovet trawls in Duluth-Superior harbor found fish with significant pathological alterations**<br>• **Approximately 80% of the 30 to 40 fish collected showed significant alterations** | Inconclusive |
| **Fish from Crawford Creek had spinal deformities and possibly tumors (number of fish not given)** | Possibly due to polynuclear aromatic hydrocarbons (PAHs) in sediment. |
| **Piping plover have not nested in the estuary since 1985** | Loss of suitable nesting habitat |
| **Declining great blue heron populations** | Human disturbance of rookeries from housing development |
| **Low reproductive success for common tern** | Lack of suitable habitat, chemical contamination, human disturbance, predation, inclement weather, competition with other species |
| **Die-off of immature ring-billed gulls and adult mallards** | Inconclusive |
| **Common tern chicks with cross-bills found at Interstate Island** | Toxic contaminants |
| **Low reproductive success for bald eagles around Lake Superior** | Eating contaminated fish |
| **Resident bird populations accumulating contaminants** | PCBs at Erie Pier |

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 2 - 2. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

**Table BUI 2 - 2: Timeline of Actions: Degraded Fish and Wildlife Population.**

| Year | Actions | Agents |
|---|---|---|
| 1981 | Bluegill re-introduction | MDNR |
| 1982 | | |
| 1983 | Sturgeon re-introduction | WI, MN DNRs |
| 1983 | Muskellunge re-introduction | WI, MN DNRs |
| 1983 | Black crappie re-introduction | MDNR |
| 1984 | | |
| 1985 | | |
| 1986 | | |
| 1987 | Interstate Island habitat restoration | MN, WI DNRs |
| | Interlake Superfund site | Interlake |
| 1988 | | |
| 1989 | | |
| 1990 | | |
| 1991 | | |
| 1992 | | |
| 1993 | | |
| 1994 | | |
| 1995 | Biocontrol of purple loosestrife | MDNR, 4H, Girl Scouts |
| 1996 | Grassy Point restoration | MDNR |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | Lower St. Louis River Habitat Plan | St. Louis River AOC |
| 2003 | | |
| 2004 | Piping plover habitat restoration in Wisconsin Point | WDNR |
| 2005 | Hog Island remediation/restoration | Douglas Co, WDNR, EPA, City of Superior |
| | FERC relicensing of St Louis River dam/reservoir system | FERC |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | Sturgeon spawning habitat created downstream of Fond du Lac Dam | MDNR |
| | Lake Superior NERR Management Plan | LS NERR, UWS |

| Year | Actions | Agents |
|---|---|---|
| 2010 | Tallus Island habitat restoration | Interlake |
| 2011 | National Important Bird Area (approved by Audubon Minnesota) designation | Audubon and NRRI |
| | Sturgeon young of the year found in St. Louis River | FDL |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 2 - 1) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Degraded Fish and Wildlife Populations

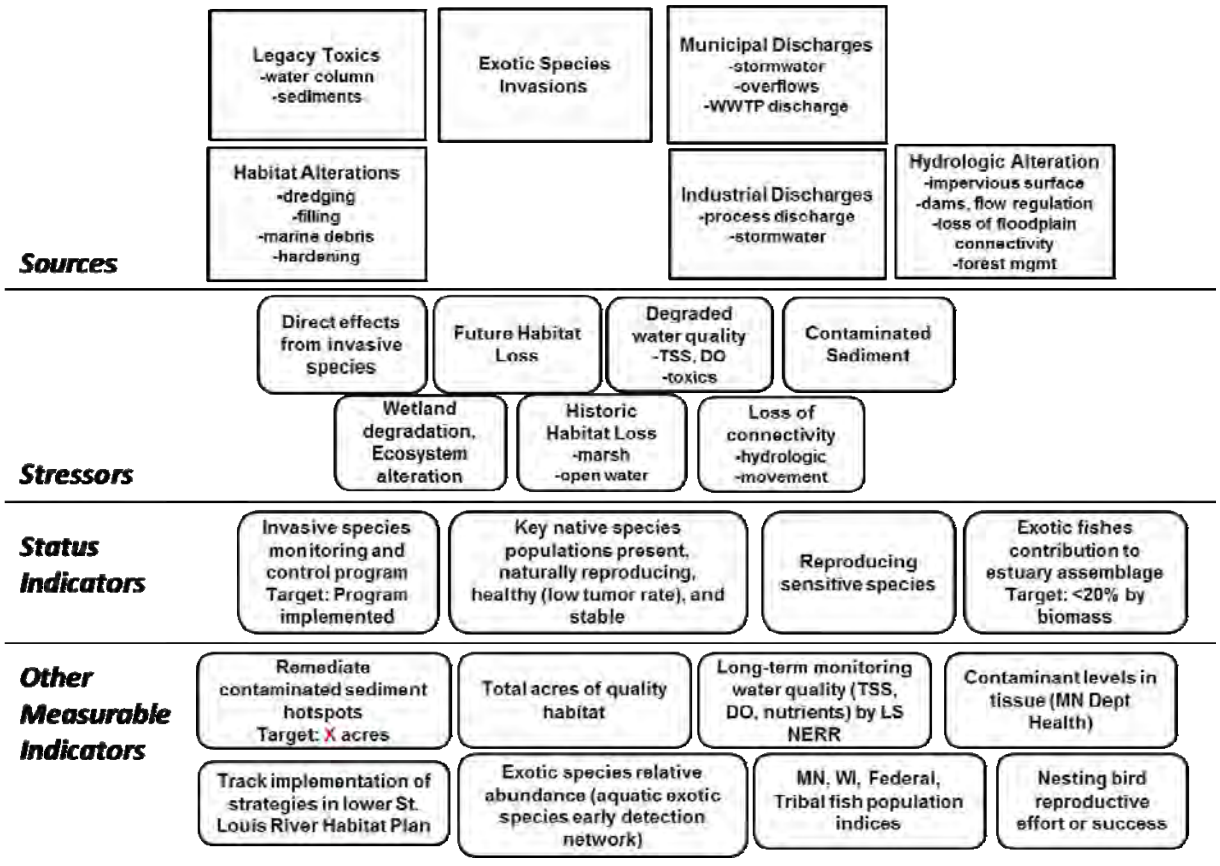


**Figure BUI 2 - 1: Source and Stressor Model for the BUI Degraded Fish and Wildlife Populations.**

Table BUI 2 - 3 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing and may be local or persist beyond the boundaries of the SLRAOC.

### Table BUI 2 - 3: Description of Source Types.

| Source | Description |
|---|---|
| **Legacy Toxics in Sediments and Water Column** | Historical discharges of toxics[1] to the AOC that occurred from municipal and industrial operations, potential for movement with water |
| **Habitat Alterations** | Habitat alterations include destruction of habitat through dredging, filling, marine debris, and shoreline hardening |
| **Industrial Discharges** | Permitted industrial water discharges within the AOC |
| | Permitted industrial stormwater discharges within the AOC |
| **Exotic Species Invasions** | Includes invasions of terrestrial and aquatic species, including those resulting from ballast water discharges and regional introductions. |
| **Municipal Discharges** | Municipal WWTP discharges to the AOC |
| | Municipal overflows from WWTPs and their collection systems within the AOC |
| | Stormwater runoff from regulated municipal separate storm sewer systems (MS4s) and construction in the AOC; this includes both sewered and un-sewered urban runoff |
| **Hydrologic Alteration** | Altering of natural hydrologic regime through increased impervious surfaces caused by development, the presence of dams and flow regulation associated with them, loss of floodplain connectivity, and forest management |

[1]Specific toxic chemicals of concern will be defined on a site by site basis once characterization of sediments in the AOC is complete.

## Description of Stressors:

The cumulative impact of the identified stressors has resulted in impairments to critical fish and wildlife habitat, with cascading impacts to fish and wildlife populations (Table BUI 2 - 4). Prior to establishment of WLSSD in 1979, identified sources of stress were severely limiting the biological functions of fish and wildlife habitat. Presence of contaminated sediments and degradation of water quality by industrial and urban discharges limited the ability of the aquatic habitat to support macrophytes and other healthy ecological functions. The stressors were particularly acute in the industrialized portion of the AOCs, limiting the ability of the habitat to support abundant and diverse populations of fish and wildlife. Even though fish and wildlife populations have been restored by both deliberate management actions and natural processes since WLSSD came on line in 1979, stressors to habitat within the industrialized portion of the AOC have persisted and will require mitigating actions. Habitat and population stressor impacts have improved dramatically in the less-developed portion of the AOC above Grassy Point since 1979, but they are still acute in specific locations such as the U.S. Steel Superfund Site and several bays that supported historical sawmill operations. Introduction of exotic plants and animals has slowed in recent years, and resource professionals speculate that negative impacts of nonnative invasive species have been dampened by improvements in habitat quality, which has resulted in the increased abundance of native species. Although hydrologic alteration continues to be a significant stressor within

the AOC, regulation of Minnesota Power's hydroelectric facilities and the implementation of stormwater management strategies have reduced some of the impacts.

### Table BUI 2 - 4: Description of Stressors.

| Stressor | Description |
|---|---|
| **Direct effects from invasive species** | Non-indigenous species of plants and animals have been introduced to the estuary since the opening of the St. Lawrence Seaway. Many of these species have been invasive. Although the exact impacts of invasive species are not well quantified, most native species have maintained their population levels over the last three decades. |
| **Wetland Degradation, Ecosystem Alteration** | Negative impacts to the biological function aquatic habitat resulting from legacy contamination, industrial runoff and marine debris, with resulting impacts to fish and wildlife populations. Terrestrial habitats negatively impacted by urban and industrial development |
| **Future Habitat Loss** | Unregulated impacts of future development and industrial activities result in loss of additional habitat and negative impacts to fish and wildlife populations. |
| **Historic Habitat Loss** | Terrestrial and aquatic habitat functions that have been negatively impacted by historic industrial and urban development have negatively impacted fish and wildlife populations. |
| **Degraded Water Quality** | Contaminated sediments, suspended sediments and organic sediments historically or currently discharged into the AOC result in the impairment of fish and wildlife habitat and populations with an overall reduction of biological productivity of the system. |
| **Loss of Connectivity** | Human alterations to hydrologic connectivity limit natural sediment transport, resulting in both sediment starvation and excessive sedimentation. Interruption of connectivity also negatively impacts movement of fish and wildlife populations. |
| **Contaminated Sediment** | Legacy contamination results in the inability of aquatic habitat to support healthy biological functions including benthic macroinvertebrates, aquatic macrophytes and fish and wildlife populations. |

## Final Delisting Target: Degraded Fish and Wildlife Populations

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (MPCA, 2009), is:

> *In consultation with their federal, tribal, local, and nonprofit partners, state resource management agencies concur that diverse native fish and wildlife populations are not limited by physical habitat, food sources, water quality, or contaminated sediments.*

## Measureable Indicators: Degraded Fish and Wildlife Populations

The Final Delisting Target for this BUI, as established by stakeholders in 2008, describes a process that leads to delisting through concurrence between State resource management agencies in consultation with other AOC partners. As stated earlier, the team agreed that the delisting target for populations is strongly correlated to the delisting target for habitat. AOC partners must concur that fish and wildlife populations are maintaining themselves through natural means (given the presence of industrial development in estuary) and that they are not limited by physical habitat, food sources, water quality, or contaminated sediments. It was determined by the team that, although most native fish and wildlife populations have been reestablished, there is a strong need for collection of baseline population information for some species. Analysis of historic and newly collected population information and synthesis of this information into a useful format will allow the AOC partners to identify quantifiable targets.

The BUI Team has identified indicators of stress that can be measured to assess the status of BUI. These qualitative and quantitative metrics provide the basis for measuring the progress towards delisting a BUI. The status indicators and other measurable indicators for this BUI are presented in Tables BUI 2 - 5 and BUI 2 - 6, respectively. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily imperative information.

### Table BUI 2 - 5: Status Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Invasive species monitoring and control program** | Program implemented | Yes/No |
| **Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable** | Evaluation based on population indexing by AOC partners | Concurrence, specific target not required |
| **Naturally reproducing sensitive species** | Evaluation based on population indexing by AOC partners | Concurrence, specific target not required |
| **Exotic fishes contribution to estuary assemblage** | By biomass | <20% |

### Table BUI 2 - 6: Other Measureable Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Remediate contaminated sediment hotspots** | Acres | X acres (based on GIS analysis of identified hotspots) |
| **Total acres of quality habitat** | Acres | X acres (Concurrence by resource managers that area of quality habitat has been restored or protected based on other defined indicators) |
| **Long term monitoring of water quality (TSS, DO, nutrients) by Lake Superior NERR** | Benchmarks established for each water quality indicator | Water quality exceeds identified benchmark at index locations for all water quality indicators |
| **Contaminant levels in tissue (MN/WI Dept. of Health)** | Parts per X. Needs to be determined by AOC partners | Target needs to be determined by AOC partners |
| **Track implementation of strategies in Lower St. Louis River Habitat Plan** | Projects Completed | All projects identified in the roadmap as critical to delisting this BUI are completed |
| **Nonnative invasive species relative abundance (aquatic nonnative invasive species early detection network)** | Variable dependent upon species and measurement gear | Concurrence, specific target not necessary |
| **MN, WI, Federal, Tribal fish population indices** | Variable dependent upon species and measurement gear | Concurrence, specific target not necessary |
| **Nesting bird reproductive effort or success** | Evaluation based on population indexing by AOC partners | Concurrence, specific target not necessary |
| **Migratory bird populations** | Evaluation based on surveys by AOC partners | Concurrence |

## Current Conditions: Degraded Fish and Wildlife Populations

The status of assessment of this BUI is reflected in Table BUI 2 - 7, and is based on the most recently available research and monitoring data compiled and reviewed for this BUI Blueprint.

**Table BUI 2 - 7: BUI Current Conditions Status Check.**

| Check | Yes/No/Unknown | Notes |
|---|---|---|
| **Data for status indicators available?** | Data available for almost all indicators | Almost all necessary datasets are available or are currently being collected |
| **Data for status indicators assessed?** | Status of assessment is variable depending on the dataset | Although a substantial amount of assessment work has been or soon will be completed, a relatively small amount of funding support would result in the assessment of almost all critical datasets. |
| **Status indicator targets set?** | Most indicators do not yet have targets established | A relatively small amount of funding support would result in available datasets being synthesized into targets for status and other measureable indicators |
| **Status indicator targets met?** | No indicator targets have been met | Completion of the worked defined in previous three sections will result in a detailed process to assess to progress towards meeting the status and other measureable indicators |

## Description of Most Recent Data Sets for Indicators:

The Team identified datasets and pathways for addressing each status indicator, which are described below. They also identified the current condition of the datasets and needs associated with utilizing them as measures of progress towards delisting. It was understood that additional datasets exist that correlate to "Other Measureable Indicators." Although these datasets were not defined as primary measures of progress towards delisting, they should continue to be monitored and incorporated into the decision-making process as funding and staff availability allow.

## Current Conditions for Status Indicators:

### Invasive Species Monitoring and Control Program

- ***Monitoring Program:***
    - USEPA and FWS have conducted annual nonnative invasive species early detection monitoring in the estuary since 2006.
    - USEPA and FWS currently have funding through the GLRI to implement an aquatic nonnative invasive species early detection monitoring program (multi-gear/annual) in the estuary for fish and benthic invertebrates, which is a Great Lakes wide effort. There is a Regional Red List of nonnative invasive species called the Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS). The program will develop monitoring strategies, identify key groups of organisms that should be monitored,

determine sampling frequency, and identify target sampling locations. Fisheries staff from Fond du Lac assist in these efforts.
    - This is only a monitoring program and will not necessarily result in a rapid action response to newly identified species.
    - *Needs:* Because the program is funded by the GLRI, it is subject to termination caused by the removal of financial support.
    - *Timeline:* The program will be ongoing dependent upon funding.

- ***Nonnative Invasive Species Action Plan:***
    - The Plan will most likely be developed through collaboration between NERR, USEPA, FWS and Sea Grant, and will reference the Lake Superior Complete Aquatic Invasive Species Prevention Plan. Need funding support to accomplish.
    - The Plan should identify how to reduce the risk of the AOC being a vector for movement of nonnative invasive species to inland waters.
    - The Plan should develop a framework for a rapid response to newly identified species that resource management professional can utilize to determine most appropriate actions.
    - *Needs:* Funds. Determine how the ballast water initiative fits into the AOC plan for nonnative invasive monitoring and response. Need to determine the handling of species identified in the Delisting Targets from those that have been introduced after. *Timeline:* The plan could be completed within 1.5 years if funding is acquired.

## Key Native Species Populations Present, Naturally Reproducing, Healthy (Low Tumor and Deformity Rate), and Stable

- *Datasets Associated with Indicator*: More long-term datasets are available for fish than wildlife species. Although evaluation of the indicators will be quantitative, the delisting of the BUI is based on concurrence by resource professionals. Key native species should be specifically identified by AOC resource professionals and AOC partners.
    - *Fish*: Several long-term indices are available for the evaluation of key native fish populations. The datasets have been collected by MDNR, WDNR, USFWS and USEPA. The indices have been analyzed but not summarized with the intent of drawing conclusions on their status relative to the delisting process. Individual indices have also not been evaluated in conjunction with other fish indices.
    - *Birds*: Some data are present but have not been summarized to provide information for drawing conclusions on their status relative to the delisting process. Indices based on bird data have not been developed. Population data are spatially and temporally limited. Systematic, Estuary or AOC-wide survey protocols and monitoring data have not been developed. Selected sites have been monitored by NRRI staff since 2001.
    - *Wildlife*: Not much data are available on wildlife populations that are utilizing the AOC. Most of the information is anecdotal. Amphibians have been monitored by NRRI staff at selected sites since 2001.

- *Needs:* Additional effort in the form of agency time and potentially funding will need to be applied to summarize existing information on key native species. Key native species need to be specifically identified by AOC resource professionals and AOC partners. Effort will need to be applied to summarize and correlate between existing long-term fisheries datasets. Independent bird and wildlife surveys will need to be funded and completed (existing bird surveys will need to be summarized with regard to utility for delisting discussions). Existing information on the health (contaminants, tumors, and deformities) of key species will need to be gathered, which will require time committed by agencies and perhaps additional funding.
- *Synthesis:* After identification of key native fish and wildlife species and completion of needed surveys, a document should be produced that includes a summary of past and current population conditions for key species, including a synthesis of agency fish and wildlife activities. The document should be formatted by species sections that contain all existing and relative information to determine their status in the process of delisting the BUI.
- *Timeline:* It is anticipated that the collection of new survey information and synthesis of existing information will require approximately 2 to 3 years. Collection of required new information will be dependent on the identification of key wildlife species and ability of agencies to complete surveys. Required surveys and report generation may need to be funded and contracted externally.

## Naturally Reproducing Sensitive Species

- *Datasets Associated with Indicator:* Although only three species (piping plover, common tern and lake sturgeon) were identified in the delisting targets, it may be appropriate to identify other sensitive species for evaluation of the Indicator.
  - *Piping Plover* – The Piping Plover Great Lakes distinct population segment is listed as Endangered under the Federal Endangered Species Act. Piping Plover population levels within the estuary were documented to be as high as 10-12 nesting pairs annually (The Flicker, 193x and 1940?). Nesting regularly occurred through 1985. Nesting sites varied depending on where suitable habitat was present. To meet recovery plan targets for the Great Lakes, 3-5 nesting pair will likely be required in the AOC (http://ecos.fws.gov/docs/recovery_plan/030916a.pdf).
  - *Common Tern* – WDNR has collected a long-term index of tern abundance in the estuary. Tern abundance has increased in recent years, due in part to ongoing habitat management and perhaps, more recently, as a result of increased abundance of forage (shiner minnows).
  - *Lake Sturgeon* – Stocking and fish tagging records are available since the sturgeon rehabilitation plan began in 1983. Long-term indices are available (MDNR and WDNR) for sturgeon abundance in the estuary and on the South Shore of Lake Superior. Existing data are most likely adequate to make determination on status of sturgeon relative to evaluation of this Indicator.

- *Needs:* Assessment and summary of past and current conditions for Piping Plover and Common Tern populations. This will require analysis of existing data and collection of additional survey information. Continue recently initiated plover monitoring program. Identify additional sensitive species that would inform the delisting process. Completion of needs may require additional funding and/or time commitment by agency staff.
- *Synthesis:* Information on sensitive species should be contained in the document identified above.
- *Timeline:* It is anticipated that the collection of new survey information and synthesis of existing information will require approximately 2 to 3 years. Collection of required new information will be dependent on the potential identification of additional sensitive species and ability of agencies to complete surveys. Required surveys and report generation may need to be funded and contracted externally.

## Exotic Fishes Contribution to Estuary Assemblages

- *Datasets Associated with Indicator:* Data required to evaluate the status of this Indicator are available through past and present USEPA/FWS monitoring programs identified in SI#1. It will be possible to establish a target (tentative target has been identified as exotic species contributing less than 20% to the estuarine fish assemblage) with existing and funded effort.
  - USEPA and FWS have conducted exotic species early detection monitoring in the estuary since 2006.
  - USEPA and FWS currently have funding through the GLRI to implement an exotics monitoring program in the estuary. This is a Great Lakes-wide effort. There is a Regional Red List of exotic species called GLANSIS. The program will develop monitoring strategies, determine sampling frequency, and identify target sampling locations.
- *Needs:* Analysis of existing data and data scheduled to be collected.
- *Synthesis:* Incorporate information relative to this Indicator into the Exotic Species Action Plan identified in SI#1. Assess the need for and potential benefits of actions to control or limit the impacts of exotic invasive species currently present in the AOC.
- *Timeline:* Although the plan could be completed within 1.5 years if funding is acquired, the target for this Indicator could be established at an earlier time.

The BUI Team has identified information gaps for this BUI that are described in Table BUI 2 - 8. The responsible parties, timeline and funding requirement for obtaining this information are also presented.

**Table BUI 2 - 8: Information Gaps: Degraded Fish and Wildlife Populations.**

| | Description | Responsibility | Timeline | Funding |
|---|---|---|---|---|
| **1** | Annual long-term exotics species monitoring program (fish and inverts) | EPA/FWS/NERR | 2012 | Monitoring will continue dependent on GLRI funding |
| **2** | Invasive species rapid response action plan | DNRs/EPA/FWS/NERR | 2013 | Completed locally with support from AOC partners – capacity limited |
| **3** | Summarize and integrate existing long-term fish datasets possessed by agencies | DNRs/EPA/FWS | 2012 | Completed locally with support from AOC partners – capacity limited |
| **4** | Identify key fish species - concurrence | DNRs/EPA | 2012 | none required – AOC Partners |
| **5** | Fish population targets - concurrence | AOC partners/DNRs/EPA | 2012 | none required – AOC Partners |
| **6** | Summarize and integrate historical fish contaminants datasets possessed by agencies | DNRs/MDH | 2012/2013 | Completed locally with support from AOC partners – capacity limited, some funding maybe required |
| **7** | Fish contaminant and tumor target - concurrence | DNRs/MDH | 2012/2013 | none required – AOC Partners |
| **8** | Identify key wildlife species - concurrence | DNRs/FWS | 2012 | none required – AOC Partners |
| **9** | Summarize and integrate historical bird datasets possessed by agencies and groups | DNRs/NRRI | 2012/2013 | Completed locally with support from AOC partners – capacity limited, some funding may be required |
| **10** | Bird population targets - concurrence | AOC partners/DNRs/NRRI | 2012/2013 | none required – AOC Partners (population surveys, assessments and analyses supporting concurrence need additional funding) |
| **11** | Collect and summarize wildlife information | DNRs/NRRI | 2012 - 2014 | Completed locally with support from AOC partners – capacity limited, some funding may be required |
| **12** | Wildlife population targets - concurrence | AOC partners/DNRs/NRRI | 2012 - 2014 | none required – AOC Partners (population surveys, assessments and analyses supporting concurrence need additional funding) |
| **13** | Identify additional sensitive species - concurrence | AOC partners/DNRs | 2012/2013 | none required – AOC Partners |
| **14** | Targets for additional sensitive species - concurrence | AOC partners/DNRs | 2012 - 2014 | none required – AOC Partners |

| | Description | Responsibility | Timeline | Funding |
|---|---|---|---|---|
| **15** | Accurate summary of plover and tern population | AOC partners/DNRs | 2012 - 2014 | Completed locally with support from AOC partners – capacity limited, some funding may be required |
| **16** | Piping plover and common tern targets - concurrence | AOC partners/DNRs | 2012 - 2014 | none required – AOC Partners and regional (Great Lakes) plover experts |
| **17** | Lake sturgeon target - concurrence | AOC partners/DNRs | 2012 | none required – AOC Partners |
| **18** | Summarize existing information on exotic vs native abundance indices | AOC partners/DNRs/EPA/NERR | 2012 | Completed locally with support from AOC partners – capacity limited, some funding may be required |
| **19** | Exotic fish contribution target - concurrence | AOC partners/DNRs/EPA/NERR | 2012 | none required – AOC Partners |
| **20** | Contaminants levels in top wildlife predators - concurrence | DNRs/NRRI/EPA/FWS | 2012 - 2014 | none required – AOC Partners |

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions in this list include those selected to address data and information gaps, monitoring and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table BUI 2 - 9, followed by a supplementary table key.

## Table BUI 2 - 9: Sequential List of Prioritized Actions: Degraded Fish and Wildlife Populations.

Note: For this BUI, project sequence is defined as follows:

1. Project complete (on-going monitoring necessary)
2. Project ongoing or in progress
3. Project is next priority

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Lake Sturgeon Rehabilitation (MDNR and WDNR) | Re-establish naturally reproducing lake sturgeon population, protect and enhance critical habitat | All macrosites below dam | 1, 2, 3, 4, 5, 6, 7, 9, 10, 13, 14 | 2, 9 | Key native species populations present, naturally reproducing and healthy; reproducing sensitive species | Wetland degradation and ecosystem alteration; historic habitat loss | 1983 | Mostly completed but monitoring and regulation are ongoing | $$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO (for Fond du Lac riffle project) | Ongoing monitoring and continued support of program by State agencies |
| 1 | Muskellunge Rehabilitation (MDNR and WDNR) | Re-establish naturally reproducing muskellunge population protect and enhance critical habitat | All macrosites below dam | 1, 2, 3, 4, 5, 6, 7, 9, 10, 13, 14 | 2, 9 | Key native species populations present, naturally reproducing and healthy; reproducing sensitive species | Wetland degradation and ecosystem alteration; historic habitat loss | 1983 | Mostly completed but monitoring and regulation are ongoing | $$$ | None required | Ongoing monitoring and continued support of program by State agencies |
| 1 | Re-colonization of Key Native Fish Species from Upper St. Louis River After Establishment of WLSSD (channel catfish, smallmouth bass) | No stocking required, but populations are regulated by State Agencies (MDNR and WDNR) | All macrosites below dam | 1, 2, 3, 4, 6, 7, 10, 13, 14 | 2, 9 | Key native species populations present, naturally reproducing and healthy; reproducing sensitive species | Wetland degradation and ecosystem alteration; historic habitat loss | 1979 | Mostly completed but monitoring and regulation are ongoing | $$ | None required | Ongoing monitoring and continued support of program by State agencies |
| 2 | Piping Plover Rehabilitation | Re-establish naturally reproducing plover population at low abundance level, protect and enhance critical habitat | Lake Superior macrosite, Superior Bay macrosite, St. Louis Bay macrosite, Lower St. Louis River macrosite | 1, 2, 3, 4, 5, 6, 7, 9, 10, 13, 14 | 2, 9 | Key native species populations present, naturally reproducing and healthy; reproducing sensitive species | Wetland degradation and ecosystem alteration; historic habitat loss | 2011 | Last nesting plover recorded in 1985 | $$$ | Fed permit for gull control may be needed | Coordination with Great Lakes Piping Plover recovery efforts, work with public landowners to protect key habitat sites |
| 2 | Common Tern Rehabilitation | Maintain naturally reproducing Common Tern population, manage, protect and enhance habitat | Lake Superior macrosite, Superior Bay macrosite, St. Louis Bay macrosite, Lower St. Louis River macrosite | 1, 2, 3, 4, 5, 6, 7, 9, 10, 13, 14 | 2, 9 | Key native species populations present, naturally reproducing and healthy; reproducing sensitive species | Wetland degradation and ecosystem alteration; historic habitat loss | 1982 | Ongoing | $$$ | Fed permits for gull control | Habitat maintenance and ongoing management need, land acquisition at WI nesting site (Interstate Island WMA) |
| 2 | Panfish (Bluegill and Black Crappie) Rehabilitation (MDNR and WDNR) | Re-establish naturally reproducing panfish populations, protect and enhance critical habitat | All macrosites below dam | 1, 2, 3, 4, 5, 6, 7, 9, 10, 13, 14 | 2, 9 | Key native species populations present, naturally reproducing and healthy; reproducing sensitive species | Wetland degradation and ecosystem alteration; historic habitat loss | 1981 | Mostly completed but monitoring and regulation are ongoing | $$ | None required | Ongoing monitoring and continued support of program by State agencies |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Exotic Species Index and Long-Term Monitoring Program (USEPA and FWS) | Quantify and monitor populations of non-native species within the estuary | All macrosites below dam | 1, 2, 3, 4, 13, 14 | 2, 9 | Invasive species monitoring and control program | Direct effects from invasive species; future habitat loss; wetland degradation and ecosystem alterations | 2008 | | $$$ | State collection permits | |
| 2 | Long-term exotics monitoring program (fish and inverts) | Project currently funded by GLRI and being implemented by EPA, FWS and NERR | All macrosites below dam | 1,2,3,4 | 2,9 | Invasive species monitoring and control program | Wetland degradation, ecosystem alteration | 2012 | Ongoing | $$$ | None required | Will be completed and maintained if funding continues. |
| 3 | Native wildlife Population Indexing | Quantify and monitor native birds, aquatic mammals, and herptile populations | All macrosites below dam | 1, 2, 3, 4, 6, 7, 10, 14 | 2, 9 | Key native species populations present, naturally reproducing and healthy; reproducing sensitive species | Wetland degradation and ecosystem alteration; historic habitat loss | | Initiate 3-year project and determine interval for repeat | $$$ | | Project needs definition and funding |
| 3 | Invasive species rapid response action plan | Develop a plan that will identify the appropriate agency responses to the future introduction of exotic organisms to the AOC. | All macrosites below dam | 10,12 | 2,9 | Invasive species monitoring and control program | Wetland degradation, ecosystem alteration | 2013 | 1 year | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |
| 3 | Integrate long-term fish datasets | Existing data controlled by State and Federal agencies needs to be summarized and integrated into a format that can be used to make decisions relative to fish population targets | All macrosites below dam | 3 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable; exotic fishes contribution to estuary assemblage | | 2012 | | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |
| 3 | Identify key fish species | AOC partners need to convene and come to concurrence on a list of key fish species in the AOC | All macrosites below dam | 10, 12 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate) | | 2012 | | Zero | None required | Commitment and participation by AOC partners |
| 3 | Fish population targets - concurrence | Existing data summarized from the "Integrate Long-Term Datasets" project and used to establish targets for key fish species | All macrosites below dam | 4 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate) | | 2012 | | Zero | None required | Commitment and participation by AOC partners |
| 3 | Summarize historical fish contaminants data | Existing data controlled by State and Federal agencies need to be summarized and integrated into a format that can be used to make decisions relative to fish contaminants and tumors | All macrosites | 3,4 | 2 | Contaminant levels in tissue (MN Dept Health) | | 2012/2013 | 1 year | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |
| 3 | Fish contaminant and tumor target | Existing data summarized from the "Summarize Historical Fish Contaminants Data" project and used to establish targets for fish contaminants and tumors | All macrosites | 4 | 2 | Contaminant levels in tissue (MN Dept Health) | | 2012/2013 | 1 year | $ | None required | Commitment and participation by AOC partners |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Identify key wildlife species | AOC partners need to convene and come to concurrence on a list of key fish species in the AOC | All macrosites | 10, 12 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable | | 2012 | | Zero | None required | Commitment and participation by AOC partners |
| 3 | Summarize and integrate historical bird data | Existing data controlled by State, Federal and other groups need to be summarized and integrated into a format that can be used to make decisions relative to bird population targets | All macrosites | 3,4 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable | | 2012/2013 | 1 year | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |
| 3 | Bird population targets - concurrence | Existing data summarized from the "Summarize and Integrate Historical Bird Data" project and used to establish targets for key bird species | All macrosites | 4 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable | | 2012/2013 | 1 year | $ | None required | Commitment and participation by AOC partners |
| 3 | Collect and summarize wildlife information | Need to collect baseline information on wildlife populations within the AOC | All macrosites | 3,4 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable | | 2012 - 2014 | 2 years | $$ | State collection permits | Requires some level of funding and a commitment from AOC partners to coordinate and complete |
| 3 | Wildlife population targets - concurrence | After wildlife population information is collected and analyzed, AOC partners will establish targets for key wildlife species | All macrosites | 10, 12 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable | | 2012 - 2014 | 2 years | $ | None required | Commitment and participation by AOC partners |
| 3 | Identify additional sensitive species - concurrence | AOC partners will convene and identify additional sensitive species | All macrosites | 10, 12 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable; Reproducing sensitive species | | 2012/2013 | 1 year | Zero | None required | Commitment and participation by AOC partners |
| 3 | Targets for additional sensitive species - concurrence | AOC partners will come to concurrence on targets for additional sensitive species | All macrosites | 10, 12 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable; Reproducing sensitive species | | 2012 - 2014 | 2 years | $ | None required | Commitment and participation by AOC partners |
| 3 | Accurate summary of plover and tern pop. | AOC partners need to collect accurate information on plover and tern populations in order the determine targets for these key bird species identified in the delisting targets | All macrosites below dam | 3,4 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable; Reproducing sensitive species | | 2012 - 2014 | 2 years | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Piping plover and common tern target - concurrence | After information is collected and summarized AOC partners will come to concurrence on targets for these key bird species | All macrosites below dam | 10, 12 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable ; Reproducing sensitive species | | 2012 - 2014 | 2 years | $ | None required | Commitment and participation by AOC partners |
| 3 | Lake sturgeon target - concurrence | Existing information will be summarized and AOC partners will come to concurrence on the target for this key fish species | All macrosites below dam | 10, 12 | 2 | Key native species populations present, naturally reproducing, healthy (low tumor rate), and stable ; Reproducing sensitive species; Reproducing sensitive species | | 2012 | | Zero | None required | Commitment and participation by AOC partners |
| 3 | Summarize existing data on exotic vs native | Existing information will be summarized relative to the relative distribution of native and exotic species so that AOC partners con determine the exotic fish contribution target | All macrosites | 3,4 | 2 | Exotic fishes contribution to estuary assemblage | | 2012 | | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |
| 3 | Exotic fish contribution target - concurrence | After existing information is summarized, AOC partners will come to concurrence on the target for exotic species contribution to the overall fish community of the AOC | All macrosites below dam | 10, 12 | 2 | Exotic fishes contribution to estuary assemblage | | 2012 | | Zero | None required | Commitment and participation by AOC partners |
| 3 | Contaminant levels in top wildlife predators - concurrence | Existing information needs to be summarized relative to contaminant levels in top wildlife predators utilizing the AOC | All macrosites | 4 | 2 | Contaminant levels in tissue (MN Dept Health) | | 2012 -2014 | 2 years | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |

## Key for Sequential List of Prioritized Actions

Reference numbers for "Type of Action":

1. Monitoring program development
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = <$5M

Reference numbers for BUIs:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Degraded Fish and Wildlife Populations

The Lower St. Louis River Habitat Plan contains descriptive and strategic information relative to BUI #2 (loss of fish and wildlife habitat). However, fish and wildlife population information, which is contained within appendices in the back of the plan, is mostly limited to fish populations. The Habitat Plan contains only a list of birds that are known or likely to utilize the AOC and nothing on other wildlife species. Since water quality improved in the early 1980's, State resource management agencies have actively restored some fish species, while others have migrated downstream from less impaired areas. The estuary currently supports naturally reproducing populations of most native fish species. Native wildlife populations have largely reestablished themselves through natural migratory patterns. The primary need identified by the team was to collect new, system-wide population information, summarize new and existing information, and transform it into a format that will be useful to establish targets for key native fish and wildlife species. It is important to realize that the current condition of fish and wildlife habitat in the AOC is adequate to support relatively robust populations of native fish and wildlife populations. However, large areas of the AOC are impaired and contribute little to the biological productivity of the estuary. So, although most native fish and wildlife species are present, the absolute productivity of the system is probably far less than it was historically.

The team concluded that with the expenditure of a relatively small amount of effort by key AOC partners and investment of a relatively small amount of financial support (<$500,000), an accurate assessment of the status of this BUI could be achieved within two years. Based on the parameters defined in the Rationale for Listing, it is likely that the St. Louis River AOC is relatively close to being considered in a state of recovery for the degradation of fish and wildlife populations.

## Ongoing Monitoring Needs: Degraded Fish and Wildlife Populations

Ongoing monitoring of native fish populations will be maintained as part of base-level resource management activities funded by both the MNDNR and WDNR. An attempt should be made to develop a standard method to index key wildlife populations within the AOC and to establish a means by which they can be monitored over time. Monitoring of exotic species populations will be accomplished through the program currently being established by USEPA, FWS and NERR and should be maintained over time. Special methods may have to be developed to accurately assess the status of key species such as Piping Plover, Common Tern and Lake Sturgeon. Common Tern monitoring and management is ongoing and will need to continue to ensure sustainable populations in the AOC. Piping Plover habitat enhancement, monitoring, and public education have begun and will need to be continued if the population is to recover locally. A bird population monitoring program needs to be developed and implemented. Work is especially needed for migratory birds, such as waterfowl and raptors that use the estuary.

## Future Issues or Concerns: Degraded Fish and Wildlife Populations

There are many issues and concerns identified for future consideration in their impact to the delisting efforts and management of the St. Louis River Area of Concern. It is expected that other issues not yet

understood may arise that could also impact the St. Louis River Area of Concern in the future. Some issues identified through the framework planning process that may negatively impact fish and wildlife habitat include:

- Potential negative impacts of currently established non-native species.
- Potential negative impacts of non-native species that are established in the future.
- Limited resources at all levels of administration, management, inspection, education, construction, enforcement, and assessment efforts to maintain and continue progress on activities that support delisting the St. Louis River Area of Concern.
- Negative impacts to the land cover and hydrologic processes that shape the St. Louis River and its tributaries. These negative impacts are particularly focused at the base of the watershed, within the AOC.
- Continued increase of impervious surfaces, which increase runoff and result in negative impacts to water quality and habitat within the AOC.
- Continued increase in fragmentation of land ownership in the watershed, which results in increased development pressure and potential negative impacts to fish and wildlife habitat and populations.
- Uncertain impacts and outcomes associated with global climate change.
- Continued trend of decreased management of water quality pollutants may result in impaired fish and wildlife habitat and populations.

## References: Degraded Fish and Wildlife Populations

Minnesota Pollution Control Agency. 1990. Final Report. Remedial Investigation: St. Louis River Interlake Duluth Tar Site: 97 pages plus appendices.

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Spurrier, J. 1991. Letter from John Spurrier, Fisheries Manager, Minnesota Department of Natural Resources, to Nancy Larson, Wisconsin Remedial Action Plan Coordinator, Wisconsin Department of Natural Resources: 1 page.

U.S. Fish and Wildlife Service. 2003. Recovery Plan for the Great Lakes Piping Plover (*Charadrius melodus*). Ft. Snelling, Minnesota. vii + 141 pp. http://ecos.fws.gov/docs/recovery_plan/030916a.pdf

# BUI 3 Blueprint: Fish Tumors and Deformities

This section contains the BUI Blueprint for Fish Tumors and Deformities. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below, followed by a Summary Statement for this BUI developed by the Team.

## BUI Team Membership

- Tracey Ledder, WDNR
- Ruth Oppedahl, UW-Extension
- Rick Gitar, Fond du Lac Tribal Water Resources Program
- Howard J. McCormick, SLRA Habitat Workgroup
- Zachary Jorgenson, USFWS
- Guy Partch, Barr Engineering
- David Bolgrien, USEPA Mid-Continent Ecology Lab
- Joel Hoffman, USEPA Mid-Continent Ecology Lab

## BUI Team Summary Statement

The target for this BUI states that the tumor incidence does not exceed the reference location. Tumors and deformities as used currently in the AOCs include liver neoplasms and external neoplasms, but not skin or lip lesions caused by viruses or parasites (though these issues are indicators of fish health for other purposes). Polycyclic aromatic hydrocarbons (PAHs) are thought to be the main cause of liver tumors because they are broken down to carcinogenic by-products upon metabolism in the liver. PAHs do not accumulate in the skin to the degree of other contaminants.

Both monitoring of white suckers for tumor incidence and continued remediation of contaminated sediments are main actions. Mountain Bay, the reference site for the Jackfish Bay AOC, will be considered the reference site for white suckers in Lake Superior for our purposes. Mountain Bay is located on the north side of Lake Superior in Ontario, northeast of Thunder Bay. We will utilize the entire record of data, all years, from Mountain Bay, to include variations in samplings from year to year. If information becomes available that shows those white suckers are not resident to Mountain Bay, another south shore reference site will have to be established.

The sampling strategy will continue as in 2011, with fish taken from sections of the entire AOC, including above the Fond du Lac dam. According to research done by others for Presque Isle Bay, fish will be greater than 3 years old, and more than 100 fish will need to be sampled. We expect fish may be sampled in spring or fall, but suspect spring spawning may make it easier to collect the initial goal of 200 fish.

We expect to be getting the Mountain Bay fish tumor data once Environment Canada has entered its data into its database. That study did not include analyses for stable isotopes or other methods to

determine a measure of residency time within Mountain Bay. Scientists based the sampling plan on fish tagging data from river stretches in the area that show most white suckers range within a 3 km area.

We will encourage Mountain Bay samplers to utilize a method such as stable isotopes to establish the residency of that white sucker population. If those white suckers are not resident to Mountain Bay, then Mountain Bay may not be a good reference. Other methods to establish the range of white suckers, such as standard fish tagging, may be necessary to supplement the stable isotope information if that method is not generally accepted yet (for both the St. Louis River and Mountain Bay or other reference site).

## Rationale for Listing: Fish Tumors and Deformities

The IJC listing criteria indicate that when the incidence rates of fish tumors or other deformities exceed rates at non-impacted control sites, or when survey data confirm the presence of neoplastic or pre-neoplastic liver tumors in bullheads or suckers, the beneficial use is impaired. The Stage I RAP stated that observations suggested that fish tumors and deformities represented an impaired use in the St. Louis River estuary, but at that time there were no studies that documented the incidence rates of tumors in fish. The State I RAP stated that additional work was needed to assess this BUI.

**Stage I RAP Rationale for Listing**
Observations suggest that fish tumors and deformities represent an impaired use in the St. Louis River estuary. However, at present, there are no studies that document the incidence rates of tumors in fish. Additional work is needed to fully determine the incidence of fish tumors and deformities in the Area of Concern (AOC).

Fish tumors and deformities were included as a BUI because of observations of external tumors and lesions, and the presence of contaminated sediments in the AOC, since tumor incidence has been shown to increase in areas with contaminated sediments. The observations described in the Stage I RAP and subsequent progress reports include:

- A U.S. Fish & Wildlife study (unpublished) of 32 black bullheads from the shipping channel of Allouez Bay showed external lesions on two fish, and lesions on the liver of one. This was not considered a high incidence of abnormalities.
- A number of fish collected from Crawford Creek in 1985 by Wisconsin Department of Natural Resources appeared to have spinal deformities and possibly tumors (specific numbers were not provided). These fish were not reviewed histopathologically. Fish tumor incidences are known to be higher in areas of high polynuclear aromatic hydrocarbons (PAHs). The sediments in Crawford Creek were known to contain detectable levels of phenanthrene, pyrene, and other PAHs. Crawford Creek received drainage from a contaminated wetland area below Koppers Co. near Superior, Wisconsin.
- 80% of 30 to 40 suckers and burbot collected in Envirovet trawls in 1991 had significant pathological alterations, including lesions and hemorrhagic liver tissue. Preliminary observations from this sampling suggested that fish from the Duluth-Superior Harbor had significant pathologic alterations in blood proteins and organ structures. Fish were also collected in trawls near Stockton Island in the Apostle Islands. Fish from that location did not exhibit changes in organ structure or signs of stress. No firm conclusions could be drawn from comparison of fish from the two sites because of differences in fish species collected at each site.

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 3 - 1. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

**Table BUI 3 - 1: Timeline of Actions: Fish Tumors and Deformities.**

| Year | Action |
|---|---|
| Major Actions Pre-1992 | |
| 1992 | BUI Listed in Stage I Remedial Action Plan |
| 1993 | |
| 1994 | |
| 1995 | |
| 1996 | |
| 1997 | |
| 1998 | |
| 1999 | |
| 2000 | |
| 2001 | |
| 2002 | |
| 2003 | |
| 2004 | |
| 2005 | Sediment cleanup at Hog Island/Newton Creek complete |
| 2006 | |
| 2007 | |
| 2008 | |
| 2009 | |
| 2010 | |
| 2011 | 200 White suckers collected for histopathology (USGS) |
| … | Stryker Bay cleanup completed |
| 2016 | US Steel clean-up estimated completion |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 3 - 1) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Fish Tumors and Deformities

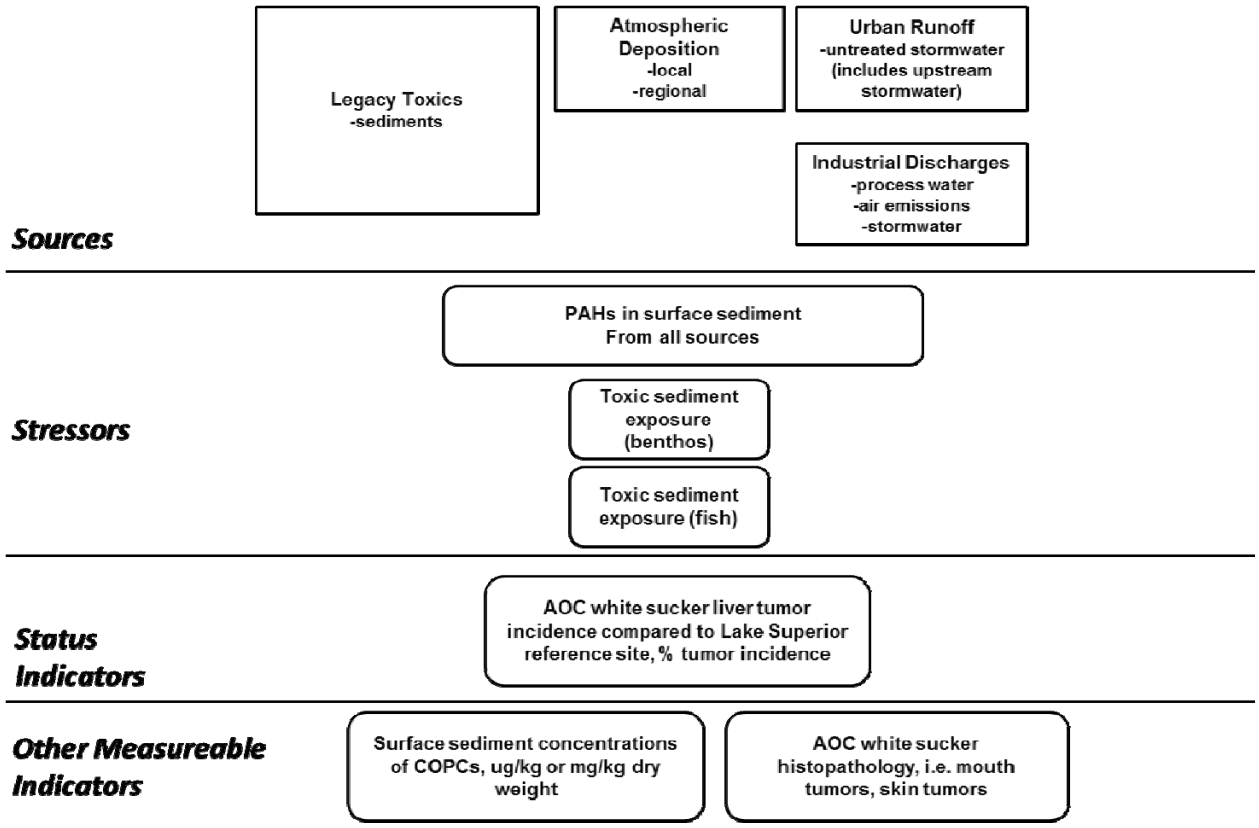


**Figure BUI 3 - 1: Source/Stressor Model for the BUI Fish Tumors and Deformities.**

Table BUI 3 - 2 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing, and may be local or persist beyond the boundaries of the SLRAOC.

**Table BUI 3 - 2: Description of Source Types.**

| Source | Description |
|---|---|
| **Legacy Toxics in Sediments** | Historical discharges of toxics[1] to the St. Louis River that occurred from municipal and industrial operations |
| **Atmospheric Deposition** | Deposition from local, and regional atmospheric transport of air emissions (residential heating, burn barrels and car emissions included) |
| **Industrial Discharges** | Permitted industrial water discharges within the AOC |
| | Permitted industrial air discharges within the AOC |
| | Permitted industrial stormwater discharges within the AOC |
| **Urban Runoff** | Stormwater runoff from regulated municipal separate storm sewer systems (MS4s) and construction in the AOC; this includes both sewered and un-sewered urban runoff |
| | Runoff from non-regulated areas within the AOC (parking lots, roads) |
| | Runoff transported into the AOC from areas upstream of the AOC boundary |

[1]Specific Chemicals of Potential Concern (COPCs) will be identified through analysis of data from historic and recent sediment assessments conducted throughout the AOC.

## Description of Stressors:

It is highly probable that skin lesions and liver neoplasms in suckers from the Great Lakes areas are associated with exposure to chemical contaminants, and in particular, to polynuclear aromatic hydrocarbons (PAHs) in contaminated sediments (Baumann, et al. 1996). Polynuclear aromatic hydrocarbons entering in the environment become sediment-associated. Concentrations of these parameters at toxic levels can cause impacts to fish through consumption of contaminated sediment while feeding and direct skin contact with contaminated sediment while feeding, resulting in tumors and deformities in fish.

## Final Delisting Target: Fish Tumors and Deformities

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (MPCA, 2009), is:

> *Incidence rates of contaminant-related internal and external tumors and deformities in resident benthic fish species, including neoplastic or preneoplastic liver tumors, do not exceed incidence rates from unimpaired areas elsewhere in the Great Lakes basin.*

## Measureable Indicators: Fish Tumors and Deformities

The BUI Team has identified indicators of stress that can be measured to assess the status of BUI. These qualitative and quantitative metrics provide the basis for measuring the progress towards delisting a BUI. The status indicators and other measurable indicators for this BUI are presented in Tables BUI 3 - 3 and BUI 3 - 4, respectively. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily imperative information.

### Table BUI 3 - 3: Status Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **AOC white sucker liver tumor incidence** | % tumor incidence | Statistically similar to or less than incidence rate in reference location for three consecutive samplings in a 6-year period |

### Table BUI 3 - 4: Other Measureable Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **AOC white sucker histopathology (skin and mouth lesions)** | % tumor incidence | Statistically similar to or less than incidence rate in reference location for three consecutive samplings in a 6-year period |
| **Surface sediment concentrations of COPCs[1]** | mg/kg or µg /kg dry weight | Less than COPC-specific SQT2 (MN) or PEC (WI)value (Crane and Hennes 2007; WDNR 2003) |
| **Surface sediment concentrations of COPCs[2]** | µg /kg or mg/kg dry weight; below SQT2 (MN)or PEC (WI) and trending toward SQT1 (MN) or TEC (WI) with time | COPC-specific CBSQGs for MN and WI (Crane and Hennes 2007; WDNR 2003) |

[1]Specific Chemicals of Potential Concern (COPCs) within the AOC will be identified through analysis of data from historic and recent sediment assessments. Currently, PAHs and metals and mercury have been the most common concern.
[2]Use of this indicator depends on availability of sediment concentrations over time in the form of surface grabs or depth-dated sediment cores for each COPC

## Current Conditions: Fish Tumors and Deformities

The first-ever, broad-scale effort to define the incidence of fish tumors and deformities in the St. Louis River AOC was conducted in the river in spring 2011 by staff from Wisconsin DNR, Minnesota DNR, Fond du Lac Tribe, USEPA (Mid-Continent Ecology Division), and U.S. Fish and Wildlife Service (USFWS) as part of the USFWS Environmental Contaminants Program's Contaminants of Emerging Concern (CEC) project. The CEC project required fish in pre-spawn condition, so all fish were collected at that time.

Following Rutter (2010), the probability that a fish has a tumor can be modeled as

$$P\left(y_{i,j}=1\right)=\text{logit}^{-1}\left(f\left(x_{i,j,k,1},x_{i,j,k,2},\ldots,x_{i,j,k,l}\right)\right)$$

where $f$ is a function of covariates $x_{..1}$, $x_{...2}$, $x_{...l}$ and $l$ is the number covariates including age, sex, and the proportion of diet obtained from a habitat. In the model, $y_{i,j,k} = 1$ if the $k^{th}$ fish in the $j^{th}$ year (to include repeat samplings), from the $i^{th}$ site (A-E) has a tumor; 0 if no tumor. Skin and liver tumors will be modeled separately.

Tumor incidence rates will be compared to incidence rates at Mountain Bay, the Lake Superior reference site on the Canadian side. White suckers in Mountain Bay have been studied for years as part of the Canadian AOC studies; however, the most recent histopathological study was in 2006 (other more numerous studies focused on mixed-function oxidase activity relative to contaminants).

Expected strategy based on results of studies:

1. If AOC tumor incidence rate does not exceed reference rate, then sample two more times within six years, with plan to remove BUI if results continue this way.
2. If AOC tumor incidence rate exceeds the reference rate, then continue to address remediation of contaminated sediments in the AOC….then go back to #1.
3. If AOC tumor incidence rates are the same as the reference rate, but residency as a percentage of time spent in the AOC is a significant factor, then go back to #1.
4. If AOC tumor incidence rate exceeds the reference rate, but age/sex is a significant factor but not residency, then go to #2.

This model includes the year sampled as a factor. If it is found not to be a significant factor, the sampled year could be removed from the model and all sampled years pooled. Since the white sucker is a long-lived fish, it may be more effective to replicate sampling on a longer-term cycle, i.e., at least three years, and potentially five to eight years between samplings, to ensure the inclusion of different fish "generations" (given that the mean age sampled in 2011 was 7 to 8 years old).

A total of 200 white suckers were collected during congregation prior to spawning, 50 in each of four evaluation areas:

1. Superior Bay – from Lake Superior to Rice's Point bridge (Site C)
2. St. Louis Bay – Rice Point bridge to Grassy Point bridge (Site AB)
3. Upper Estuary – Grassy Point Bridge to Fond du Lac Dam (Site D)
4. Upper AOC – Fond du Lac Dam to upstream reach of the AOC (Site E)

The areas were defined to provide coverage throughout the AOC, while maintaining the ability to compare results from the lower, industrially-influenced estuary (Sites A, B, and C) to those from the upper estuary and above the dam.

Liver histopathology and external lesion examination with histopathology follow-up for observed lesions and deformities were performed on each fish by the USGS. The age, size (weight, length), sex, and sample location were tracked for each fish. To determine residency of each fish, a dorsal muscle tissue sample was collected and analyzed for the natural abundance of the stable isotopes $^{13}C$ and $^{15}N$. The stable isotope results are intended to establish whether the fish reside in Lake Superior (only undertaking movements into the estuary for spawning) or more broadly use a mix of riverine, estuarine, and lake habitats, as annual movements of white suckers within the AOC are unknown at this time.

The fish were collected under coordination by the AOC Coordinators in cooperation with their agency fisheries staff, and with assistance by the USFWS staff on-site for the Contaminants of Emerging Concern study. All fish were processed in the field by a team composed of Vicki Blazer (USGS) and her graduate students. Carcasses were disposed of at the Moccasin Mike Landfill in Superior, under a Special Waste, non-hazardous, permit.

The fish were weighed and measured. A necropsy-based assessment was completed, and all external and internal abnormalities were recorded. Any grossly visible abnormalities were removed and placed in preservative. From all fish, five to eight pieces of liver from various areas were removed and placed in fixative. A 1 $cm^2$ section of dorsal muscle tissue was frozen for stable isotope analysis. Lapillus otoliths were removed during necropsy and placed in a labeled coin envelope for subsequent processing and analysis for fish age.

Nonneoplastic, pre-neoplastic and neoplastic changes in the liver and skin were documented in the sampled white suckers, following previously described diagnostic criteria for brown bullhead and other species. (Blazer et al. 2007). The Canadian studies also utilized this manual in the histopathology of white suckers.

Of the 200 white suckers collected, 94 were female and 106 were male. They ranged in age from 3 to 19 years, with the majority in the 6- to 11-year range. There was a difference among the sites in mean age. Suckers collected at sites AB and D were older than those at site C, and fish from E were intermediate. There was a difference in the sex ratio among the sites. Sites C (Superior Bay) and Site D (upper estuary) had approximately even numbers of male and female, while only 18% of the suckers collected at Site AB were female, and 72% of those collected at Site E were female.

Carbon and nitrogen stable isotope analysis was used to provide information about the movement of each fish within the estuary and Lake Superior. The $^{13}C$ and $^{15}N$ signatures are related to the location of a fish's diet. In the St. Louis River, the $^{13}C$ abundance in benthic invertebrate is similar from Fond du Lac dam to St. Louis Bay, but is increasingly $^{13}C$-enriched from St. Louis Bay to Lake Superior (Hoffman et al. 2010). In contrast, the $^{15}N$ abundance in benthic invertebrates is similar throughout the estuary, but is $^{15}N$-depleted in Lake Superior. Therefore, the stable isotope results were used to determine where each fish had been feeding (residing). The signal is acquired over time, and represents the diet over the past 1-2 years.

Within each of the estuary sites sampled, the white suckers exhibited the full range of possible isotopic signatures, indicating that there was no relationship between the location of their capture and their migration history. Of the 149 fish sampled below the dam, 46 were found to be largely resident in a single location (i.e., >75% of their diet was based in a single location); seven fish were largely Lake Superior residents; while 22 fish were largely resident in the lower estuary and 17 fish in the upper estuary. The remainder, 103 white suckers, relied on a mix of locations for feeding. The majority (57%; 85 of the 149 fish) of the white suckers sampled in the estuary spent more of their time feeding in the estuary than in the open Lake. The 50 fish captured above the Fond du Lac dam, unable to migrate through the estuary to the Lake because of the dam, were isotopically distinct because they had been feeding solely above the dam.

Stable isotope results reveal the following regarding residency of the 150 white suckers collected below the Fond du Lac dam for the study (Hoffman 2011):

- 19% fish are lower estuary (Superior Bay and St. Louis Bay) "residents" (>75% diet)
- 11% are middle estuary residents (>75% diet)
- 3% are Lake Superior residents (>75% diet)
- 50% fish are St. Louis River residents (>75% diet)
- 82% fish spent majority (>50%) of recent life history in St. Louis River

A high percentage (30.5%) of the white suckers collected within the St. Louis River AOC had grossly observable raised skin and lip lesions (Figure BUI 3 - 2; Table BUI 3 - 5). These were primarily mucoid plaques that by microscopic examination were hyperplastic lesions and not neoplasms. St. Louis Bay had the highest prevalence (42%), although this was not different from the Middle Estuary (32%) and Upper Estuary (38%). Superior Bay had the lowest prevalence (10%). Overall, 4.0% of the white suckers had skin neoplasms. and all of these were papillomas. None of the raised lesions noted for Superior Bay captured fish were neoplastic, while 10% of those from St. Louis Bay were neoplastic.

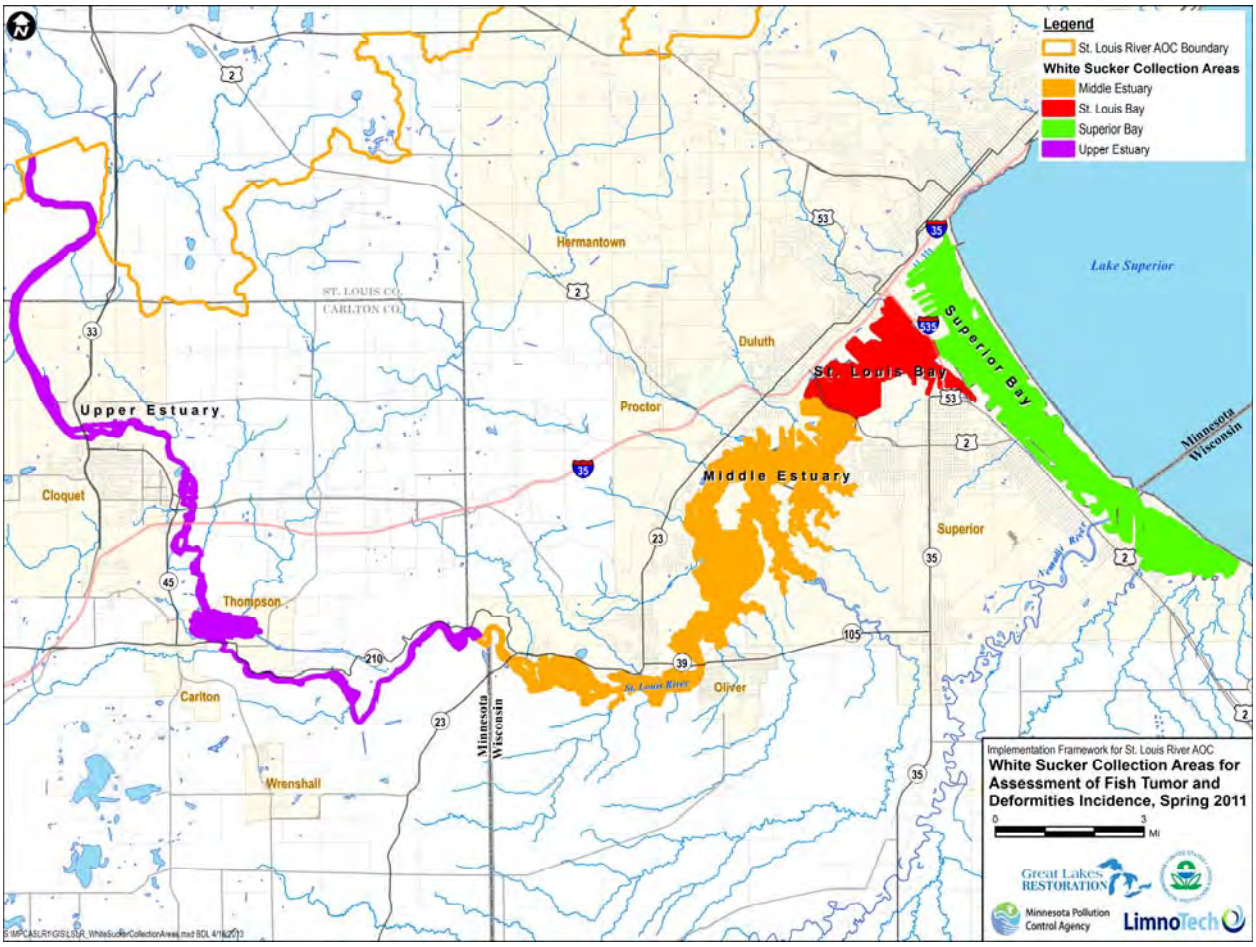


**Figure BUI 3 - 2: Sites of white sucker collection areas.**

**Table BUI 3 - 5: Percentage of White Suckers with Specific Abnormalities Collected within the St. Louis River Area of Concern.**

| Abnormality | Site AB | Site C | Site D | Site E | Total |
|---|---|---|---|---|---|
| ***Raised Skin lesions*** | | | | | |
| Body Surface/fin | 40 | 10 | 28 | 38 | 29.0% |
| Lips | 2 | 0 | 4 | 0 | 1.5% |
| Total | 42 | 10 | 32 | 38 | 30.5% |
| **Skin Neoplasia - Papilloma** | 10 | 0 | 4 | 2 | 4.0% |
| ***Liver*** | | | | | |
| Altered Foci | 6 | 8 | 4 | 0 | 4.5% |
| Bile duct proliferation | 4 | 52 | 58 | 46 | 49.0% |
| Cholangioma | 2 | 2 | 2 | 0 | 1.5% |
| Cholangiocarcinoma | 2 | 2 | 4 | 4 | 3.0% |
| **Total Liver Neoplasms** | 4 | 4 | 6 | 4 | 4.5% |

**Table BUI 3 - 6: Skin lesions and skin neoplasia by age group.**

| Age Range | Total | Raised Skin Lesions | Skin Neoplasia |
|---|---|---|---|
| 3-6 | 40 | 8 | 1 |
| 7-8 | 44 | 13 | 1 |
| 9-10 | 31 | 9 | 3 |
| 11+ | 32 | 12 | 3 |

There was a low prevalence (4.5%) of liver neoplasms, all of which were of bile duct origin. These were spread throughout all four capture locations with no difference among the sites. Bile duct proliferation was also common in the liver of white suckers from all locations. Altered foci were only observed at the sites below the dam. Both eosinophilic and vacuolated foci were noted. While altered foci have been considered by some to be preneoplastic lesions, it is not known if any type (eosinophilic, vacuolated, basophilic or clear cell) altered foci progress to hepatocellular neoplasms in white sucker (Blazer 2007).

Based on the stable isotope results, fish with either neoplastic skin lesions or raised skin lesions fed more in the upper estuary and less in the lake than those with no skin lesions (Table BUI 3 - 6). We found a similar habitat pattern in those fish with liver neoplasms. The upper estuary includes two Superfund sites.

Based on the logistic regression model, for fish captured at sites A-D (below Fond du Lac dam), there was corroborating evidence that the time spent in the upper estuary was a factor for increased skin lesions and skin neoplasia. Grossly observable skin lesions significantly ($p < 0.05$) increased with the proportion of the fish's diet that was obtained from the upper estuary, and also increased with age, though the latter factor was weakly supported ($p < 0.10$). Grossly observable lesions that were neoplasms increased with feeding in the upper estuary, though the factor was marginally significant ($p = 0.06$); neither age or nor sex was a significant factor. The incidence of liver neoplasms was not significantly related to any factor. It is not known, however, whether the duration and timing of

exposure to contaminated sediments necessary to produce skin and liver neoplasia are similar to the isotopic turnover time (1 -2 years). Also, it is not known whether the feeding behavior of white sucker is consistent over many years, such that stable isotope information would reflect a general life history pattern for that individual.

Full results from this study are documented in Blazer *et al.* (2013).

## Summary

This first white sucker tumor study indicates that the neoplasm incidence rate in the St. Louis River AOC is greater than the Lake Superior reference site, Mountain Bay. The most recent sampling of Mountain Bay for white sucker liver tumors was 2006. None of the one hundred fish sampled had neoplasms, making the incidence rate <1%. It may be important to note as well that the average age of the Mountain Bay sampled fish was 13.4 (range 5 – 24) years old, an older population than that sampled in the St. Louis River.

The St. Louis River liver neoplasm incidence rate is also greater than that of Jackfish Bay AOC (2006).

Stable isotope studies indicated an association with neoplasms and the upper estuary, which is also the location of the SLR Superfund sites.

The Canadian AOCs (Figure BUI 3 - 3) will be studied again in 2013, which will include another sampling Mountain Bay reference site for tumor incidence rate (Mark McMaster, e-mail contact). Follow-up with both SLRAOC 2013 sampling and Mountain Bay 2013 results comparison should be completed before plans for next sampling (i.e., should consider timing of actions being taken in the AOC for remediation of Superfund site). The Canadian studies in the past did not include the stable isotope data for residency information. The stable isotope study results for SLR AOC have been shared with Mark McMaster, Environment Canada. He is interested in collecting stable isotype data as well.

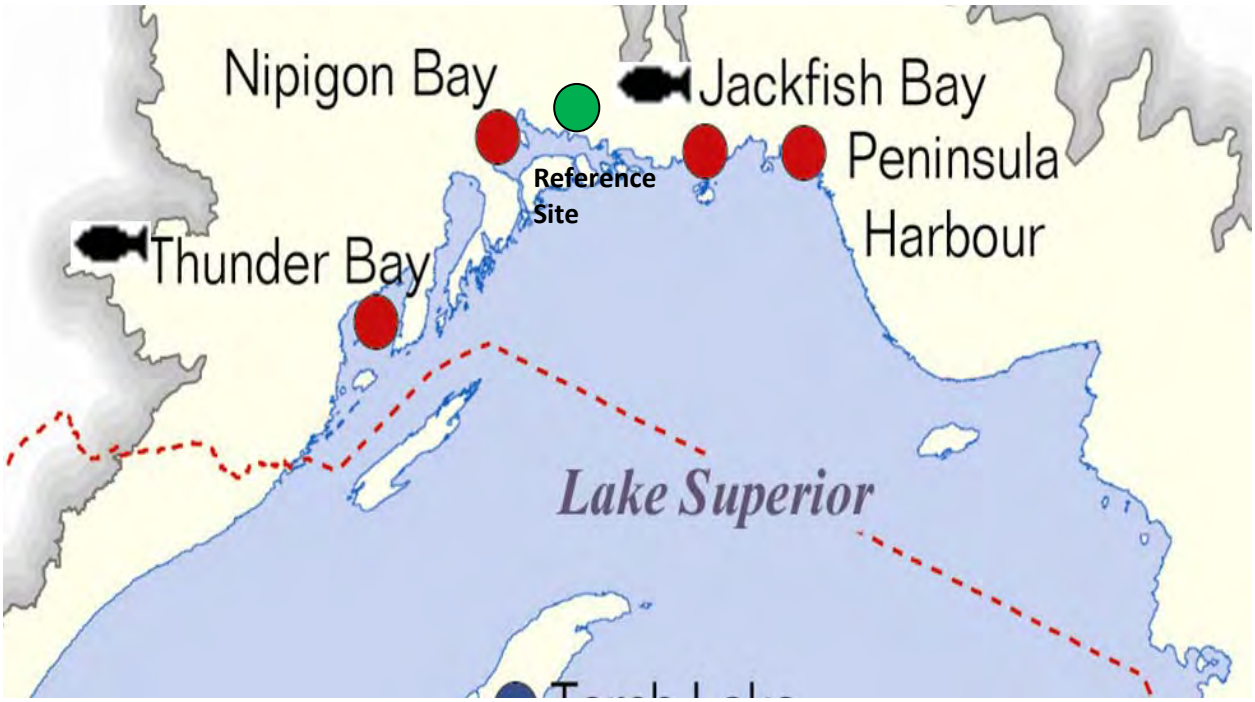


**Figure BUI 3 - 3: Location of the Canadian study sites and Mountain Bay reference sites (Source: McMaster, Environment Canada, 2011, Power Point presentation.)**

## Information Gaps: Fish Tumors and Deformities

- Studies have indicated the variable nature of liver histopathology from year to year. Depending on study results from the 2011 white sucker sampling event, a decision will need to be made regarding the necessary frequency of monitoring for liver tumor incidence in the AOC.
- Depending on incidence rate observed in the first sampling round, an evaluation of the number of fish sampled per event may need to be conducted to establish low incidence rates with better certainty (using higher numbers of fish per sampling round).
- Applicability of the Mountain Bay, Ontario, reference site should be assessed against the establishment of a more local reference site. Fish age and residency are two important variables.
- Characterization of the extent and level of PAH and metals contamination in the sediments of the AOC is not yet complete.
- Depending on availability of appropriate sediment sampling data, evaluation in the change of COPC concentrations over time (depth) in the sediments can possibly be used to support delisting of this BUI if COPC levels are seen to be declining over time.

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions included in this list include those selected to address data and information gaps, monitoring and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table BUI 3 - 7, followed by a supplementary table key.

## Table BUI 3 - 7: Sequential List of Prioritized Actions: Fish Tumors and Deformities.

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Fish Tumor Model | Set up model for sampling and monitoring, recommend 3 consecutive samples in a 6-year period in which the SLR tumor rate does not exceed that of Mountain Bay. Will need representative sampling of fish resident within SLR greater than 50%; fish to be greater than 3 years old; expect to need more than 100 fish to be able to detect a tumor incidence rate of 3% or less. | The St. Louis River within the AOC boundary, four sections as sampled in 2011 | 1 | 3 | tumor incidence rate | contaminated sediments | 2011 | ongoing | Staff time commitment from all partners for work plan, collection of fish and data analysis | | Data set from Mountain Bay from all samplings to allow comparison with confidence levels. |
| 2 | Fish Sampling | Fish sampling process: Need a representative sampling from entire AOC. Continue to use white suckers. Note: intend to continue 2011 sample plan, which includes AOC-wide sampling. What is best season of year to collect the number of fish required? | The St. Louis River within the AOC boundary, four sections as sampled in 2011 | 2 | 3 | tumor incidence rate | contaminated sediments | 2011 | ongoing | 2011 Workplan $76,000 total; 200 white suckers histopathology and reporting $75,000; 13C $8 per fish; in-kind fish collection | | |
| 3 | Reference site determination | Evaluate if one overall reference site (Mtn Bay) is acceptable for all Lake Superior AOCs, and SLR. Within the appropriate time frames. If information indicates Mtn Bay fish are mostly living in the large lake, then they are not representative of the reference site bay. Establish a more appropriate reference site. | Mountain Bay or other reference site if needed | 4 | 3 | tumor incidence rate | contaminated sediments | | | | | |
| 4 | Residency determination | Residency determination: Fish tagging methods could be used as a substitute for residency time estimates (if stable isotope measures are not acceptable to decision makers). | St. Louis River AOC and reference site | Fish need to spend the majority of their time in the estuary. (50% or more of their time is acceptable.) | | | | | | | | |
| 5 | Continuation of remediation projects | Recommend to continue remediation of contaminated sediments, especially PAHs | St. Louis River AOC | 8 | 3, 2, 4, 5, 9 | tumor incidence rate | contaminated sediments | | | | | |
| 6 | Local research into causation of fish tumors if incidence rate exceeds reference | If there is reason to suspect other local causes of tumors, then consider doing lab series on causation. Potentially determine if local fish strain makes them more susceptible to tumors. | St. Louis River AOC | 2 | 3 | tumor incidence rate | contaminated sediments or other? | | | | | |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | Other concerns for estuary | Continuing concerns: emerging contaminants (caffeine, nanoparticles, pharmaceuticals, etc.) Recommend continued efforts to study this issue to protect the estuary from wastewater, municipal, industrial and other processes. | St. Louis River AOC | | | | | | | | | |

## Key for Sequential List of Prioritized Actions

Reference numbers for "Type of Action":

1. Monitoring program development
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = <$5M

Reference numbers for BUIs:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Fish Tumors and Deformities

The BUI Team noted the fish tumor incidence rate variability seen in other AOCs and decided that several consecutive samplings in which the St. Louis River AOC white sucker incidence rate was less than or equal to a reference site would be necessary to remove this BUI. Data from the first large sampling of white suckers (2011) is not yet available. If there is not an elevated tumor incidence rate in this AOC at this time, conceivably this BUI could be removed by 2017. Table BUI 3 - 8 gives the costs for sampling as conducted in 2011.

### Table BUI 3 - 8. Estimated costs for the 2011 sampling event conducted in conjunction with the US Fish and Wildlife Contaminants program were estimated.

| Sampling Element | Approximate Cost ($) |
|---|---|
| External lesion and liver histopathology analyses (200 white suckers)[1] | $50,000 |
| Data management, analysis and reporting<br>• Contractual | $25,000 |
| Stable carbon ($^{13}C$) isotope analysis [2]<br>• $8 per fish<br>• 200 fish | $1600 |
| Sample collection<br>• MDNR, middle estuary area, 3 days, 2 people plus equipment use - $1,500<br>• Fond du Lac Tribe, upper estuary – $1,500<br>• WDNR, Superior Bay - $1,500<br>• Total = $4000 | In-kind |
| **Budget (with in-kind services)** | **$76,000** |

1. In conjunction with Contaminants of Emerging Concern study.
2. Analysis by MED lab

## Ongoing Monitoring Needs: Fish Tumors and Deformities

It is expected that fish tumor incidence rate monitoring will have to continue in the St. Louis River AOC, because of variability within the population. Three consecutive samplings within six years in which the reference incidence rate is not exceeded meeting the BUI removal target would be acceptable.

Expected strategy based on results of studies:

1. If AOC tumor incidence rate does not exceed reference rate, then sample two more times within 6 years, with plan to remove BUI if results continue in this way.
2. If AOC tumor incidence rate exceeds the reference rate, continue to address remediation of contaminated sediments in the AOC, then go back to #1.
3. If AOC tumor incidence rates are the same as the reference rate, but residency as a percentage of time spent in the AOC is a significant factor, then go back to #1.
4. If AOC tumor incidence rate exceeds the reference rate, but age/sex is a significant factor but not residency, then go to #2.

## Future Issues or Concerns: Fish Tumors and Deformities

The BUI team notes concern for Contaminants of Emerging Concern (CEC) and their impact on the health of fish and other aquatic life.

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# BUI 4 Blueprint: Degradation of Benthos

This section contains the BUI Blueprint for Degradation of Benthos. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below followed by a Summary Statement for this BUI developed by the Team.

## BUI Team Membership

- Tracey Ledder, WDNR
- Ruth Oppedahl, UW-Extension
- J.Howard McCormick, retired USEPA
- David Bogrien, USEPA MED Lab
- Guy Partch, Barr Engineering
- Lorena Rios, UW-Superior
- David Wright, MDNR
- Zachary Jorgenson, USFWS
- Dan Breneman, NRRI
- Doug Beckwith, MPCA
- Joe Graham, WDNR

## BUI Team Summary Statement

The Team identified an overwhelming need to establish the benthic community reference condition at "least-impacted" areas in the AOC. This is important to understanding site restoration potential and measuring progress toward the removal of the Degradation of Benthos BUI. This action would be a sampling project, likely to take several phases. The Team discussion emphasized that this BUI is concerned with both sediment contamination and habitat alteration. The members suggest that bioaccumulation concerns in the AOC should be further investigated, as the current sediment quality guidelines are based on toxicity alone. Improving habitat conditions (chemically and physically) would allow the benthic community to recover on its own, but that may take time. Therefore, remediation and restoration projects will need long-term monitoring to document benthic community improvement for removal of this BUI. The continuation of remediation and restoration projects in the AOC is therefore important for removal of this BUI. Restoration efforts should include emergent and submergent vegetation and estuary flats communities as important historic habitat in the AOC.

## Rationale for Listing: Degradation of Benthos

When the benthic macroinvertebrate community structure significantly diverges from non-impacted control sites of comparable physical and chemical characteristics, the IJC listing criteria consider the beneficial use impaired. In addition, this use is considered impaired when toxicity (as defined by relevant, field-validated, bioassays with appropriate quality assurance/quality controls) of sediment associated contaminants at a site is significantly higher than controls. A number of observations suggesting benthic impacts led to the listing of this BUI.

While reduced benthic invertebrate density, diversity, and species richness had been reported within portions of the AOC in areas subjected to physical disturbance or in proximity to known contamination, it was difficult to assess the extent of degradation to the benthic community because benthic sampling had generally been sporadic and limited in geographical extent. However, benthic sampling data and toxicity testing, at the time of listing, indicated areas with decreased organism diversity and observed toxicity to benthic organisms.

The following observations regarding the benthic community were reported in the Stage I RAP:

- Benthic sampling in the 1970s (Koch et al. 1976) between the Pokegama River and the Blatnik Bridged showed decreased diversity in the downstream locations, with the lowest diversity and number of organisms observed adjacent to and downstream of the former Duluth Sewage Treatment Plant. Benthic sampling from the channel near the former Duluth Sewage Treatment Plant contained 97% nematodes. The highest benthic invertebrate diversity indices were seen at the mouth of Pokegama Bay, where *Hexagenia sp.* (burrowing mayfly) and various species of *Trichoptera* (caddis flies) were found. An intermediate diversity index was found in samples in the Grassy Point area.
- Bioassays conducted in the 1970s (Prater and Anderson 1977) with sediment from Duluth and Superior Harbor indicated toxicity to benthic organisms. The greatest toxicity was observed off Wisconsin Point and the Elevator O Slip in the Superior Harbor Basin, and off the Superwood Corp. and Cargill Elevator B Slips in the Duluth Harbor Basin.
- Sampling in the 1980s in the vicinity of the WLSSD plant outfall (Roush 1992) showed the benthic community was dominated by oligochaetes and chironomids, which are generally relatively tolerant of organic pollution. 93.4% of the organisms sampled in this study were oligochaetes and chironomids.

**Stage I RAP Rationale for Listing**

The limited data available suggest that there has been some improvement in the benthic community in areas impaired in the past from organic pollutant loading. No system-wide benthic studies have been conducted in the estuary. Current studies show that benthic communities in certain locations are impaired by contaminated sediments. Work conducted in 1989-1991 indicates degraded benthos at the Interlake Site or Stryker Embayment and at the Newton Creek/Hog Island Inlet of Superior Bay.

- Additional benthic sampling was conducted by USACE contractors in the 1980s (Envirodyne 1983 and LimnoTech 1984) in the harbor dredged channels and shallow areas upstream of the bays around the Minnesota Power Hibbard electric generating station. These studies also showed domination by oligochaetes, though wide variability between samples was observed.
- The 1980s sampling included several locations at which no macroinvertebrates were found in some or all of the samples: the Duluth entry, Superior entry, and Stryker Bay adjacent to the Interlake Iron Superfund site. The paucity of organisms at the Duluth and Superior entry sites is likely to the result of unsuitable substrate and physical disturbances (Envirodyne, 1983).
- Sediment contaminant levels at both the U.S. Steel and Interlake Iron Superfund sites were known to be toxic to benthic organisms. No benthic invertebrate sampling had been done at that time in connection with the U.S. Steel site. However, low benthic density and diversity were found in Stryker Bay adjacent to the Interlake Iron site during sampling conducted in 1989 (MPCA 1990).
- Bioassays conducted in the early 1990s found that sediments from Newton Creek, which receives wastewater from the Murphy Oil USA refinery in Superior, exhibited both acute and chronic toxicity to benthic organisms (Masnado 1990).
- Some test organism mortality was observed in bioassays of sediment collected from the Hog Island Inlet in the early 1990s. In addition, field observations indicated an absence of benthic invertebrates in this area (Koshere 1990).
- The 1995 RAP progress report indicated that some sediment samples near the U.S. Steel Superfund site were acutely toxic to chironomids.
- The 1995 RAP progress report indicated that the harbor area contains pollution-tolerant organisms such as sowbugs, chironomids, and oligochaetes, while sites upstream of Cloquet include armored mayflies and primitive minnow mayflies, which prefer clean water.
- Pollution-tolerant tubificid worms and nematodes represented 68%-94% of the organisms collected in the Hog Island Inlet, but less than one-third of the organisms at an uncontaminated reference site as reported in the 1995 RAP progress report.

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 4 - 1. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

**Table BUI 4 - 1: Timeline of Actions: Degradation of Benthos.**

| Year | Action |
|---|---|
| 1992 | BUI Listed in Stage I Remedial Action Plan |
| 1993 | Mudpuppy sampling project, including US Steel and Interlake Sites |
| 1994 | |
| 1995 | EPA re-map study, need raw data, Judy Crane |
| 1996 | |
| 1997 | |
| 1998 | |
| 1999 | |
| 2000 | |
| 2001 | Stryker Bay SLR IDT site (tox study) |
| 2002 | Lower St. Louis River Habitat Plan created |
| 2003 | |
| 2004 | |
| 2005 | Sediment cleanup at Hog Island/Newton Creek complete |
| 2006 | |
| 2007 | |
| 2008 | NRRI-GLEI Aquatic Habitat Reference sites may have benthic information |
| 2009 | |
| 2010 | |
| 2011 | Stryker Bay cleanup completed |
| 2011 | NOAA Mussel watch site outside of MN Point |
| | Look at SLR data slam information from Feb 2011 St. Louis River Summit |
| 2012 | Upcoming Feb 20-21 SLR data slam |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 4 - 1) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Degradation of Benthos

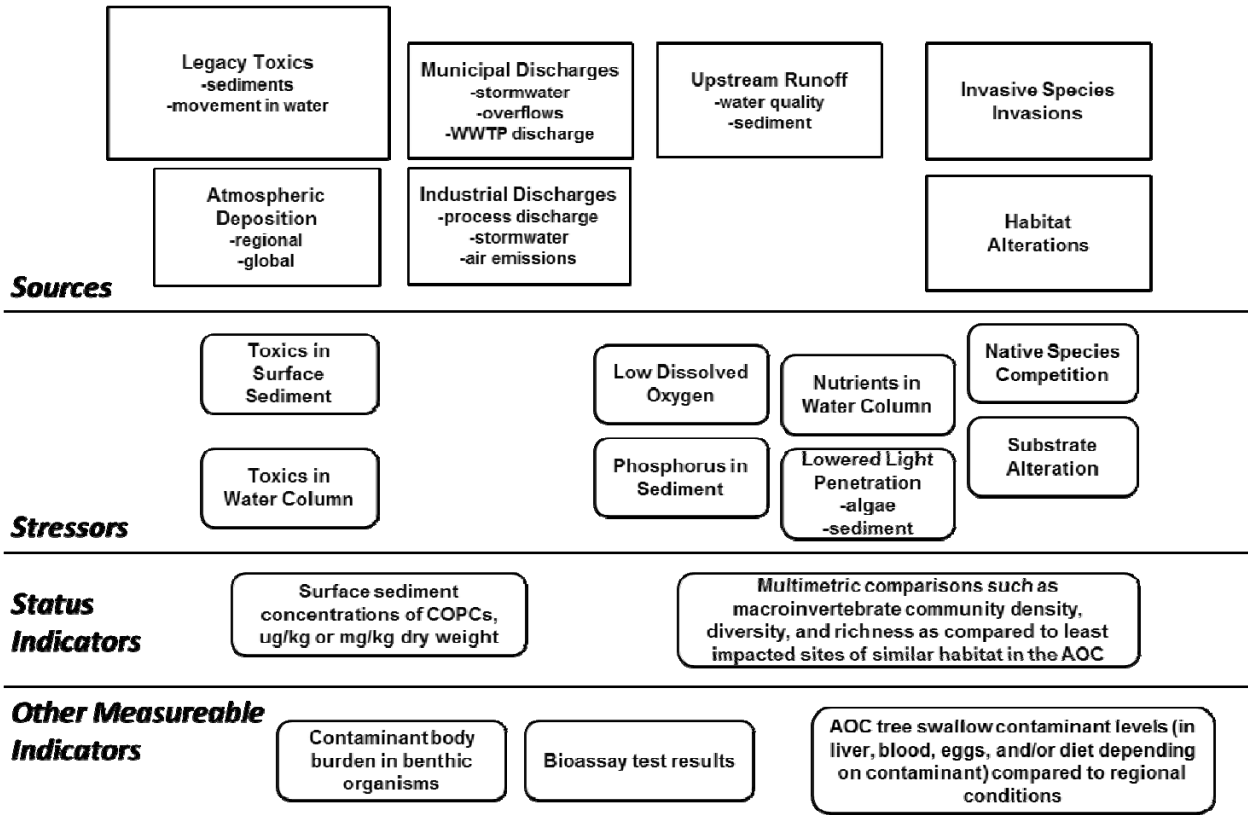


**Figure BUI 4 - 1: Source Stressor Concept Model for the BUI Degradation of Benthos.**

Table BUI 4 - 2 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing, and may be local or persist beyond the boundaries of the SLRAOC.

**Table BUI 4 - 2: Description of Source Types.**

| Source | Description |
|---|---|
| **Legacy Toxics in Sediments** | Historical discharges of toxics[1] to the AOC that occurred from municipal and industrial operations, potential for movement with water |
| **Atmospheric Deposition** | Deposition from regional- and global-scale atmospheric transport of air emissions |
| **Habitat Alterations** | Habitat alterations include destruction of habitat through urban development, industrial operations, dam operations, and dredging |
| **Industrial Discharges** | Permitted industrial water discharges within the AOC |
| | Permitted industrial stormwater discharges within the AOC |
| | Permitted industrial air discharges within the AOC |
| **Invasive Species Invasions** | Includes invasions of terrestrial and aquatic species, including those resulting from ballast water discharges and regional introductions. |
| **Municipal Discharges** | Municipal WWTP discharges to the AOC |
| | Municipal overflows from WWTPs and their collection systems within the AOC |
| | Stormwater runoff from regulated municipal separate storm sewer systems (MS4s) and construction in the AOC; this includes both sewered and un-sewered urban runoff |
| **Upstream Runoff** | Runoff from non-regulated rural areas within the AOC, including residential, silviculture, agriculture, animal waste, feedlots and erosion |

### Description of Stressors:

Degradation of benthic habitat and communities has occurred in the AOC due to legacy contamination from past discharge of toxic substances from municipal and industrial activities, habitat alterations by anthropogenic activities, and sedimentation. Current impacts may include discharges from runoff, habitat alterations, invasive species invasions, and sedimentation.

Differences in physical habitat (water depth) have also been shown to contribute to differences in habitat communities between sites (Breneman 2000). Comparison studies between communities will have to control for basic differences in physical factors.

## Final Delisting Target: Degradation of Benthos

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (MPCA, 2009), is:

> *The benthic community in historically degraded areas (e.g., chemically, biologically, or physically degraded areas) of the AOC does not significantly differ from non-impacted sites of comparable characteristics within the AOC. Benthic communities' characteristics including native species richness, diversity, abundance, and functional groups will be considered when comparing sites.*

## Measureable Indicators: Degradation of Benthos

The BUI Team has identified indicators of stress that can be measured to assess the status of BUI. These qualitative and quantitative metrics provide the basis for measuring the progress towards delisting a BUI. The status indicators and other measurable indicators for this BUI are presented in Tables BUI 4 - 3 and BUI 4 - 4, respectively. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily imperative information.

### Table BUI 4 - 3: Status Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Surface sediment concentrations of COPCs**[1] | µg/kg or mg/kg dry weight | Less than COPC-specific SQT1 or SQT2 (MN) or TEC or PEC (WI)[2] depending on site and its habitat type |
| **Multi-metrics such as macroinvertebrate community density, diversity, and richness as compared to least-impacted sites of similar habitat in the AOC** | Multi-metrics calculated from site community data (chosen from metrics capable of characterizing this estuary) | Compared to multi-metrics calculated for similar habitats in least-impacted sites within the AOC. Need to consider long-term monitoring for recovery after site remediation and restoration. |

[1]Specific Chemicals of Potential Concern (COPCs) will be identified through analysis of data from historic and recent sediment assessments conducted throughout the AOC.
[2]Consensus-Based Sediment Quality Guidelines for MN (Crane and Hennes 2007) and WI (WDNR 2003)

***Note:***

***The Scientific Advisory Group has recommended that hexagenia be considered for use as a status indicator for this BUI. The BUI Team agrees that hexagenia could be one of a suite of matrices utilized.***

### Table BUI 4 - 4: Other Measureable Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Contaminants body burden in benthic organisms** | µg/g in tissue of benthic organisms | Similar to or less than assessment guidelines, especially for bioaccumulative concerns |
| **Bioassay test results** | Significant toxicity | No significantly higher toxicity response |
| **AOC tree swallow contaminant levels (in liver, blood, eggs, and/or diet depending on contaminant)** [1] | Contaminant dependent | Similar to or less than regional levels for 3 consecutive years |

[1]Custer and Custer, 2011

## Current Conditions: Degradation of Benthos

The status of assessment of this BUI is reflected in Table BUI 4 - 5 and is based on the most recently available research and monitoring data compiled and reviewed for this BUI Blueprint.

**Table BUI 4 - 5: BUI Current Conditions Status Check.**

| Check | Yes/No/Unknown | Notes |
|---|---|---|
| **Data for status indicators available?** | No | Existing macroinvertebrate community reference sites for remediation projects in the AOC must be evaluated for applicability; new sites may need to be established; data exists for comparison of sediment concentrations to consensus-based sediment quality guidelines to protect benthic health |
| **Data for status indicators assessed?** | No | Recent sediment data has not yet been assessed (expect data finalization Spring 2012). |
| **Status indicator targets set?** | No | Need to define specific metrics for defining community density, diversity, and richness |
| **Status indicator targets met?** | Unknown | |

## Description of Most Recent Data Sets for Status Indicators:

### Surface Sediment Concentrations of COPCs

Over the past four years, sediment assessments have been completed on both the Minnesota and Wisconsin sides of the AOC, resulting in the ability to characterize 78% by area of AOC surface sediments (at the preliminary assessment level).

Consensus-based sediment quality guidelines (CBSQGs) have been adopted by Wisconsin and Minnesota for use in the St. Louis River to define the potential for toxic effects to benthic macroinvertebrate communities based on sediment contaminant concentrations. CBSQGs for both states are based on the work of MacDonald et al. (2000) in which a threshold effect concentration (TEC) defines the level at which toxic effects to benthos are unlikely and a probable effect concentration (PEC) defines the level at which toxic effects to benthos are probable. This TEC and PEC terminology is used in Wisconsin (WDNR 2003), while Minnesota defines the two levels using “sediment quality targets” or SQT1 and SQT2 (Crane and Hennes 2007). This approach does not include concerns for bioaccumulation.

### Macroinvertebrate Community Multi-metrics

#### Impacted Sites in the AOC

The Phase IV GIS-based Sediment Quality Database for the St. Louis River includes benthic community summary data of many types; raw data are not included in the database. Macroinvertebrate data in the Phase IV database are generally older (late 1990s). Some analyses of this data have been done to

determine those physical habitat characteristics that contribute variability to benthos communities (Breneman 2000).

In 2005 and 2006, over 160 sites were sampled around the St. Louis River with the objective of testing methods for finding aquatic invasive species. These samples were taken by ponar and petite ponar, while another 11 sites were sampled with survey nets, bottom sled and colonization plates. Samples were identified to lowest possible taxa (Trebitz et al, 2010). These data have not yet been analyzed for benthic community health matrices.

In 2010, benthic macroinvertebrate communities were sampled by Natural Resources Research Institute (NRRI) researchers for the 40th Avenue West pilot project (Brady et al. 2010). A total of 20 locations within the project area were sampled. Five upstream reference areas were also established, as described in the next section. Sample point locations were selected by U.S. Fish and Wildlife Service, NRRI, and AOC Habitat Workgroup members. Benthic macroinvertebrate samples were collected in duplicate at all locations using a petite ponar dredge sampler. Identification of macroinvertebates to the phylum or class level was conducted. The class Insecta was identified to the family level.

In 2011, benthic macroinvertebrate communities were sampled by NRRI researchers for the 21st Ave. West pilot project (in progress). A total of 35 locations within the project area were sampled and compared to both the 40th Ave. West project area and five upstream reference areas. Sample point locations were selected by the USFWS, NRRI, and AOC Habitat Workgroup members. Benthic macroinvertebrate samples were collected in triplicate at all locations using a Petite Ponar dredge sampler. Identification of macroinvertebrates to the phylum or class level was conducted. The class Insecta were reported to the family level.

## AOC Least-impacted Sites

Data for benthic community structure at least-impacted sites within the AOC have not been established. Data on least-impacted sites would be used as “reference” for remediation study and restoration goals. There most likely are no “non-impacted” sites within the AOC; therefore, the comparison would be to “least-impacted” sites.

A reference site was established for the Hog Island/Newton Creek remediation project that could have applicability for comparison to other impacted sites, depending on similarity of characteristics of the reference site and impacted site in question. Other remediation studies have sampled reference sites for similar purposes (Interlake reference site upstream of Oliver Bridge).

A recent field effort conducted in 2010 by NRRI researchers as part of the 40th Avenue West Complex pilot project established five reference areas near Spirit Lake/Clough Island (Brady et al. 2010). The reference areas were selected to include two low-energy sites and three high-energy sites, based on wind fetch modeling conducted by Tom Hollenhorst at U.S. EPA. Benthic macroinvertebrate samples were collected in triplicate at two locations within each reference area using a petite ponar dredge sampler. Identification of macroinvertebates to the phylum or class level was conducted. The class Insecta was identified to the family level.

# Current Conditions for Status Indicators:

## Surface Sediment Concentrations of COPCs

As of November 1, 2011, data from recent Minnesota and Wisconsin sediment assessment surveys were being compiled in a combined AOC database. Quality assurance/quality control has not been complete for all datasets. Results from recent survey efforts will be available in winter 2011/spring 2012. Sampling results have not yet been assessed.

# Macroinvertebrate Community Data as Compared to Least-impacted Sites of Similar Habitat in the AOC

## Impacted Sites in the AOC

Macroinvertebrate community data for impacted sites in the AOC have not been analyzed with respect to BUI removal. The Phase IV database does not include information on habitat types, sediment types, or water depth at any of these specific sampling locations; however, the database does include information on sediment types (% clay, % sand, etc.) near many of the locations.

Results of macroinvertebrate sampling conducted in 2010 for the 40$^{th}$ Avenue West pilot project are summarized in the Brady et al. report "40th Avenue West Remediation to Restoration Project: Biological Survey Results." An electronic database of project results was also created. Among the study findings are:

- The total number of taxa between the project area and reference areas was not significantly different
- Mean % of *Chironomidae* (Diptera) was significantly greater in the reference area, while non-insect invertebrates were significantly more abundant at the project area comparatively
- A significantly greater percent of collector-filterers was found in the reference area, though this did not represent a large percentage of the overall community
- The total number of "very-tolerant" taxa were significantly greater within the project area
- *Ephemeroptera, Plecoptera*, and *Tricoptera* (EPT) taxa per sample and mean number of total taxa per sample were significantly greater in the reference area

## AOC Reference Sites

Reference site data are limited to results from particular remediation projects (the Hog Island/Newton Creek remediation project reference location, reference locations established for the 40$^{th}$ Avenue West pilot project, reference sites utilized for Interlake project). These data have not been compiled yet with the existing benthic data in the Phase IV GIS-based Sediment Quality database.

Data for the five individual reference areas established for the 40$^{th}$ Avenue West pilot project are summarized in Brady et al. 2010; data for the five reference areas are averaged within the report for comparison to project area results (described in the preceding section). Individual reference area results are available in the attachments to the report and in an electronic database established for the project.

## Information Gaps: Degradation of Benthos

- Benthic communities at existing AOC reference sites should be evaluated for use in comparison with impacted sites in the AOC. Information on the benthic community at least-impacted sites AOC-wide needs to be established. Habitat type must be considered for selection of appropriate least-impacted sites. Information on habitat type must be kept for all studies to facilitate appropriate comparisons between least-impacted sites and project site data.
- A benthic community database should be compiled for use within the AOC while a sediment database is being updated.
- The specific metrics to be used to define "community richness, density, and diversity" need to be determined.

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions included in this list include those selected to address data and information gaps, monitoring, and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table BUI 4 - 6 followed by a supplementary table key.

## Table BUI 4 - 6: Sequential List of Prioritized Actions: Degradation of Benthos.

| **Project Sequence** | **Project Title** | **Description of Action and Rationale** | **Location** Indicate waterbody, site name, or other geographic reference | **Type of Action** Enter number(s) from table key, separated by commas | **BUI(s) Involved** Enter number(s) from table key, separated by commas | **Indicator(s) Involved** | **Source or Stressor Involved** | **Start Date** | **Duration** Enter "Ongoing" for actions that will occur continue over time | **Estimated cost** See key above and enter appropriate "$" level based on best professional judgement | **Permitting requirements** | **Important resources needed (landowner, project leader, etc)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Reference Benthic Community Study | Sample Benthic Community at several microhabitats within SLR areas described as "reference" or least-impacted by land use and FQI (NRRI-GLEI 2008). Transect from shallow to deeper water. Analyze macroinvertebrate data to determine most appropriate multimetrics to define community richness, density, and diversity. | Sites chosen within AOC | 2 | 4 | Benthic community data; multimetrics to describe least-impacted areas | none; data acquisition | May 2012 | 1 year for Phase I | $-$$ for each of several phases | none | Existing contract, capacity funding, staff time to develop QAPP for Phase I; funding for further phases |
| 2 | Benthic Database | Compile existing benthos study data into database we can use to describe benthos in AOC | Lower St. Louis River data | 3 | 4 | Benthic community data for use in multimetrics for AOC tracking | none; data compilation | March 2012 | 6 months to build; ongoing | $ | none | Staff time, expert assistance |
| 3 | Sheltered Bay/Shallow Wetland - Radio Tower Bay, Habitat Worksheet 2-11 | Remove sawmill debris, restore sheltered bay habitat | Radio Tower Bay (Coffee Ground Flats), Upper Estuary | 6, 7 | 4, 9 | Multimetrics after restoration | Altered Habitat, Altered substrate | February 2012 | 3 years | $$$ | | Funding for Phase II |
| 4 | Clough Island Wetlands; Habitat Worksheet 2-5 | Restore lost emergent/submergent vegetation bed habitat; control erosion | Wetlands surrounding Clough Island, Upper Estuary | 6 | 4, 9, 6 | Multimetrics after restoration | Altered habitat | | 2 to 6 years | $$$ | USACoE, WDNR | Project leader |
| 5 | Grassy Point; Habitat Worksheet | Remove sawmill debris, restore sheltered bay habitat | sheltered bay at Grassy Point, Upper estuary | 6, 7 | 4, 9 | Multimetrics after restoration | Altered Habitat, Altered substrate | | 3 years | $$$ | | Funding |
| 6 | Upper Estuary Flats - Spirit Lake; Habitat Worksheet 2-6 | Restore lost emergent/submergent vegetation bed habitat; control erosion | Spirit Island, Upper Estuary | 6 | 4, 9 | Multimetrics after restoration | Altered habitat | | 3 to 6 years | $$$ | USACoE, MDNR, WDNR | Funds, project leader |
| 7 | Sheltered Bay/Shallow Wetland - Perch Lake; Habitat Worksheet 2-12 | Re-connect wetland to estuary | Perch Lake, Upper estuary | 2, 7 | 4, 9 | Multimetrics after restoration | Altered habitat (hydrologic connection) | | 1 year | $$$ | USACoE, MNDOT | Funds, project leader |
| 8 | Sheltered Bay - 40th Ave West Complex | Remediate contaminated sediments, restore lost emergent/submergent vegetation habitat | Hibbard Power Plant Bay, bays surrounding Erie Pier, Coffee Ground Flats, St. Louis Bay | 8, 6, 7 | 4, 9 | Sediment concentrations; multimetrics | contaminated sediment, altered habitat | | 3 to 5 years | $$$$$+ | USACoE, MDNR | Funds, project leader |
| 9 | Sheltered Bay - 21st Ave W | Remediate contaminated sediments, restore lost emergent/submergent vegetation habitat | Bay east of WLSSE, St. Louis Bay | 8, 6, 7 | 4, 9 | Sediment concentrations; multimetrics | contaminated sediment, altered habitat | | | | | |
| 10 | Sheltered Bay/Shallow Wetland - Spirit Lake; Habitat Worksheet 2-7 | Remediate contaminated sediments, restore lost emergent/submergent vegetation habitat | Spirit Lake Flats, Upper Estuary | 8, 6 | 4, 9 | Sediment concentrations; multimetrics | sediment contamination, habitat alteration | | 10 years | $$$$$ | USX Superfund process, | Project lead |

## Key for Sequential List of Prioritized Actions

Reference numbers for "Type of Action":

1. Monitoring program development
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = <$5M

Reference numbers for BUIs:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Degradation of Benthos

The timeline for removal of this BUI is tied to sediment remediation and habitat restoration projects. Two of the major sediment remediation sites have been completed within the AOC (SLIDRT, Hog Island). Restoration efforts at Hog Island have included buffer zone revegetation and control of wetland invasive species among other projects. WDNR monitoring of the benthic community has shown that at least 6 years are necessary for benthic community return if no benthic habitat restoration is done in conjunction with remediation. If no effort is made to combine restoration needs with remediation projects, invasive species can also take hold. which will ultimately mean costs for control of invasive species.

Costs for each upcoming project cannot be projected at this time by this BUI Team. Decisions on remediation and restoration still depend, at this time, on an AOC team looking at all sediment data (which is still in finalization), and making decisions on which sites need to be remediated, which remediated and then restored, and which simply restored.

In most cases, projects that will restore aquatic wildlife habitat will also improve the benthic community.

## Ongoing Monitoring Needs: Degradation of Benthos

There will be ongoing monitoring needs as each remediation and/or restoration is completed. Conceptually, if the habitat is restored (vegetation and bottom substrate), the benthic community will return. Natural return of the benthic community to a point that is relative to St. Louis River reference sites could take as much as 5 to 10 years.

## Future Issues or Concerns: Degradation of Benthos

The BUI Team concerns on contaminated sediments and benthos included the benthic community role in bioaccumulation (as relates to Fish Consumption Advisories especially).

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# BUI 5 Blueprint: Restrictions on Dredging.

This section contains the BUI Blueprint for Restrictions on Dredging. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below, followed by a Summary Statement for this BUI developed by the Team.

## BUI Team Membership

- Tracey Ledder, WDNR
- Ruth Oppedahl, UW-Extension
- Marc Hershfield, MPCA
- Joseph Graham, WDNR
- Guy Partch, Barr Engineering
- David Bolgrien, EPA MED
- Todd Fryzek, SEH
- Gene Clark, WI Sea Grant
- Jim Sharrow, Duluth Seaway Port Authority
- J. Howard McCormick, SLRA Habitat Work Group
- Lisa Neitzal, SLRA Habitat Work Group

## BUI Team Summary Statement

The established dredged materials procedures for testing and placement at Erie Pier are not considered restrictions. Restrictions are defined as special handling requirements above what is the normal procedure, due to contamination in sediments. Legacy sediment contamination may cause a "restriction" on dredging, and therefore increased costs to private and municipal owners of slips and marinas in dredging of those areas and/or disposal of dredged materials.

The definition of navigation includes all the movement of a boat of any size in channels, marinas, slips, ramps, etc. Therefore, legacy contamination of sediments in these locations as well as the federal navigational channel make up the Restriction on Dredging.

For this BUI there is a real need to be able to use all sediment data. Recent sediment sampling results need to be finalized to identify "hot spots" on a map. Further actions cannot be defined without the knowledge of where sediment contamination is causing a restriction on dredging. The USACE navigational channel sediment sampling data should also be utilized with the sediment database for more complete coverage of the AOC. The process of interpreting data and mapping "hot spots" will likely involve state staff and multiple sediment sampling events.

It must be noted that restrictions on dredging and disposal of dredged materials due to legacy contamination of sediment may also place an additional economic burden on stakeholders (private owners, municipalities, and others) interested in waterfront redevelopment projects.

## Rationale for Listing: Restrictions on Dredging

**Stage I RAP Rationale for Listing**

The BUI, Restrictions on Dredging, can be clearly identified as impaired in the St. Louis River AOC. Sediments in many parts of the AOC exceed guidelines developed by regulatory agencies to characterize in-place sediments and contain a variety of toxic, bio-accumulative contaminants that have been shown to cause adverse effects to aquatic and terrestrial organisms. Serious economic and social consequences are also imposed upon some resource users through special dredging requirements and obligations for long-term sediment containment.

The IJC listing criteria indicate that when contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities, the beneficial use is considered impaired. Sediments are pollutant sinks and reservoirs of contaminants that can be mobilized and bioaccumulated by aquatic organisms. Within the St. Louis River AOC, sediment bulk chemistry data were available only for the navigation channels, and laboratory bioassays and in-field biological studies were available only for a limited number of sites. Comprehensive sampling had not been performed throughout the AOC at the time of Stage I RAP development. However, the available data confirmed the presence of elevated levels of contaminants within the sediments of the AOC. Data for the AOC indicated that contaminants present included nutrients and conventional pollutants (BOD, oil and grease, ammonia-nitrogen, phosphorus), metals and cyanide, and synthetic or xenobiotic organic compounds (PCBs, PAHs). Five distinct locales within the AOC were identified as having clearly elevated levels of contaminants:

- St. Louis River adjacent to the settling pond and unnamed creek from the U.S. Steel site in Duluth;
- Stryker Embayment, Hallet Boat Slip, and an area in the river at the foot of the 54$^{th}$ Avenue Peninsula (Interlake/Duluth Tar site) in West Duluth;
- Newton Creek and Hog Island Inlet of Superior Bay;
- The embayment of St. Louis Bay into which effluent from the WLSSD wastewater treatment plant is discharged; and
- The wetlands of Crawford Creek (a tributary of the Nemadji River) associated with the Koppers Company wood treatment facility in Superior.

Most of these sites (with the exception of WLSSD) were known to be contaminated by PAHs originating from coal tars, petroleum, and creosote. Metals, mercury (from historical usage by the paper industry above Fond Du Lac, use by U.S. Steel Duluth Works, and discharges from WLSSD), and PCBs (from atmospheric emissions, wastewater effluent, and various industrial activities) were also found at several of these sites. Data described in the Stage I RAP indicated elevated concentrations of mercury, PCBs, dioxins, and PAHs:

## Mercury

- Levels of mercury associated with discernible impacts on benthic organisms (> 200 µg/kg according to guidelines of the Ontario Ministry of the Environment cited in the Stage I RAP) were known to exist in a number of sites within the AOC, including the Interlake site, sites adjacent to WLSSD and the Superior Midwest Energy Terminal, and in predominantly off-channel areas of Superior Bay. These levels also exceed dredge disposal guidelines cited in the Stage I RAP, which classify mercury concentrations greater than 100 µg /kg as polluted.
- Mercury in the St. Louis River was studied by Glass et al. (1990). The study identified the following:
    - Historical usage of mercury by the paper industry above the community of Fond du Lac contributed to contamination of the lower St. Louis River.
    - The use of mercury for iron analysis by a steel mill (U.S. Steel Duluth Works Mill) may have contributed to the sediment accumulation of mercury.
    - The highest sediment concentrations of mercury were detected near the WLSSD discharge outfall and ranged from 1,000 to 5000 µg /kg.
    - Mercury in sediments below Thompson Dam were the second highest in concentration ranging from 861 to 962 µg /kg.

## PCBs

- Sampled areas of the St. Louis River had sediment PCB concentrations ranging from non-detectable to 2,000 µg /kg.
- MPCA sampling showed sediment PCB concentrations of 280 µg kg and 2,500 µg /kg at two sites adjacent to WLSSD. and a concentration of 240 µg /kg at the Scanlon Dam (Janisch 1991). Concentrations greater than 70 µg /kg are considered significantly polluted, according to Ontario Ministry of Environment guidelines cited in the Stage 1 RAP.

## Dioxin

- Sediment dioxin concentrations were highest near WLSSD's outfall, with concentrations ranging from 10.5 pg/g to 13.7 pg/g. Concentrations greater than 1.0 pg/g were considered polluted. Dioxins were also detected in sediments at Fond du Lac, the Thomson Dam, and the Knife Falls Dam, at concentrations of 1.9 to 3.4 pg/g (UMD 1990).

## PAHs

- Sediment PAH concentrations at the Interlake Steel/Duluth Tar and Chemical Company Superfund Site ranged from 27,000 µg /kg to 6,090,000 µg /kg. Concentrations greater than 2,000 µg /kg represent significantly polluted sediments according to the Ontario Ministry of Environment Guidelines cited in the Stage I RAP.
- Sediment PAH concentrations at Newton Creek ranged up to 4,000 µg /kg, and concentrations at Hog Island Inlet were as high as 80,000 µg /kg.
- Sampling by the Corps of Engineers in shipping channel sediments showed PAH levels up to 2,800 µg /kg.

The 1995 RAP progress report indicated that surficial sediments at a site in the St. Louis River near the U.S. Steel Superfund site had phenanthrene concentrations more than 250 times greater than EPA criteria, acenapthene levels more than 100 times greater, and fluoranthene concentrations more than 50 times greater than EPA criteria. Eight of eleven cores collected in this area showed PAH concentrations in excess of EPA criteria. Metals analyses showed extremely elevated concentrations of lead, cadmium, copper, chromium, zinc, and mercury at most of the sampling sites near the U.S. Steel Superfund site.

The 1995 RAP progress report identified petroleum and/or petroleum products as the primary cause of sediment contamination in the Newton Creek system, with the Murphy Oil refinery, bulk storage facilities south of Newton Creek as 21st Street, railroad facilities and operations, and historical releases from shipping and oil transfer activities at the Lakehead Dock identified as the probable sources.

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 5 - 1. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

### Table BUI 5 - 1: Timeline of Actions: Restrictions on Dredging.

| Year | Action |
|---|---|
| 1979 | Erie Pier CDF created, subsequently expanded in 1989 and 1990 |
| ... | |
| 1992 | BUI Listed in Stage I Remedial Action Plan |
| 1993 | |
| 1994 | |
| 1995 | |
| 1996 | |
| ... | |
| 1998 | |
| 1999 | Last expansion of Erie Pier completed |
| 2000 | |
| 2001 | |
| 2002 | |
| 2003 | |
| 2004 | |
| 2005 | Sediment cleanup at Hog Island/Newton Creek complete |
| 2006 | |
| 2007 | Erie Pier Management Plan completed by Metropolitan Interstate Council |
| 2008 | |
| 2009 | |

| Year | Action |
|---|---|
| 2010 | Erie Pier transformation completed to processing and reuse facility |
| 2011 | Stryker Bay cleanup completed |
| 2011 | Erie Pier Management Plan updated with new data |
| 2012 | MPCA to develop permanent restriction for Slip 6 & Slip 7 |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 5 - 1) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Restrictions on Dredging

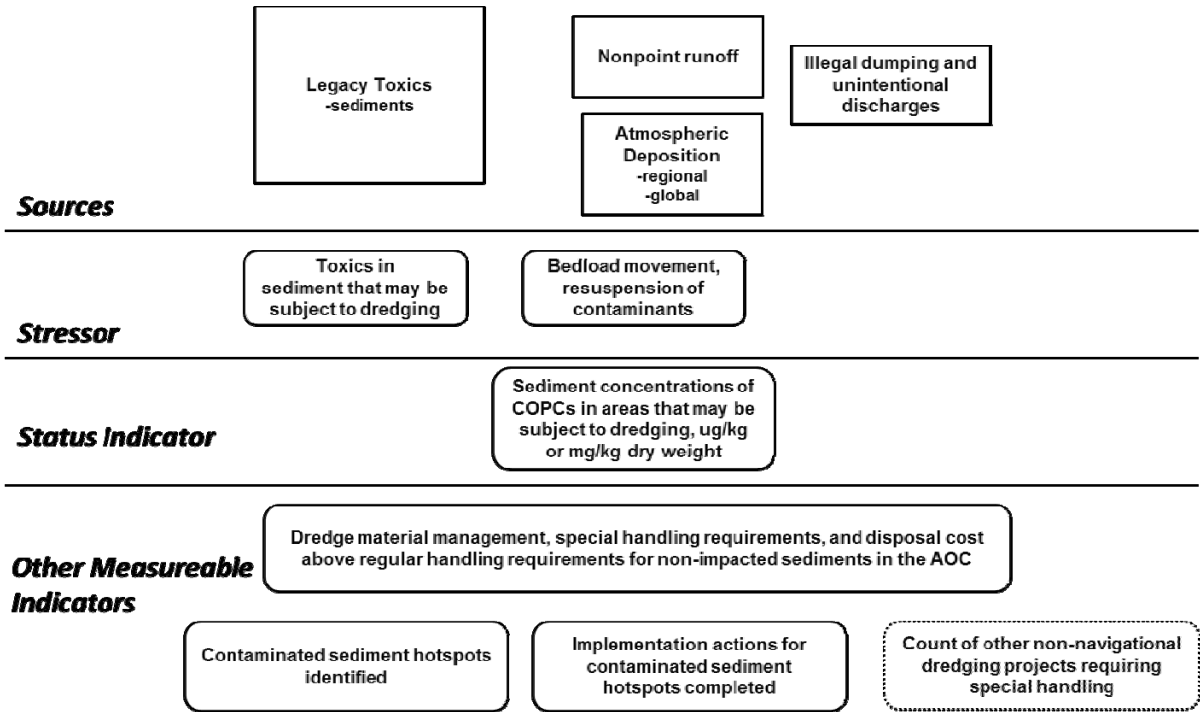


**Figure BUI 5 - 1: Source Stressor Model for the BUI Restrictions on Dredging.**

Table BUI 5 - 2 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing, and may be local or persist beyond the boundaries of the SLRAOC.

### Table BUI 5 - 2: Description of Source Types.

| Source | Description |
|---|---|
| **Legacy Toxics in Sediments** | Historical discharges of toxics[1] to the St. Louis River that occurred from municipal and industrial operations |
| **Atmospheric Deposition** | Deposition from local, regional and global-scale atmospheric transport of air emissions |
| **NonpointRunoff (Urban and Upstream** | Runoff from non-regulated areas within the AOC |
| | Contaminated water and sediment transported into the AOC from areas upstream of the AOC boundary, includes sedimentation |
| **Illegal dumping and unintentional discharges** | Non-permitted activities that may result in contaminated sediments in areas that may require dredging |

[1]Specific Chemicals of Potential Concern (COPCs) will be identified through analysis of data from historic and recent sediment assessments conducted throughout the AOC.

## Description of Stressors:

The presence of toxic substances in the sediments of the AOC from historical industrial and municipal discharges, industrial activities, and many other potential sources restrict this use. Contamination present from activities that occurred in the AOC prior to current regulations is understood to be the issue for this BUI. Current sources of toxic substances are regulated and will be controllable in the future.

## Measureable Indicators: Restrictions on Dredging

The BUI Team has identified indicators of stress that can be measured to assess the status of BUI. These qualitative and quantitative metrics provide the basis for measuring the progress towards delisting a BUI. The status indicators and other measurable indicators for this BUI are presented in Tables BUI 5 - 3 and BUI 5 - 4, respectively. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily imperative information.

### Table BUI 5 - 3: Status Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Sediment concentrations of COPCs[1] in areas that may be subject to dredging** | µg /kg or mg/kg dry weight | COPC-specific SQT2 (MN) or PEC (WI) value (Crane and Hennes 2007; WNDR 2003) for beneficial reuse consideration; Soil Reference Values (MN) or Soil Cleanup Standards (WI) for material deposited on land without further controls |

[1]Specific Chemicals of Potential Concern (COPCs) will be identified through analysis of data from historic and recent sediment assessments conducted throughout the AOC.

Note: For purposes of this BUI, chemicals of concern should be those regularly tested for purposes of evaluating reuse and disposal opportunities.

### Table BUI 5 - 4: Other Measurable Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Dredge material management and disposal cost above regular handling requirements for non-impacted sediment in other areas of the AOC** | U.S. dollars | Zero |
| **Special handling requirements for routine navigational dredging** | Cubic yards of dredged material disposed at landfills or other special handling | Zero |
| **Contaminated sediment hotspots in the AOC identified** | Hotspot defined as locations where surface sediment concentrations are greater than COPC-specific SQT2 (MN) or PEC (WI)[2] | Yes |
| **Implementation actions for contaminated sediment hotspots completed** | % of prioritized hotspots | 100% |

Note: The SAG suggested consideration of the total volume of contaminated sediment in the AOC as a surrogate for cost (or to be used to calculate cost). However, the SAG felt the BUI team was best-suited

to select appropriate indicators for this BUI. The BUI team felt that this could be a future potential progress tracking tool, once a complete set of data and a sediment database tool are complete.

## Final Delisting Target: Restrictions on Dredging

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (reference), is:

> *All contaminated sediment hotspots within the AOC have been identified and implementation actions to remediate contaminated sites have been completed. There are no special handling requirements of material from routine navigational dredging due to contamination originating from controllable sources within the AOC.*

## Current Conditions: Restrictions on Dredging

The status of assessment of this BUI is reflected in Table BUI 5 - 5 and is based on the most recently available research and monitoring data compiled and reviewed for this BUI Blueprint.

**Table BUI 5 - 5: BUI Current Conditions Status Check.**

| Check | Yes/No/Unknown | Notes |
|---|---|---|
| **Data for status indicators available?** | Yes | Sediment database, MN/WI recent sampling, USACE channel data, Erie Pier data |
| **Data for status indicators assessed?** | No | Data have not been compiled for overall assessment |
| **Status indicator targets set?** | Yes | Regulatory process exists for dredging and material reuse |
| **Status indicator targets met?** | Unknown | |

## Description of Most Recent Data Sets for Status Indicators:

### Surface Sediment Concentrations of COPCs

Over the past four years, sediment assessments have been completed on both the Minnesota and Wisconsin sides of the AOC, resulting in the ability to characterize 78% by area of AOC surface sediments (at the preliminary assessment level).

Consensus-based sediment quality guidelines (CBSQGs) have been adopted by Wisconsin and Minnesota for use in the St. Louis River to define the potential for toxic effects to benthic macroinvertebrate communities based on sediment contaminant concentrations. CBSQGs for both states are based on the work of MacDonald et al. (2000), in which a threshold effect concentration (TEC) defines the level at which toxic effects to benthos are unlikely and a probable effect concentration (PEC) defines the level at which toxic effects to benthos are probable. This TEC and PEC terminology is used in Wisconsin (WDNR 2003), while Minnesota defines the two levels using “sediment quality targets” or SQT1 and SQT2 (Crane and Hennes 2007).

For both Minnesota and Wisconsin, consideration of the CBSQGs for dredging-related activities occurs for permits related to the dredging activity itself versus disposal of the dredge materials. In Minnesota,

permits for excavation of materials from beds of public waters are issued through the Minnesota DNR under Minnesota Statute 103G.245 “Work in Public Waters.” There is no specific reference to or requirement for compliance with the CBSQGs in the Minnesota permitting process. However, Subdivision 6 of the Work in Public Waters statute states: “A public waters work permit may not be issued under this section if the project does not conform to state, regional, and local water and related land resources management plans.” Per communication with Tom Hovey, Public Waters Hydrologist at MDNR, if it is known that sediments are contaminated above CBSGQs, a MDNR permit reviewer could require special project consideration or permitting conditions based on this language in the statute.

In Wisconsin, consideration of the CBSQGs occurs through the Dredging Operations General Permit (WPDES Permit No. WI-0046558-05-0). This permit applies to discharges associated with sediment dredging where contaminants are less than the PEC. WDNR may grant coverage under the general permit in instances where sediment contaminant concentrations are greater than the PEC if treatment of carriage and/or interstitial water is provided and pilot studies demonstrate compliance with applicable effluent limits (WDNR 2011).

This regulatory basis for beneficial reuse of dredged materials in Minnesota and Wisconsin is described in the Erie Pier Management Plan (2007). The plan was developed to address the short predicted lifespan of the Erie Pier confined disposal facility (CDF) for the Duluth-Superior Harbor through development of a dredged materials reuse program. Applicable soil standards for both Minnesota and Wisconsin are described in this document for consideration of appropriate disposal and beneficial reuse of dredge materials.

In Minnesota, dredged materials must be analyzed for a suite of defined parameters using specified analytical methods to determine the appropriate reuse. Three management levels are defined based on comparison of contaminant concentrations to Soil Reference Values (MPCA 20011):

- Level 1 dredged material is suitable for use or reuse on properties with a residential or recreational use category.
- Level 2 dredged material is suitable for use or reuse on properties with an industrial use category.
- Level 3 dredged material is characterized as having significant contamination that may be regulated under Resource Conservation and Recovery Act (RCRA) or the Toxic Substances Control Act (TSCA).

In Wisconsin, dredged materials are considered solid waste. However, many dredged material reuse projects can be exempted from solid waste regulatory requirements. Dredged materials must be sampled and analyzed for a suite of parameters using specified analytical methods and results compared to soil standards (WDNR 2004). Options for beneficial reuse of the dredged materials become limited if any of the specified parameters exceed soil standards.

## Current Conditions for Status Indicators:

### Erie Pier Dredged Material Processing and Reuse Facility (PRF)

Every year approximately 100,000 – 125,000 $yds^3$ of newly deposited sediment is dredged from the Duluth-Superior Harbor federally maintained navigation channels. The harbor is a naturally shallow harbor (averaging only 8 ft. deep) and requires annual maintenance dredging to deepen the shipping channels to depths varying from 20 to 32 feet. In the late 1970s, Erie Pier was built to be a disposal area for these sediments and was designed as a Confined Disposal Facility (CDF), which was one of several dozen built throughout the Great Lakes. This 89-acre facility is owned by the Duluth Seaway Port Authority (DSPA) and operated by the U.S. Army Corps of Engineers.

The Erie Pier facility was designed to last 10 years and store approximately 1 million cubic yards of navigation channel dredged material as a disposal facility. Erie Pier has since been redesigned to process and store dredged materials, making both granular and fine materials available for beneficial reuse. To date, over 2.8 million cubic yards has been deposited into the facility. Unlike many other Great Lakes CDFs that contain sediments that contain heavy metals, PCBs and other "legacy-type" materials, the dredged materials in Erie Pier are relatively uncontaminated. Much of the coarser material (mostly sand) has been successfully reused as construction material by local contractors. Some of the finer fraction of the processed materials have been reused as topsoil. Dredged materials have also been directly reused for beach nourishment and construction materials without occupying capacity at Erie Pier. The capacity of Erie Pier has been increased by raising the dikes above the original design.

Recognizing the potential for beneficial reuse of this material, testing of material to be dredged was performed each year from 1982 through 1995; after 1995 the testing was performed every four to five years to ensure the material that is placed into Erie Pier meets or exceeds "Tier II" material as defined by the State of Minnesota in its Soil Reference Values. This is the definition given to material that is suitable for industrial or recreational uses. In a few instances, material from private slips and areas adjacent to the federal navigation channel has been allowed to be deposited in Erie Pier if testing of that material shows that its meets the same criteria as material from the federal channel.

Material suitable for placement into Erie Pier is unloaded at the southeast corner of the facility. The dredged material is then hydraulically sorted by using recycled washwater from the interior settling ponds within Erie Pier. The coarse sediment fraction settles quickly and is stockpiled near the unloading area while the finer material is moved down a sluiceway by the water into the first of two settling basins.

Significant funds and effort since approximately 2006 have transformed Erie Pier from its initial configuration as a CDF to a Processing and Re-use Facility (PRF) to facilitate the beneficial reuse of dredged materials. The coarse fraction can be used right away, and the finer material is periodically removed from the settling basins, allowed to dewater naturally, and then retested to ensure it continues to meet the Tier II standards or better for the beneficial reuse of the material.

To date, this material has been successfully demonstrated to be useful for mine land reclamation, habitat restoration, and recreational area material (golf course topsoil). Other ports in the Great Lakes are looking at the Erie Pier PRF as a model for managing dredged material.

### Surface Sediment Concentrations of COPCs

There are several databases of sediment quality from the AOC, including the Phase IV GIS-based Sediment Database, a USACE database of navigation channel sediment data, and Erie Pier materials data. As of November 1, 2011, data from recent Minnesota and Wisconsin sediment assessment surveys was currently being compiled in a combined AOC database. Quality assurance/quality control has not been complete for all datasets. Results from recent survey efforts will be available in summer/fall 2012. Sampling results have not yet been assessed but are scheduled to be assessed by spring 2013.

## Information Gaps: Restrictions on Dredging

- Sediment data from recent AOC surveys must be analyzed with respect to appropriate CBSQGs, soil reference values (Minnesota), and soil standards (Wisconsin).
- The number of smaller privately owned projects requiring special handling for dredging or disposal because of contaminated sediment in recent years is unknown.

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions included in this list include those selected to address data and information gaps, monitoring, and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table BUI 5 - 6 followed by a supplementary table key.

## Table BUI 5 - 6: Sequential List of Prioritized Actions: Restrictions on Dredging.

| Project Sequence | Project Title | Description of Action and Rationale | Location Indicate waterbody, site name, or other geographic reference | Type of Action Enter number(s) from table key, separated by commas | BUI(s) Involved Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration Enter "Ongoing" for actions that will occur continue over time | Estimated cost See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Update and maintain an AOC Sediment database | Phase IV GIS-Based Sediment Quality database will be updated with improved queries. WI and MN staff send states' data to NOAA Great Lakes database. AOC data can then be pulled from NOAA to the SLR AOC Database. | AOC-wide sediment data | 3 | most | sediment contaminant concentration data | several | | ongoing | Staff time needed. | | State data, federal data (including USACE navigation channel data), other AOC data collected and shared. |
| 2 | Data interpretation decisions | Interpreting the data--what is the process? How is it determined which sites require remediation ("red")? | AOC-wide sediment data | 4 | most | sediment contaminant concentration data | several | | | Initial screening is not simple. Do not underestimate cost. | | MN/WI Sediment Team (costs, specifics on sites, etc.) |
| 3 | Assess sediment data | Create map of sites known to require remediation, which present a restriction on dredging. | AOC-wide sediment data | 4, 5 | most | sediment contaminant concentration data | several | | ongoing | Staff time needed. | | Cooperation of states and partners in assessment |
| 4 | Move to data system | States move to create a dynamic data system for AOC which would allow ease of updates and tracking of progress | AOC-wide sediment data | 3,4 | most | sediment contaminant concentration data | several | | | | | |
| 5 | Implement remediation | Determine which sites should be remediated, continue site study and move to site remediation design and implementation | site specific work within the AOC | 8 | most | sediment contaminant concentration data | several | | | funding for remediation | | |

## Key for Sequential List of Prioritized Actions

Reference numbers for "Type of Action":

1. Monitoring program development
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = <$5M

Reference numbers for BUIs:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Restrictions on Dredging

Timeline for removal of this BUI is tied to sediment remediation projects. Two of the major sediment remediation sites have been completed within the AOC (SLIDRT, Hog Island). Costs for each upcoming project cannot be projected at this time by this BUI Team. Decisions on remediation and restoration still depend, at this time, on an AOC team looking at all sediment data (which is still in finalization), and making decisions on what sites need to be remediated. Several slips are known to contain contaminated sediments that will require special handling considerations.

## Ongoing Monitoring Needs: Restrictions on Dredging

As a sediment database and data system for the St. Louis River AOC are completed, there will be continuing need to update information on sediments within the AOC, as well as needs to sample sediments for dredging and beneficial reuse of that material according to existing state regulations.

## Future Issues or Concerns: Restrictions on Dredging

There is continual need for reuse of uncontaminated dredge materials to sustain operations at the Erie Pier facility. If this facility cannot be managed in a sustainable way and comes to full capacity, other disposal options (such as open-water disposal or construction of a new confined disposal facility) will need to be investigated. Such options could further alter the very habitat that partners are trying to restore. The BUI Team agreed that consideration of the potential for reuse of dredge materials should be included in every AOC project. Outreach to other regional projects should be continual to promote beneficial reuse.

## References: Restrictions on Dredging

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# BUI 6 Blueprint: Excessive Loading of Nutrients and Sediment

This section contains the BUI Blueprint for Excessive Loading of Nutrients and Sediment. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below, followed by a Summary Statement for this BUI developed by the Team.

**Stage I RAP Rationale for Listing**

Prior to the improvements in wastewater treatment in the late 1970s in this area, water quality and biological investigations characterized the St. Louis River Estuary as eutrophic. At that time, the Western Lake Superior Sanitary District (WLSSD) treatment plant was built and the Superior wastewater treatment plant was upgraded. Since then many indicators of trophic status have shown improvements. For instance, concentrations of total phosphorus, ammonia, and organic nitrogen have decreased in the St. Louis Bay. The loading of phosphorus to the estuary from point sources has been reduced substantially. Further work is needed to ascertain the effects of nonpoint source loadings to the system and to Lake Superior. Despite the reductions in point source loadings, phosphorus concentrations in the estuary remain at levels where eutrophic conditions might be expected. However, algal biomass has been lower than would be expected, given these high phosphorus concentrations. Chlorophyll *a* concentrations measured in the estuary have been similar to levels found in mesotrophic or oligotrophic waters. Several investigators have proposed that reduced light penetration caused by turbidity and color may be a limiting factor for algal growth in the estuary. Although persistent water quality problems associated with eutrophication are not currently observed in the estuary, the high levels of nutrients and sediments being delivered to Lake Superior are an important concern. Therefore, the RAP will use a modification of the IJC eutrophication criterion to reflect local conditions

## BUI Team Membership

- Jane Anklam, West Wisconsin Land Trust
- Rich Axler, UMD - NRRI
- Brent Bellinger, USEPA Mid-Continent Ecology Division
- Diane Desotelle, MPCA
- Joe Graham, WDNR
- Kari Hedin, Fond du Lac Band of Lake Superior Chippewa
- Marc Hershfield, MPCA
- Joel Hoffman, USEPA Mid-Continent Ecology Division
- Chris Kleist, City of Duluth
- Diane Nelson, City of Superior
- Christine Ostern, Douglas County
- Tim Tuominen, WLSSD

## BUI Team Summary Statement

The team was tasked with three main items: 1) determine the current status of water quality within the AOC; 2) define what needs to be done to meet sediment and nutrient levels based on implications related to listing this as a BUI; and 3) determine what status indicators are needed to demonstrate that requirements are met to remove this BUI from the AOC. Consensus from the team was that overall water quality is steadily progressing, but that there is still room for improvement.

Delisting activities are focused on controlling excessive nutrient and sediment loading based on reasons for listing this as a BUI when the AOC was designated, and as a means to enhance water quality in the AOC and the waters of Western Lake Superior.

In the past two decades a tremendous number of water quality improvements have been made; however, some are more easily quantified than others. Many area groups have comprehensive outreach and education programs; these may certainly have a positive impact on water quality within the AOC, but assigning a numerical value to them is virtually impossible.

The monitoring data available indicate that certain water quality parameters are recovering, but information gaps leave the team unable to state with a level of confidence that there have been measurable improvements in the overall water quality of the AOC. A long-term and comprehensive monitoring plan must be in place before removal targets can be reached.

## Rationale for Listing: Excessive Loading of Sediment and Nutrients

When there are persistent water quality problems (e.g., dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity) attributed to cultural eutrophication, the IJC criteria consider the beneficial use impaired. The Stage I RAP indicated that a literal interpretation of this criterion seems to show the use is not impaired. However, because high levels of nutrients and sediments being delivered to Lake Superior presented a concern, the Stage I RAP used a modification of the eutrophication criterion to reflect local conditions. The modified criterion stated, "high nutrient and sediment levels in the St. Louis River Estuary lead to excessive loadings to Lake Superior, although these high nutrient levels do not seem to be expressed as eutrophication in the Area of Concern."

Prior to the start-up of the WLSSD in 1978, the Duluth-Superior Harbor had been characterized as eutrophic, with frequent violations of the dissolved oxygen standard resulting in numerous fish kills. After the WLSSD commenced operations, there were significant improvements in dissolved oxygen from the decrease in biochemical oxygen demand (BOD) loadings, as well as decreases in average concentrations of total phosphorus, total ammonia, and organic nitrogen. However, loadings to Lake Superior were identified as a concern. The information presented in the Stage I RAP in support of listing this use as impaired is summarized below.

Total phosphorus concentrations (summer yearly average) from 1973 to 1990 for three locations on the St. Louis River indicated a downward trend in concentration over time. Concentrations of total phosphorus at the three locations ranged from 50 µg /l to 150 µg/l (McCollor 1990).

- The highest values for algal biomass and productivity in Lake Superior had been reported at the extreme western arm of Lake Superior, though chlorophyll *a* levels in the lake and estuary were still considered in the oligotrophic range at less than 10 µg /l (El-Sharrawi and Munnawar 1978, Kwiatowski 1980; Putnam and Olson 1961).
- Chlorophyll *a* levels in the estuary have been generally less than 12 µg /l based on studies in the 1970s and 1980s (U.S. EPA 1975, Maschwitz et al. 1976, Hargis 1983; Kingston et al. unpublished

data). Studies within the AOC suggested that nutrients in the estuary were not fully expressed as phytoplankton biomass, perhaps because of high turbidity (Hargis 1983, Kingston et al. 1987).

- Blue-green algae were occasionally prominent in the Duluth Harbor prior to construction of the WLSSD (Maschwitz et al. 1976). Algal blooms in the estuary have not been reported.
- High sediment loadings were identified as a concern not only because phosphorus adsorbs onto sediment, but also because of the cost of dredging the sediment to maintain the shipping channel. Nearly half of the material dredged from the Duluth-Superior Harbor was believed to have come from the Nemadji River, according to the 1995 RAP progress report.
- The Stage I RAP noted that the complexities of the estuary bathymetry and the flow of water between the estuary and Lake Superior made it difficult to evaluate eutrophication issues. The Stage I RAP also suggested that more intensive investigation was needed to assess the impacts of nutrients on the system.

Nutrient and suspended solids concentrations in Lake Superior within the AOC boundary are available from the Minnesota Pollution Control Agency's Milestone Monitoring Program for three dates in 1974 and 1975. For all samples, data were available from three dates (12 October 1974, 24 October 1974, 13 May 1975) for multiple (generally three) depths at each station. Mean concentrations of ammonia and ammonium ($NH_3/NH_4^+$), nitrate/nitrite ($NO_3/NO_2$), and total phosphorus (TP) and suspended solids (TSS) are given in Table BUI 6 - 1. Values shown are the means of the daily means (all depths averaged). Sampling locations are shown on Figure BUI 6 - 1.

**Table BUI 6 - 1: Mean concentrations of nutrients and suspended solids in Lake Superior for three dates in 1974/1975.**

| Station | Latitude | Longitude | $NH_3/NH_4^+$, µg N/L | $NO_3/NO_2$ µg N/L | TP, µg P/L | TSS, mg/L |
|---|---|---|---|---|---|---|
| **5** | 46.7233 | -92.0244 | 46.1 | 285.6 | 10.9 | 4.9 |
| **6** | 46.7331 | -92.0022 | 55.6 | 382.8 | 13.7 | 4.6 |
| **7** | 46.7725 | -92.0739 | 34.4 | 332.8 | 12.3 | 4.1 |
| **8** | 46.7853 | -92.0414 | 62.2 | 317.8 | 9.2 | 2.5 |

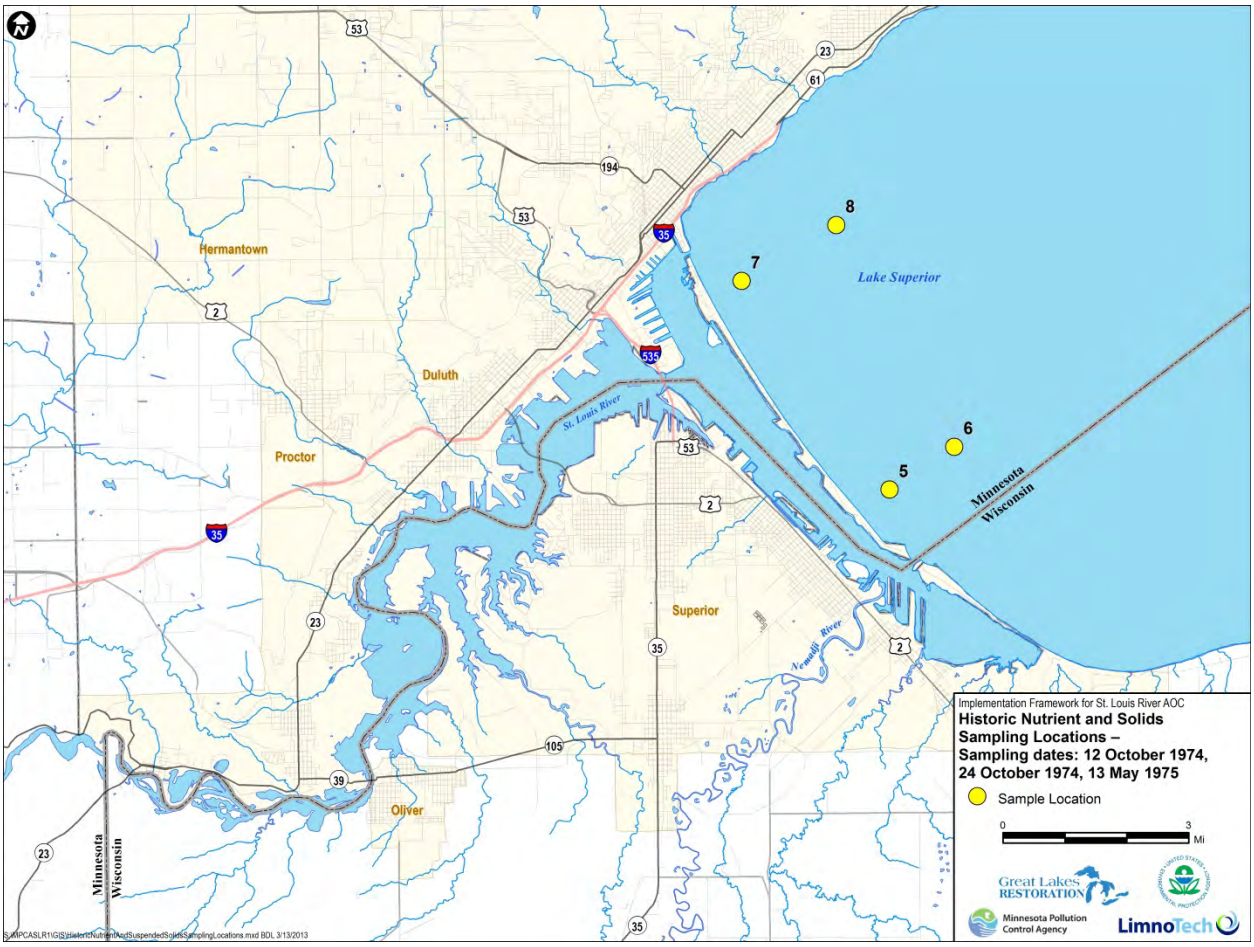


**Figure BUI 6 - 1: Historic Lake Superior Sampling Locations.**

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 6 - 2. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

**Table BUI 6 - 2: Timeline of Actions: Excessive Loading of Sediment and Nutrients.**

| Year | Action |
|---|---|
| 1975 | City of Superior sewer separation project, approx. 50% of combined sewers separated. Combined sewage treatment facilities constructed in areas not separated |
| 1976 | City of Superior Wastewater Treatment Plant was upgraded to provide secondary sewage treatment, solids removal went from 50% to >97% |
| 1978 | WLSSD begins operation |
| 1992 | BUIs listed in Stage I RAP |
| 1993 | |
| 1994 | |
| 1995 | St. Louis/Red River Stream bank Protection Area created through purchase of 5,000 acres, including 5 miles of St. Louis River shoreline |
| 1996 | Northern Minnesota Onsite Wastewater Technical Committee created to share technical expertise, conduct applied research to test system performance, improve regulations, and conduct outreach, education, and training in Northeastern MN |
| | City of Superior implements SAMP (Special Area Management Program) |
| 1997 | Village of Oliver connected to WLSSD |
| 1998 | |
| | City of Duluth forms stormwater utility to fund operation and maintenance of its' storm sewer system |
| | Installation of a new sewer line and diversion structure along E 2nd St was completed. This line eliminated most of the sewer bypasses along the E 2nd St corridor. |
| | Installation of two new storage facilities at Lift Station 5 and 7 provide storage for 450,000 and 900,000 gallons of sewage, respectively. |
| | Replacement of failing Faxon Creek interceptor and relocation of the sewer out of the floodplain eliminated a major source of inflow into the sanitary sewer in the City of Superior. |
| 1999 | Implementation of City of Superior Sanitary Sewer Collection System Cleaning and Inspection Program with a goal of cleaning and inspecting 20% of the sewers every year, or 100% every five years. |
| | Installation of an automation and control system allows operational staff to monitor and respond to potential overflow problems before they occur in the City of Superior. |
| 2000 | City of Superior implemented a GIS program for mapping the sanitary, combined and storm sewer lines provided much greater understanding of the system and improved response capabilities. |
| 2001 | |
| 2002 | Lift station 26 - overflow eliminated (Duluth) |

| Year | Action |
|---|---|
| 2002 | Columbus St and Arrowhead Rd overflow eliminated (Duluth) |
| 2002 | Regional Stormwater Protection Team (RSPT) formed to share technical expertise and combine outreach, education, and training activities among western Lake Superior stormwater permittees (MS4s) and other collaborators and cooperators, including researchers, NGOs, businesses, and extension educators. Now numbers 14 permittees and 11 other organizations. |
| 2002 | Lake Superior Beach Monitoring and Advisory program initiated by MPCA/EPA (www.MNBeaches.org) focused on informing the public about health risks due to disease causing microorganisms. Program is ongoing, but has been directed by MN Dept of Health since 2011. |
| 2002 | 29th E and 2nd St overflow (SSO) eliminated (Duluth) |
| | www.DuluthStreams.org project began as partnership between Duluth, NRRI-UMD, Sea Grant-UMD, MPCA, WLSSD, the Great Lakes Aquarium, and the Duluth Zoo to improve public environmental decision-making about water resource issues focusing on stormwater in Duluth. Has since expanded to include the broader western Superior Basin in scope and includes the WI South Shore to the Apostle Islands and the MN North Shore to Canada. Has co-evolved with the RSPT. Information can be found at (www.LakeSuperiorStreams.org). |
| 2002-2008 | Rain garden and rain barrel program at the City of Superior |
| | 42nd E and London road overflow (SSO) eliminated (Duluth) |
| 2003 | Lift station 17 - overflow eliminated (Duluth) |
| 2004 | Lift station 22 - overflow eliminated (Duluth) |
| | Start-up of the City of Superior Stormwater Flood Control Program in Superior, to help address basement backups during wet weather events, utilizing televising laterals, landscaping, back flow valves, removal of illicit gray water connections, etc. |
| 2005 | Fond du Lac Reservation begins water quality monitoring on two St. Louis River sites in the upper part of the AOC. |
| | Dodge Street lift station - overflow eliminated (Duluth) |
| | Gary New Duluth pump station - overflow eliminated (Duluth) |
| | Minnesota bans phosphorus fertilizer in the absence of a need as demonstrated by a certified soil analysis |
| | Potentially accelerated corrosion of steel piling infrastructure in the lower St. Louis River harbor reported by US Army Corps of Engineers. |
| | Remediation of Hog Island inlet and Newton Creek complete |
| | Installation of South Superior Wet Detention Basin |
| 2006 | Lift station 1 - overflow eliminated (Duluth) |
| | Lakeside interceptor - overflow eliminated (Duluth) |
| | 90 acres of Bluff Creek riparian land along Bluff Creek in the Town of Parkland protected via WWLT and WDNR |
| | Lift station 3 - overflow eliminated |
| | 14 MS4 permits issued in the Duluth Superior area under EPA/MPCA's Phase II Stormwater Program (details at http://www.lakesuperiorstreams.org/stormwater/rspt.html) |
| | Lift station 20 - overflow eliminated (Duluth) |
| | Endion pump station - overflow eliminated (Duluth) |
| 2007 | Miller Creek TMDL (study began in 2007); Sucker River TMDL |
| | Lake Superior Grazing Initiative begun – educational and technical assistance to encourage producers to implement rotational grazing – Wisconsin's Pri-Ru-Ta Resource Conservation and Development (RC&D) |

| Year | Action |
|---|---|
| | Program and Douglas County |
| | Lake Superior Conservation Reserve Enhancement Program begun – technical assistance and incentive program for landowners and producers to restore riparian buffers on their land - NRCS & Douglas County |
| | Faxon Creek Project, volunteers planted 719 native trees and shrubs on both sides of a 900-ft stream corridor to help stabilize the stream banks and restore the vegetative buffer |
| | Faxon Creek Bank Stabilization - mechanically graded approximately 60-foot section of bank to a 3:1 slope, dug a 2-3 foot wide trench just below the ordinary high water mark (OHM) and lined it with geotextile fabric and medium riprap |
| 2008 | 3 acres of "Airport Wetland" in City of Superior Donated to Superior School District for permanent protection and environmental education |
| | No-Till Drill program begun – educational, technical, and equipment rental program for conservation seeding pasture-land and grassland – Douglas County |
| | Nutrient Management program begun – educational and incentive program to encourage farmers to adopt and implement certified nutrient management plans on their land – Douglas County |
| | Aquatic Invasive Species (AIS) Program – educational, monitoring, and technical assistance – Douglas County |
| | GLRI funding approval for grant RFPs for AOC region restoration-related activities |
| 2009 | Proctor Interceptor - overflow eliminated (Duluth) |
| | Division D Manholes - overflow eliminated (Duluth) |
| | Courtland Str. Manholes - overflow eliminated (Duluth) |
| | Stormwater Utility Program with mitigation credits for stormwater BMPs begun – educational and regulatory - City of Superior |
| 2010 | GLRI USFWS grant to Douglas Co for habitat restoration in Lake Superior basin – some projects chosen within AOC boundary – USFWS & Douglas County |
| | Wisconsin Bans phosphorus fertilizers |
| | ~ 6 miles of the Upper Nemadji in Wisconsin permanently protected by Douglas County, State of Wisconsin, and NOAA including 3,995 acres of adjacent upland. |
| | Lake Superior National Estuarine Research Reserve (NERR) established |
| | RSPT baseline Stormwater survey performed |
| | Riparian Landowner Workshop – education about shoreline restoration and stormwater BMPs – City of Superior |
| | South Superior Phase II Project, which included the installation of separate storm sewers to redirect stormwater out of the combined sewer and into the wet detention pond, was completed. |
| | Installation of a wet detention basin and separated storm sewers in the Billings Park area was completed. |
| 2011 | Educational Program :Tree planting for stormwater velocity control, City of Superior and UW-Extension, Master Gardeners |
| | GLRI restoration related projects initiated (40th West and 21st West; Amity Creek and, Duluth Stream Corps |
| | St. Louis River TMDL |
| | NERR and USGS (Richard Kiesling) conduct preliminary research on nutrient enrichment and attached algae along the nutrient gradient from Oliver Bridge to Blatnik Bridge. Research into attached algae productivity and nutrient enrichment will continue in 2012. |

| Year | Action |
|---|---|
| 2009-2012 | Hog Island/Newton Creek Restoration Project – Hog Island site – 25 total acres of the following activities: invasive plant control; riparian restoration; aquatic habitat structures; emergent vegetation restoration; and submergent vegetation restoration – Douglas County |
| | Hog Island/Newton Creek Restoration Project – Newton Creek site – 15 total acres of the following activities: invasive plant control; and riparian restoration – Douglas County |
| | Hog Island/Newton Creek Restoration Project – Allouez Bay site – 27 total acres of the following activities: invasive plant control; emergent vegetation restoration; and wild rice restoration – Douglas County |
| | Hog Island/Newton Creek Restoration Project – Bluff Creek site – 2 total acres of the following activities: invasive plant control; and riparian restoration |
| | Hog Island/Newton Creek Restoration Project – Bear Creek site – 20 total acres of the following activity: wetland restoration |
| | Hog Island/Newton Creek Restoration Project – St. Louis River sites – 2 total acres of the following activity: invasive plant control; and emergent vegetation restoration – Douglas County |
| | Hog Island/Newton Creek Restoration Project – Wisconsin Point site – 5 total acres of the following activity: piping plover habitat restoration – Douglas County |
| 2010-2012 | Protection of ½ mile of Lake Superior shoreline on Wisconsin Point through conservancy easements – City of Superior, Douglas County, & USACE |
| Annual | Lake Superior Day – 2 educational programs (Superior and Duluth) about importance of enhancing and maintaining water quality of Lake Superior – Lake Superior Binational Forum |
| 2012 | Stormwater Overflow Tanks completed at Lake Avenue (Duluth) |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 6 - 2) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Excessive Loading of Sediment and Nutrients

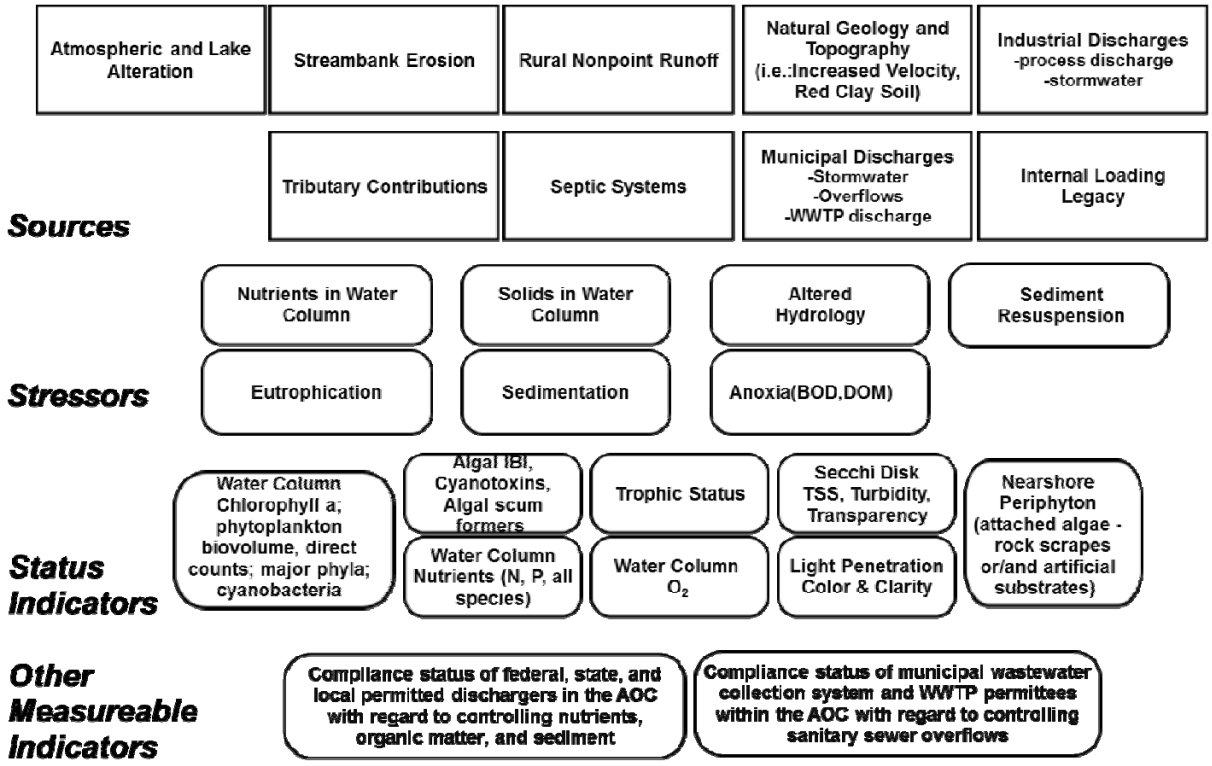


**Figure BUI 6 - 2: Source Stressor Model for the BUI Excessive Loading of Sediment and Nutrients.**

Table BUI 6 - 3 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing, and may be local or persist beyond the boundaries of the SLRAOC.

### Table BUI 6 - 3: Description of Source Types.

| Source | Description |
|---|---|
| **Industrial Discharges** | Permitted industrial water discharges within the AOC |
| | Permitted industrial stormwater discharges within the AOC |
| **Municipal Discharges** | Municipal WWTP discharges to the AOC |
| | Municipal overflows from WWTPs and their collection systems within the AOC |
| | Runoff from regulated (NPDES) municipal separate storm sewer systems (MS4s) and construction sites |
| **Rural Nonpoint Runoff** | Runoff from non-regulated rural areas, including silviculture, agriculture, animal waste, feedlots, small construction areas, etc. |
| **Septic Systems** | Septic systems serving homes and businesses in areas not served by a municipal wastewater treatment plant |
| **Stream Bank Erosion** | Erosion resulting from unstable banks, recreational uses, livestock crossing, shoreline practices, and excessive stormwater runoff |
| **Tributary Contributions** | Tributary loading of nutrients and sediment from areas within the AOC boundary. Loads derived from both watershed inputs and from in-stream channel and bank/bluff erosion caused by excess stormwater runoff. |
| **Internal Loading Legacy** | Re-suspension of nutrients within the St. Louis River, seasonal fluctuations and dredging, releasing legacy nutrients via seasonal anoxia. |
| **Atmospheric/Lake Interaction** | Atmospheric deposition of nutrients. Wind, waves and seiche driven resuspension. |
| **Natural Geology and Topography (i.e. Increased Velocity, Red Clay Soil)** | Impervious clay soils of the watershed interact with topography to allow for high velocity runoff to the tributaries of the estuary. This delivery of energy impacts detachment of the upland nutrients, bank slumping and down cutting of tributaries. |

## Description of Stressors:

Excess nutrients delivered to a waterbody can result in eutrophication, causing nuisance algal blooms, reduced water column clarity, and low dissolved oxygen. Sedimentation, which can degrade aquatic habitat, reduce aesthetics, and increase the need for dredging, can occur when excess particulates are delivered to a waterbody. Internal loading of legacy nutrients can result from resuspension of superficial sediments and/or lower water column anoxia caused by increased organic matter loading. Naturally occurring and human induced processes contribute to increased internal loadings. Altered hydrology leads to increased runoff velocity and decreased storage contributing more nutrients and sediments to the estuary (i.e. forest roads, failing culverts, altered wetlands, forest fragmentation, and development). A description of these stressors is shown in Table BUI 6 - 4.

### Table BUI 6 - 4: Description of Stressors.

| Stressor | Description |
|---|---|
| **Nutrients in Water Column** | Phosphorus and nitrogen in various forms which could lead to increased algal and higher plant growth, and changes in food webs (see Eutrophication below) |
| **Eutrophication** | Process by which lakes and streams are enriched by nutrients (usually phosphorus and nitrogen) leading to excessive plant growth - algae in the open water, periphyton (attached algae) along the shoreline, and macrophytes (aquatic plants) in the nearshore zone. Impacts include harmful or obnoxious algal blooms; oxygen depletion; disruption of food webs; loss of fish habitat; and loss of water clarity. |
| **Suspended sediment(solids) in water (TSS or SSC)** | Excess suspended sediments darken the water, decreasing algal and higher plant photosynthesis and affecting visual predators and prey; high sediment loading can also smother habitat and mechanically abrade sensitive tissues of aquatic organisms (e.g., gills); it also transports nutrients (especially phosphorus) and many adsorptive contaminants, and the adsorbed organic matter contributes to oxygen depletion as it decays. |
| **Sedimentation** | Deposition of suspended sediment onto the bottom of a waterbody. Smothers habitat for benthic organisms and fish spawning; can deplete oxygen in surficial sediment. Leads to the need for ongoing dredging in shipping lanes. |
| **Altered Hydrology** | Exacerbates stream flow “flashiness,” leading to stormwater runoff-induced erosion and nutrient loading and loss of groundwater storage, which can severely reduce habitat during summer base flows and under ice in winter. |
| **Anoxia** | Anoxia (absence of oxygen) impacts bottom water and sediment processes. It restricts benthic habitat and increases the release of legacy phosphorus (but could also reduce legacy nitrogen via coupled nitrification-denitrification). Leads to continuous recycling of nutrient inputs. |
| **Sediment Re-suspension** | Turbulent mixing of bottom sediments up into the water column. Major drivers are wind, seiche, dredging, boat traffic and potentially fish and invertebrate foraging activities (e.g., carp). Negative impacts are associated with re-introduction of nutrients into the upper sunlit water column (euphotic zone), which can increase algal/plant growth ; reduce water clarity; and re-introduce legacy contaminants into food webs along with increasing risk of exposure to humans. |

## Final Delisting Target: Excessive Loading of Sediment and Nutrients

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (reference), is:

> *Nutrient and sediment levels have not been shown to impair water quality and habitat, and do not restrict recreation, including fishing, boating, or body contact in the estuary and within western Lake Superior based on the following criteria:*
>
> - *All federal, state, and local point source and nonpoint source discharge permits in the Area of Concern are in compliance with regard to controlling sources of nutrients (particularly nitrogen and phosphorous), organic matter, and sediment; and*
> - *Total phosphorus concentrations in the Lake Superior portion of the AOC do not exceed 0.010 mg/l (ppm) or 10 µg/l (ppb) (upper limit of oligotrophic range); and*
> - *There are no exceedances of the most protective water quality standard for either state in the western basin of Lake Superior due to excessive inputs of organic matter or algal growth attributed to loadings from wastewater overflows into the St. Louis River; and,*
> - *Total phosphorus concentrations within the St. Louis River portion of AOC do not exceed an interim guide of 0.030 mg/l (ppm) or 30 µg/l (ppb) (upper limit of mesotrophic range) or the most restrictive water quality standards.*
>
> *This ensures that anthropogenic sources and activities in the St. Louis River Area of Concern do not result in excessive productivity and nuisance conditions within the St. Louis River Estuary.*

## Measurable Indicators: Excessive Loading of Sediment and Nutrients

The Final Delisting Target for this BUI, as established by stakeholders in 2008, focused on levels of total phosphorus measured in the St. Louis River and Western Lake Superior portion of the AOC. However, the Team and the Science Advisory Group (SAG) noted these delisting targets were estimates selected in the absence of sufficient data and analyses that could specify targets with a level of confidence for the protection of the AOC. Further, since these targets were specified, there has been additional analysis of historical data (Hoffman 2011) and more comprehensive water quality data collected by a number of different organizations (i.e., FDL Band, WDNR, NRRI-UMD, LLO-UMD, MPCA, MDNR, Superior NERR/USGS, possibly others) in addition to new drafts for final standards promulgated by MPCA and WDNR (see interim status indicators table below).

To best protect and restore the condition of the AOC related to this BUI, it is recommended that measurable status indicators be determined for the interim status indicators listed below including chemical indicators (e.g., total phosphorus, un-ionized ammonia), biological indicators (e.g., chlorophyll *a*) and physical indicators (e.g., TSS). These indicators relate to progress made in terms of implementing projects/plans designed to address sources of potentially excess nutrients and sediments based on the reasons for listing this as a BUI. The BUI Team also discussed the fact that existing standards for the St. Louis River portion of the AOC may not be appropriate and should be determined via a separate study. This study is not intended to set state standards, but to develop BUI removal objectives agreeable to both states. In addition, since the western arm of Lake Superior has been shown by a number of historical and more recent research papers to have higher phytoplankton productivity than the main

pelagic basins of the lake, an appropriate set of removal objectives should be developed for the lake portion of the AOC as well.

Table BUI 6 - 5 summarizes water quality standards (established or drafted) for TSS, TP, and chlorophyll *a* for various agencies and research organizations. These critical "status indicators" are shown in the source/stressor model and are the core indicators needed to address BUI removal. However, there are other measurable indicators that may be used to help interpret status. These are shown in the source/stressor model. In the absence of AOC-specific standards, these could help qualify the 2008 Delisting Target. In addition, the BUI Team and SAG noted that "other measurable indicators" exist for streams and rivers, and that these indicators may need to be monitored to better understand the following:

- How the AOC's trophic status responds to changes in nutrient and sediment loading from watershed and shoreline restoration activities; and
- How future environmental changes (e.g., climate change) affect hydrology and temperature, invasive species introductions and other food web modifications, atmospheric deposition of nutrients, and population and land use in the AOC.

For example, Minnesota rules call for a 25 NTU standard for turbidity and 5.0 mg $O_2$/L minimum standard for dissolved oxygen in cool/warm water streams and rivers. Minnesota rules for coldwater trout streams are more stringent, calling for a 10 NTU turbidity standard and 7.0 mg $O_2$/L standard. This applies to several rivers in the AOC. A sediment budget may be useful in developing a better understanding of sediment sources and sinks in the St. Louis River portion of the AOC, which could lead to determining criteria differences for BUI removal objectives versus other Clean Water Act programs (e.g., TMDL, NPDES).

The set of "other measureable indicators" would include the following at a minimum (using the National Park Service's Vital Signs classification of Core (i.e. field) and Advanced (lab analyses):

- Core suite of field measurements: temperature, pH, specific electrical conductivity (EC25), dissolved oxygen, and water clarity (secchi in deeper waters and transparency/secchi tubes in shallow zones and wetlands);

- Advanced suite of lab analyses: ortho-P, nitrogenous nutrients (TN, $NH_4$-N, and $NO_3$/$NO_2$-N), TDS, TVS, hardness, major ions, true color, DOC (note that monitoring frequency can vary with the more conservative parameters being measured less frequently and perhaps at fewer locations); and

- Phytoplankton community composition and possibly accessory pigments to accompany chlorophyll *a* measurements for the purpose of identifying critical groups of algae associated with harmful algal blooms (HABs) and toxin producing blue-greens (cyanobacteria).

Note that these indicators, and perhaps others not included here, provide for direct assessment of the condition of AOC waters, plus the ancillary information needed to interpret the potential causes and effects of a wide variety of AOC stressors. Some of these data, in particular temperature, clarity, TSS, and DOC, would be essential for ground-truthing of satellite and airborne remote sensing techniques, which could prove to be a cost-effective monitoring tool for large spatial scales in the near future, if not already. Citizen scientist and school (e.g., St. Louis River Watch program) volunteer monitoring programs can also be used to reduce the cost of ground-truthing remote sensing data, as well as providing site-specific monitoring information in streams and wetlands within the AOC. Both Minnesota (MPCA's Citizen Stream and Lake Monitoring Programs) and Wisconsin (WDNR/UWEX Water Action Volunteer program) have excellent and mature programs that are already being used as part of the states' overall monitoring plans for lakes and streams (see also http://www.lakesuperiorstreams.org/citizen/volunteermonitor.html).

The Team also noted that the assessment and/or development of water quality standards and a long-term monitoring program might be accomplished in a coordinated manner for cost-efficiency. In particular, the Lake Superior NERR's system-wide monitoring program (SWMP: http://www.nerrs.noaa.gov/RCDefault.aspx?ID=18) will be implemented in the estuary in 2012.

The BUI Team has identified indicators of stress that can be measured to assess the status of BUI. These qualitative and quantitative metrics provide the basis for measuring the progress towards delisting a BUI. The interim status indicators and other measurable indicators for this BUI are presented in Tables BUI 6 - 5 and BUI 6 - 6, respectively. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily, imperative information.

## Interim Status Indicators:

Note: These are interim criteria or estimations based on existing standards. Although the St. Louis River holds some features in common with other rivers and flow-through lakes, this ecosystem is unique because of the implications of residence time, mixing, and biogeochemistry resulting from landward forcing of lake water (i.e., result of seiche, storm surge) mixing the lake and tributary waters. The final AOC removal objectives needs to be developed with a compilation of historical data and development of references for the status indicators within the estuary.

**Table BUI 6 - 5: Interim Status Indicators.**

| Indicator | Target | Location | Source |
|---|---|---|---|
| **Water column TSS** | 15 mg/L | St. Louis River portion of AOC | Draft MN criteria for north river region (MPCA, May 2011) |
| | 10 mg/L | Lake Superior portion of AOC | Draft MN criteria for class 2A waters (MPCA, May 2011) |
| **Water column TP** | 30 µg/L (1) | St. Louis River portion of AOC | Final Delisting Target: Note the discrepancy between current MN and WI TP criteria that might also be used for the SLR AOC - MN draft TP criterion for the north river region is 55 µg/L (MPCA, 2011); WI TP criterion |

| Indicator | Target | Location | Source |
|---|---|---|---|
| | | | for St. Louis River is 100 µg/L (WDNR, November 2010; N.R. 102.06(3)(a)) |
| | 10 µg/L (2) | Lake Superior portion of AOC | Final Delisting Target: Note WI, but not MN, has a TP criteria that should be considered of 5 µg/L (WI TP standard for Lake Superior of 5 µg/L includes open and nearshore waters- WDNR, November 2010; N.R. 102.06(5)) |
| **Chlorophyll *a*** | 10 µg/L | St. Louis River portion of AOC | Draft MN criteria for north river region (MPCA, November 2010) |
| | 1.3 µg/L | Lake Superior portion of AOC | Number derived from Annex 4 of the Great Lakes Water Quality Agreement target TP loading of 3400 metric tons per year (IJC 1983); corresponding TP is 5 µg/L. |
| | 3 µg/L | MN Class 2A | 7050.0222 Specific Water Quality Stds for Class 2; Aquatic Life and Recreation |
| **Dissolved Oxygen** | 7 mg/L | MN Class 2A | Daily minimum and compliance with the standard 50% of the days at which the flow of receiving water is equal to the $7Q_{10}$ |
| **Un-ionized Ammonia ($NH_3$)** | | | Criteria are many and varied, depending on agency and methodology. Therefore, it is not appropriate at this time to list existing Wisconsin and Minnesota standards as an interim status indicator without further review and historical data analysis. |

## Other Measureable Indicators:

Note: the indicators in this table are not removal targets, but rather they are provided here as elements that may help inform the interim status indicators.

### Table BUI 6 - 6: Other Measurable Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| Federal, state, and local permitted dischargers, including MS4s in the AOC | Determined through review by WDNR and MPCA | All permittees in compliance with regard to controlling sources of nutrients (particularly nitrogen and phosphorus), organic matter, and sediment |
| Municipal wastewater collection systems and WWTP permittees within the AOC | Determined through review by WDNR and MPCA | All permittees in compliance with permit conditions with regard to controlling sewage overflows |

| Indicator | Measurement Basis | Target |
|---|---|---|
| Knowledge, Attitudes, and Practices (KAP) by the general public. Randomized AOC-focused surveys that could be coordinated with other local/regional surveys. Visitor surveys could be conducted at the Great Lakes Aquarium, LS Zoo, Northern Great Lakes Visitors Center, and other non-formal education venues; also user interviews by SLRAC | KAP surveys, or other survey designs, repeated at 2-3 yr intervals. Determined by entities who have appropriate skills to track and evaluate education programs (requires funding) | Various regional user groups (resident and tourist). Surveys should show, over time, an increase in stormwater and pollution ***awareness***, and an ***increase*** in practices to manage or prevent it. RSPT conducted a random survey in the region (bi-State) in 2010 and set a tentative target for the future of 75% correct for key questions. |
| Education and outreach tracking metrics | Local MS4 permittees | MS4s are required to track the number of materials distributed to the public each year. A stable or increasing number will provide one indicator of success in this area. |
| Educational website use metrics (e.g., Lake Superior NERR websections; LakeSuperiorStreams.org websections; WLSSD; MN & WI Sea Grant; Superior Binational Forum; UWEX; UMN Extension, MPCA, MDNR, WDNR, UWEX, etc.) | Annual website user analyses | General public; possibly educators and other groups |
| SLR Watershed tributaries: Direct measurements of pollutant concentrations and loading rates from MPCA/DNR; USGS; UMD (NRRI & LLO); Superior NERR | Manual grab sampling (event based) and seasonal; automated, high frequency, real-time flow, temp, EC25, turbidity sensor data as surrogate WQ parameters. | Water quality and hydrologic assessment.<br><br>Note that NRRI-UMD's www.*LakeSuperiorStreams.org* project sites are on soft money. The program includes 5 trout streams within the AOC and the Duluth Inlet with automated samplers and event-based grab sampling for nutrients and other water quality parameters. Note: only 1 trout stream (Amity Creek) is currently completely funded for 2013. |
| Superior and Duluth Inlets: Automated, high frequency, real-time flow, temp, EC25, turbidity sensor data as surrogate WQ parameters | LLO-UMD and NRRI-UMD operated automated stations via GLRI-NOAA GLOS funding | AOC restoration monitoring support. Long-term operation and maintenance costs beyond 2013 are not established. |

| Indicator | Measurement Basis | Target |
|---|---|---|
| St. Louis River thalweg station automated high frequency, real-time flow, temp, EC25, turbidity sensor data as surrogate water quality parameters | Superior NERR (2 stations) and LLO/NRRI (via GLRI GLOS funding noted above) | Blatnik, Bong, and Oliver Bridges mid St. Louis River sites and other NERR stations to operate indefinitely with ancillary suite of grab sample water quality parameters. |
| Remote sensing of TSS, chlorophyll *a*, DOC/color, and temperature | 1.Great Lakes Observing System (GLOS) AOC monitoring project (GLRI-NOAA $ for 2011-13);<br>2. Landsat based secchi estimation by UM-Twin Cities for MPCA | 1. GLOS funding for support of St. Louis River AOC restoration activities (Dr. Jay Austin, PI)<br><br>2. UM-Twin Cities Remote Sensing Lab funded via MPCA for assessment of MN's inland lakes (Dr. Marvin Bauer, OI). |
| On-site septic system compliance with MPCA and WDNR Rules. | County tracking of the number of septic systems in use within a certain distance from the St. Louis River or tributaries. | Reduction of noncompliant and/or failing on-site individual wastewater treatment systems. This is feasible in the near-term as the states move toward some level of performance monitoring for ISTSs. St. Louis County now has a GIS inventory in place (att: Jim Gangl) |
| Dredge requirements at the port entries | USACE data | Volume of dredge sediments is stable to declining. |

## Other possible indicators for consideration are:

- Mapping of high slumping banks on the Nemadji and St. Louis Rivers Basins. In particular, Dr. Karen Gran (UMD-Geological Sciences Department) and George Host (NRRI-UMD) have recently purchased a new, easily portable, ground-based Lidar scanner that in combination with other similar tools (Tom Schaub at MPCA-Duluth has a similar instrument) could allow such sites to be benchmarked and then routinely monitored for trends in erosion rates. Dr. Gran is currently using it as part of the GLRI-funded Amity Restoration Project (MPCA, NRRI-UMD, Geology-UMD, Sea Grant-UMD, SSL SWCD).
- Protection or acquisition of erodible sediment-rich areas, riparian lands and wetlands.
- Implementation of BMPs: Acres and or lineal feet of wetland restorations, managed forest, buffer strips, properly installed culverts, etc.
- Demonstration Projects (e.g., Amity Creek, Hog Island, City of Superior rain gardens, educational signage).

- Indicators to assess improvements in environmental decision-making and literacy, examples of which are listed in the table above.
- Great Lakes SPARROW Model as it relates to other areas in the Great Lakes.
- Indication of long-term monitoring for tracking progress – both on the ground project completion and water quality response.

## Current Conditions: Excessive Loading of Sediment and Nutrients

The status of assessment of this BUI is reflected in Table BUI 6 - 7 and is based on the most recently available research and monitoring data compiled and reviewed for this BUI Blueprint.

### Table BUI 6 - 7: BUI Current Conditions Status Check.

| Check | Yes/No/Unknown | Notes |
|---|---|---|
| **Data for status indicators available?**<br><br>**All Status Indicators** | Partially | Water column TSS and TP are available; data must be collected and compiled from various agencies and researchers. Data may not be from sites or times of the season needed for delisting process. Locations and analysis of sample locations are critical to addressing target standard concentrations. |
| **Data for status indicators assessed?** | No | Long-term datasets for water column DO, chlorophyll *a*, secchi, TSS and TP, Algal IBI, CROSSREF assessed but not in context of targets |
| **Status indicator Delisting Targets (12/2008) set?** | Yes | Need to determine what sampling locations and method to use to spatially and temporally average data. Standards are different in MN and WI. |
| **Status indicator targets met?** | Unknown until targets refined | |

### Description of Most Recent Data Sets for Status Indicators:

A long-term monitoring program has not been developed to specifically assess attainment of the targets related to the excessive loading of sediments and nutrients. During the Delisting Target process in 2008, primary consideration was given to water column concentrations of total suspended solids (TSS), total phosphorus (TP), and chlorophyll *a* (chl-*a*). However, as described above, the list is now more comprehensive than these three status indicators.

Sampling and analysis of TSS, TP, chl-*a*, and secchi depth have occurred at numerous locations in the AOC by several groups since the 1970s, but most comprehensively by WLSSD until the late 1990s. Sampling was relatively sparse until the past 5 years or so, when MPCA, U.S. EPA, WDNR, Fond du Lac Band, WLSSD, and other (primarily local) academic researchers conducted more intensive surveys of water quality, aquatic plants, benthic macroinvertebrates, zooplankton, and fish. None of these studies were designed specifically for the purpose of establishing AOC benchmarks, although it is likely many of these data could serve this purpose. It is also noteworthy that the Lake Superior NERR, in collaboration with other local agencies and academic scientists, began the process of inventorying such data in February 2011 at the first St. Louis River Estuary Science Summit. This effort has continued as part of the current blueprint project.

Preliminary data also exist for a study on attached algae productivity and nutrient enrichment along the nutrient gradient from the Oliver Bridge to the Blatnik Bridge. This project is a partnership between the Lake Superior NERR, USGS (Richard Kiesling), and the University of Minnesota (Bob Sterner and Jaques Finley). It began in 2011, and in 2012 it was expanded to include data on attached algae production in Radio Tower Bay before and after restoration. Researchers will create a growth curve for attached algae along an experimental nutrient gradient in the estuary, and from there they will be able to determine where the estuary is on an EPA-approved impairment/stressor gradient for nutrients. This preliminary research could be an important piece of information, and it may also have potential for directing some focus toward BUI removal objectives; proposed work as part of this project also includes research into sediment loading and resuspension and the amount of bioavailable phosphorus in the sediment.

Data for each indicator must be compiled and assessed for whether their spatial and temporal extent are sufficient to determine whether status indicator targets for each parameter have been met. Since separate targets are established for the St. Louis River and western Lake Superior, data will need to be compiled and assessed specific to the river and the lake, with specific monitoring sites determined during the monitoring design process.

## Current Conditions for Status Indicators (water column concentrations of total suspended solids (TSS), total phosphorus (TP), and chlorophyll a (chl -*a*))

Dr. Joel Hoffman (EPA Research Laboratory in Duluth) prepared a summary of the trends of nutrients and suspended solids in the lower St. Louis River and Lake Superior portions of the AOC (Hoffman 2011). This assessment evaluated data from MPCA monitoring stations located near the Minnesota Highway 23 bridge, just below the Fond du Lac dam, and near the US Route 53 John A. Blatnik Bridge, directly between the cities of Duluth, MN and Superior, WI. The Minnesota Highway 23 bridge time-series extends from 1953 to 2008, and the John A. Blatnik Bridge time-series extends from 1973 to 2008.

At the Minnesota Highway 23 bridge, the assessment identified a trend of lower TP and TSS concentrations over time. In 2008, concentrations ranged from 29-48 µg/L TP and 1.2-5.6 mg/L TSS. At the John A. Blatnik Bridge, TP and TSS concentrations were also identified to have declined over time. The rate of TP decline was identified as being faster at the John A. Blatnik Bridge than at the Minnesota Highway 23 bridge.

In the Lake Superior portion of the AOC, the data were not extensive. However, the assessment did indicate that an improvement in water quality may have occurred between the mid-1970s and the mid-2000s. In particular, the assessment indicated that TP declined from 9-14 µg/L to 5-11 µg/L, and TSS from 3-5 mg/L to 1-2 mg/L.

## Information Gaps: Excessive Loading of Sediment and Nutrients

- It is possible that delisting targets have been achieved for this BUI, but existing data have not been analyzed specifically to determine this; nor is it known if the existing data come from studies that have been designed to answer this question. Data for each indicator must be compiled and assessed

for whether their spatial and temporal extent are sufficient to determine whether status indicator targets for each parameter have been met.

- Determination of spatial and temporal data needs for assessing targets for both the river and lake portions of the AOC is necessary.
- Currently a seasonal monitoring program does not exist that spans a broad area in both the St. Louis River and Lake Superior portions of the AOC and includes the range of status indicators for this BUI. The existing data analysis indicates that targets for BUI removal may be substantially met. However, confirmation with a focused monitoring effort is needed.
- Assessment of this BUI would benefit from a monitoring and assessment program that looks at both phytoplankton and benthic algae in various embayments/backwaters, wetlands, and tributaries. There is now sufficient relatively recent data and local scientific expertise to design such a program.
- There are differences between MN and WI for some of the relevant water quality standards for the lower St. Louis River. In any event, this is area is complex, and a comprehensive set of standards should be developed for the BUI removal objectives and agreed upon by both states. This will require a comprehensive analysis of historical and more recent data than has been accomplished at this time.
- Though excessive loading of nutrients and sediments to the AOC are linked, each parameter needs to be studied individually to understand how best to remove it.
- A report on whether plans and regulations are being implemented and enforced, including the Nemadji Basin Plan, Forest Management Plans, Construction Regulations, and other watershed management plans. Are any of these efforts having an effect on the amount of nutrients and sediment being released to the St. Louis River? Can an estimate be made on how many tons of sediment are being held back by current protection and mitigation efforts?
- A GIS model is needed for sediment and nutrient loading that has been calibrated using local data sources. The areas of the watershed that are contributing the most should be identified. It would also be helpful to know the location, magnitude, and potential drivers of internal loading of nutrients from legacy sediments. Many subwatersheds have no data on nutrient and sediment load.
- The nutrient budget for the estuary is unknown. A mass balance of nutrients entering and leaving the system is needed. The proportion of nutrients contributed internally versus externally is not fully understood.
- It is unknown how often or to what audience the problem of excessive nutrient and sediment loading is being discussed in an educational setting.
- Are erosion control laws effective in the AOC, and are they being enforced?
- Preliminary research into nutrient enrichment and attached algae production will give a better sense of where algae populations are along a growth curve—have they reached maximum productivity or

could additional nutrients lead to increased algae blooms? Further research needs to be done in this area.

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions in this list include those selected to address data and information gaps, monitoring and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table BUI 6 - 8 followed by a supplementary table key.

### Table BUI 6 - 8: Sequential List of Prioritized Actions: Excessive Loading of Sediment and Nutrients.

Note: All of these actions may not be necessary for BUI removal. They may be required if the removal targets cannot be met. The first two projects are necessary to refine the removal targets.

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key below and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Baseline Monitoring and statistical analysis to finalize removal targets for interim status indicators and assess if they have been achieved. | A. Determine status and trends of existing data.<br>B. Identify information gaps<br>C. Design system-wide monitoring program<br>D. Core sampling for historic changes | Upper river and estuary by geographic zones, if possible | 1,2,3,4,5,12 | 4,6,7,8,9 | Nutrients, TSS, chlorophyll, conventional field parameters. | All stressors and sources in model | 2012 | 2014 | $$$ | None | EPA may have portions |
| 2 | Comprehensive Long-term Monitoring for Assessing Trends and Conditions | A. Main Channel (thalweg) representative of all conditions.<br>B. Near Shore<br>C. Tributaries in subbasins<br>D. Open Waters<br>E. Remote Sensing<br>F. Statistical Analysis and Reporting | AOC terminus to Mouth, continuation of previous effort of grab sites and real time | 1,2,3,4 | 4,6,7,8,9 | Nutrients, TSS, chlorophyll, conventional field parameters. Include sediment data until criteria meets Status and Other Measurable Indicators within Blueprint. | All stressors and sources in model | Ice out minimum; year-round needed for nutrient budget [monthly] | This should be a long-term activity. De-listing should be evaluated after 2 years of monitoring. | $$$-$$$$ per year | None | NERR may have picked this up; NRRI-UMD (via MN+WI Seagrant funding) in 2010-11 data; GLOS - NOAA funding for 3 real-time harbor sites (LLO-UMD); IOOS funding (LLO) for western arm of Lake site; GLOS $ for LLO-UMD nearshore McQuade station and EPA |
| 3 | Outreach and Education for Multiple Targeted Audiences | A. Urban BMPs<br>B. Watershed BMPs<br>C. Great Lakes Literacy<br>D. Science Education<br>E. Volunteer Monitoring (See Questionare practices) | RSPT; MN & WI Extension; WDNR; MPCA; U of MN (St Anthony Falls Lab [SAFL]), Cities of Duluth and Superior, Regional MS4s, LSNERR, GL Aquarium | 9,14 | 1- 9 | educational metrics, seasonal and stormwater flows; stream sediment and nutrient concentrations and loading rates | , All stressors and sources in model | ongoing | On-going | $$$ | Local ordinances | RSPT Staffers,Academia, Cities and Counties in AOC, MN & WI Extension; ARDC, NERR, FDL, WDNR; MPCA; U of MN (St Anthony Falls Lab [SAFL]) |
| 4 | Implement Nemadji Basin Plan | Restore Watershed through Implementation of Plan | Nemadji River and Associated Tributaries | 6,7,10,9,12,14 | 6, 2 ,9 | TSS, Tons of sediment, P | Stream bank Erosion, Natural Geology/Topography, Velocity, Tributary Contributions, Altered Hydrology, | 2012 | Decades | $$$$$ | Local Zoning | SWCD, LWCD, NGOs, County, Local, State, Government Agencies and Landowners. |
| 5 | Implement CWA St. Louis River TMDL | This is a planned activity to be conducted by MPCA, WDNR, FDL and EPA | Lake Superior Basin in MN | 1,2,3,4,5,6,12 | 1,2,6,9 | Listed Pollutants | Air deposition, point and non-point discharges | 2012 | On-going | $$$-$$$$ | Air and water permits | TMDL cycle, geometric mean over period of time, |
| 6 | Implement Forest Management Plans | Reduce Sediment, BMPs, Reforestation, enhance infiltration | Forests and Ag. | 6,8,10,13,14 | 4,6,8 | TSS, tons of sediment, P | Rural non-point, solids, & nutrients. | 2012 | On-going | $$$ | Meet state and local requirements | County, private, state foresters, land owners, loggers |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key below and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | GIS Model for Nutrient and Sediment Loading (eg, Sparrow). | ID sources of sediment, nutrients (N & P) and water via hydrologic/watershed models to help guide field sampling design and to "fill in" sub watersheds having limited or no data. | Urban Areas | 1,2,3,4,5,12 | 6 | Nutrient Sediment Conventional Water Sampling. seasonal and stormwater flows; stream sediment and nutrient concentrations and loading rates | All stressors and sources in model | 2013 | On-going | $$$ | None | TMDL Input |
| 8 | Nutrient Budget | Mass balance of nutrients entering and leaving the system and their main conduits. Identify largest sources/sinks. | FDL Dam to mouth, Nemadji River, major tributaries | 1,2,3,4,5,12 | 6 | Nutrients | All stressors and sources in model | 2013 | On-going | $$$ | None | TMDL and Joel Hoffman work |
| 9 | Enforce Erosion Laws | Construction Sites | SWCD, local MS4s, local permitting offices, MPCA | 9,10,11,13,14 | 6 | Point & non-point stormwater sources. | Solids and sediments | On-going | On-going | $$ | Meet state and local requirements | MPCA, SWCD and Local Permitting Authority |

## Key for Sequential List of Prioritized Actions:

Reference numbers for "Type of Action":

1. Monitoring program
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = <$5M

Reference numbers for BUIs:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Excessive Loading of Sediment and Nutrients

Substantial expenditures have been realized since the AOC designation in 1989; however, the measure of those improvements' effectiveness has had minimal quantifiable monitoring to determine their overall contribution to the reduction of excessive loading of nutrients and sediments in relation to this BUI. The majority of external nutrient contributions have been addressed through the establishment of the WLSSD, permit enforcement, acquisitions of riparian areas, and altered behaviors of landowners within the watershed. The contributions of remaining nutrient and sediment sources need to be identified through specific long-term monitoring and analysis.

Recently the City of Duluth, WLSSD, MPCA and the USEPA jointly addressed the sanitary sewage overflow situation in a Consent Decree investing approximately $50 million to solve the issue by strategically placing large-capacity holding tanks to handle increased flow during storm events and also working with many landowners to separate their lateral lines from the sanitary system. In addition, the City of Superior has implemented a Combined Sewer Overflow (CSO) Long-term Control Plan to address wastewater overflows into the river and lake. In addition, numerous recurring sanitary sewer overflow points have been virtually eliminated through Infiltration and Inflow programs and construction of overflow control tanks throughout the City of Duluth. WLSSD has also installed backup generators at all pump stations to eliminate overflows caused by power outages.

A 2011 study performed my USEPA MED Lab staff indicated that significant amounts of phosphorus and nitrogen are sequestered within the legacy sediments in the lower river portion of the estuary, making up a potentially major source to the system.

The establishment of a comprehensive long-term monitoring plan is an essential first step. The plan should be coordinated with the data requirements of ongoing and future local and regional monitoring programs (SLR TMDL, LSNERR, Local, State, Tribal and University). This effort could be funded by several (coordinated) entities for an estimated $300,000-$500,000 annually.

In concert with ongoing monitoring activities, the implementation of existing plans, particularly the Nemadji River Basin Plan and the Forest Management Plans in South St. Louis and Carlton Counties, will address the major loading of sediment into the system. This requires additional capacity within local NGOs and regional governments and, depending on landowner willingness, is estimated to take a decade with an estimated cost upwards of $5 million.

As with all sources of nonpoint generated pollution, education and outreach aimed at landuse practices within the watershed can collectively reduce the nutrient and sediment loads into the St. Louis River and connected tributaries. Existing programs and partnerships comprising diverse members can effectively address the most pressing issues.

In summary, a combination of long-term monitoring, implementation of existing watershed based plans coupled with education and outreach will continue to address this BUI and eventually fulfill the criteria for removal of the beneficial use impairment.

## Ongoing Monitoring Needs: Excessive Loading of Sediment and Nutrients

The sections above provide ample justification for implementing a comprehensive monitoring program for the SLRAOC to provide science-based criteria for the delisting of the sediment and nutrients BUI. There is currently no-long-term seasonal monitoring program that spans a broad area in both the St. Louis River and Lake Superior portions of the AOC and includes the range of status indicators needed for delisting this BUI. The existing data analysis suggest that the targets for delisting may be substantially met. However, confirmation with a focused monitoring effort is needed.

The design of the monitoring program should consider not only the immediate need regarding the AOC delisting process, but also its potential usefulness for addressing other issues, for example the effects of emerging contaminants, climate change, human population changes, and invasive species introductions (i.e., food web effects). Such monitoring programs have long been known to be cost-effective by enabling management agencies and policy-makers to make more informed decisions. Relatively recent issues that have been difficult to understand and manage in the absence of sustained and coordinated water quality and biological monitoring programs include the zebra mussel and Eurasian ruffe invasions, the accelerated (microbial) corrosion of sheet pilings in the Harbor, and the effect of increased sulfate on wild rice in the SLR Watershed.

A coordinated monitoring program would benefit many agencies, with diverse responsibilities. Therefore, it is important to consider sponsoring a Monitoring Design & Implementation workshop that is broadly advertised in both states to obtain broad representation from local and regional agencies at all levels, and from interested academic scientists. The recent establishment of the LSNERR presents an additional opportunity to potentially reduce the costs associated with a necessary data management system that would have to be established in concert with the design of the sampling program. The LSNERR will have its water quality and ancillary data managed via NOAA's National NERR System's Centralized Data Management Office (http://cdmo.baruch.sc.edu/). In addition to providing a system for managing and disseminating water quality and meteorological data, there may also be associated opportunities for the LSNERR to manage spatial and temporal biological and socioeconomic data. It should be possible to link this system to the current MN and WI data management systems so the same data can be found in each state's water quality data systems.

It should also be noted that the GLOS AOC monitoring project led by LLO-UMD is already coordinating its placement of real-time water quality data stations with the LSNERR's real-time data stations with an agreement to create a common platform (likely to be map-based) where real-time data and ancillary manually collected data and metadata would be publicly accessible as a website. Additional data streams from the USGS, MPCA/MDNR and WDNR, the National Weather Service, the NRRI-UMD/City of Duluth *LakeSuperiorStreams.org* tributary network, and others that may exist now or in the future could be incorporated. The LSNERR could potentially serve as central coordinator and data warehouse.

## Future Issues or Concerns: Excessive Loading of Sediment and Nutrients

Many issues and concerns have been identified for future consideration for their impact on this BUI removal efforts and recovery of the St. Louis River AOC. It is expected that other issues not yet understood may also arise that could also impact the area in the future. These may include:

- Negative impacts to land cover and hydrologic processes that shape the St. Louis River and its tributaries, including the effects of climate change (i.e., WICCI, USDA Forest Service);
- Limited resources for efforts at all levels of administration, management, inspection, education, construction, enforcement, and assessment to maintain and continue progress on activities that support delisting the St. Louis River AOC;
- Continued increase of impervious surfaces and negative impacts to water quality from the resulting increased runoff amounts and velocities in the St. Louis River watershed;
- Continued increase in number and diversity of landowners in the watershed, making management of land-use activities and land cover for improved water quality more difficult (i.e., USDA NRCS);
- Continued trend of decreased management of water quality pollutants;
- Aging infrastructure and limited resources for infrastructure maintenance; and
- More competitive social environment for developing and disseminating information and education to local decision-makers, making it more difficult to reach decision-makers with key science-based messages about the St. Louis River AOC.

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# BUI 7 Blueprint: Beach Closings and Body Contact

This section contains the BUI Blueprint for Beach Closings and Body Contact. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below, followed by a Summary Statement for this BUI developed by the Team.

## BUI Team Membership

- Julene Boe, St. Louis River Alliance
- Cynthia Hakala, Minnesota Department of Health
- Kari Jacobson-Hedin, Fond du Lac Band of Lake Superior Chippewa
- Brandon Kohlts, WLSSD
- Brittany Story, MPCA
- Jenny Thoreson, City of Superior Environmental Services Division

## BUI Team Summary Statement

Additional information as well as analysis of existing data is needed for beach closings. Determining the sources of *E. coli* at monitored beach sites is a priority in deciding if beach closures are caused by controllable sources within the AOC. There is a need to combine and analyze beach monitoring data from all monitoring and literature sources. Actions identified in sewer overflow plans are being implemented by municipal dischargers to reduce the risk of human exposures to disease-causing microorganisms, and measures in Duluth and Superior to eliminate sanitary sewer overflows are nearly complete. Potential pathogen sources that require further investigation and action are storm sewer releases and combined sewer overflows; wildlife such as seagulls; failed septic systems; discharges from boats, marinas, and vessels; and beachgoers. Also, there is a need to continue urban nonpoint source education and best management practices (BMPs) that reduce the amount of pollutants that flow into the river through stormwater runoff.

Body contact restrictions have focused on the chemicals at Superfund contaminated sites and their associated body contact advisories. USX remediation is a priority recommendation for removing body contact advisories in the AOC. There is a need to identify the process and parties responsible for determining that a body contact advisory sign is required, and when and under what circumstances a sign is removed. At this time body contact advisory signs are located at Stryker Bay, which has been cleaned, and USX, which has yet to be addressed. Hot spots identified in future sediment sampling could identify additional locations for body contact advisories.

## Rationale for Listing: Beach Closings and Body Contact Restrictions

The IJC criterion for this use impairment is that waters that are commonly used for total body contact recreation exceed standards, objectives, or guidelines for such use. Areas of the St. Louis River, St. Louis Bay, and Superior Bay are used for body contact recreation, including kayaking, rowing, windsurfing, canoeing, and swimming, as well as fishing and recreational boating. Minnesota and Wisconsin standards at the time specified fecal coliform counts of no higher than 200 organisms/100 ml for recreational waters. The Stage I RAP did not present much quantitative information regarding beach closings and violations of water quality standards, but this BUI was listed based on potential sources of microbial contamination.

**Stage I RAP Rationale for Listing**

Water quality data indicate that improvements have been made in the St. Louis River and bay since the Late 1970's. However, there are still sources of potential microbial contamination. Sewage bypasses have occurred into the Area of Concern in both Minnesota and Wisconsin during 1990 and1991 storm events. In addition, localized problems with microbial contamination could occur from discharge of inadequately treated wastewater by marine traffic. Because of the sewage bypasses in both Minnesota and Wisconsin, body contact recreation is an impaired use.

Information presented for this BUI includes:

- Occasional violations of fecal coliform standards were reported at the Cloquet water intake, generally during periods of turbulence and storm activity.
- Sewage bypassing from the City of Superior's sewer system was reported for times of moderate precipitation, with overflows of untreated sewage occurring after one to two inches of rain.
- Sewage overflows from the WLSSD were identified as a potential source of microbial contamination. A total of 62 spills were reported between 1980 and the preparation of the Stage I RAP, with 13 spills greater than 1 million gallons in volume.
- More than 200,000 gallons of wastewater exceeding the 200 organisms/100 ml standard were discharged annually from vessels in the harbor.
- The 1995 RAP progress report noted that 19 of 55 samples collected from the St. Louis River under the I-535 bridge exceeded the fecal coliform standard, and this segment of the river is listed in Minnesota's 1994 305(b) Water Quality Report as not supporting the swimmable use.
- The 1995 progress report indicated that the St. Louis County Health Department has sporadically posted "No Swimming" signs at Boy Scouts Landing because of high fecal coliform levels in the water.
- Failing septic systems in Fond du Lac, Oliver, and other communities have been identified as additional sources of bacterial contamination.
- In addition to bacterial contamination, the high contaminant levels in the sediments within the AOC may present an additional health risk for recreational uses.

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 7 - 1. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

**Table BUI 7 - 1: Timeline of Actions: Beach Closings and Body Contact Restrictions.**

| Year | Action |
|---|---|
| 1958 | City of Superior WWTP begin operation with primary treatment |
| 1975 | City of Superior sewer separation project, separating approximately 50% of the City's sewers |
| 1975 | City of Superior's construction of 3 combined sewage overflow treatment plants |
| 1977 | Upgrade to Superior's WWTP to provide secondary sewage treatment |
| 1978 | WLSSD begins operation |
| ... | |
| 1992 | BUI Listed in Stage I Remedial Action Plan |
| 1993 | |
| 1994 | |
| 1995 | |
| 1996 | |
| 1997 | |
| 1998 | Installation of new sewer line and diversion structure along E 2nd St in Superior, which eliminated most sewer bypasses along E 2nd St corridor. |
| | Installation of 2 storage facilities at Lift Stations 5 and 7 in Superior, which provided storage for 450,000 and 900,000 gallons of sewage, respectively. |
| | Replacement and relocation of failing Faxon Creek interceptor in Superior, eliminating a major source of inflow into the sanitary sewer. |
| 1999 | Implementation of the Sanitary Sewer Collection System Cleaning and Inspection Program in Superior with a goal of cleaning and inspecting 100% of sewers every 5 years. |
| | Installation of an automation and control system in Superior, which allows staff to monitor and respond to potential overflow problems before they occur. |
| 2000 | Implementation of a GIS program in Superior for mapping sewer lines to provide a greater understanding of the system and improved response capabilities. |
| 2001 | |
| 2002 | A stormwater information web site called Duluth Streams (later called Lake Superior Streams - www.lakesuperiorstreams.org) was developed. |

| Year | Action |
|---|---|
| 2003 | WLSSD hired a consulting firm to study the effectiveness of the Inflow/Infiltration program in the eastern end of the city. The firm found a "significant reduction" in stormwater flow to the sewers. |
| | The City of Duluth joined 15 other governments and groups to form a Regional Stormwater Protection Team, designed to decrease stormwater pollution by providing public education programs and technical assistance to local communities. |
| | The MPCA began a pilot beach monitoring program. |
| | Initiation of the Stormwater Flood Control Program in Superior, to help address basement backups during wet weather events. |
| 2004 | UMD research found that the majority of identifiable sources of fecal coliform in the harbor came from birds and other wildlife, not human. |
| 2005 | Sediment cleanup at Hog Island/Newton Creek complete. “No swimming” sign taken down on Nov. 28 |
| | Installation of a sewage storage facility at Lift Station 6 in Superior |
| | Installation of the South Superior Wet Detention Basin in Superior |
| 2006 | |
| 2007 | |
| 2008 | |
| 2009 | Consent decree filed for City of Duluth and WLSSD sewer overflow control |
| 2010 | Completion of Superior's South Superior Phase II Project, which included the installation of separate storm sewers, redirecting stormwater out of the combined sewers. |
| | Completion of the Billings Park wet detention basin and storm sewer separation project in Superior. |
| 2011 | |
| 2012 | SLR is on the Minnesota draft 2012 303(d) list. Being impaired for the designated use of aquatic recreation with the stressor of fecal coliform from the mouth of ST. Louis bay at Blatnik Bridge to Duluth ship channel. |
| 2013 | |
| 2014 | CSTP 5 & 6 Enhanced Treatment Project (reduce SSOs) - City of Superior |
| 2015 | Headworks Upgrade Project (reduce SSOs) - City of Superior |
| 2016 | Sewer overflows completely eliminated from City of Duluth and WLSSD (anticipated) |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 7 - 1) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Beach Closings and Body Contact Restrictions

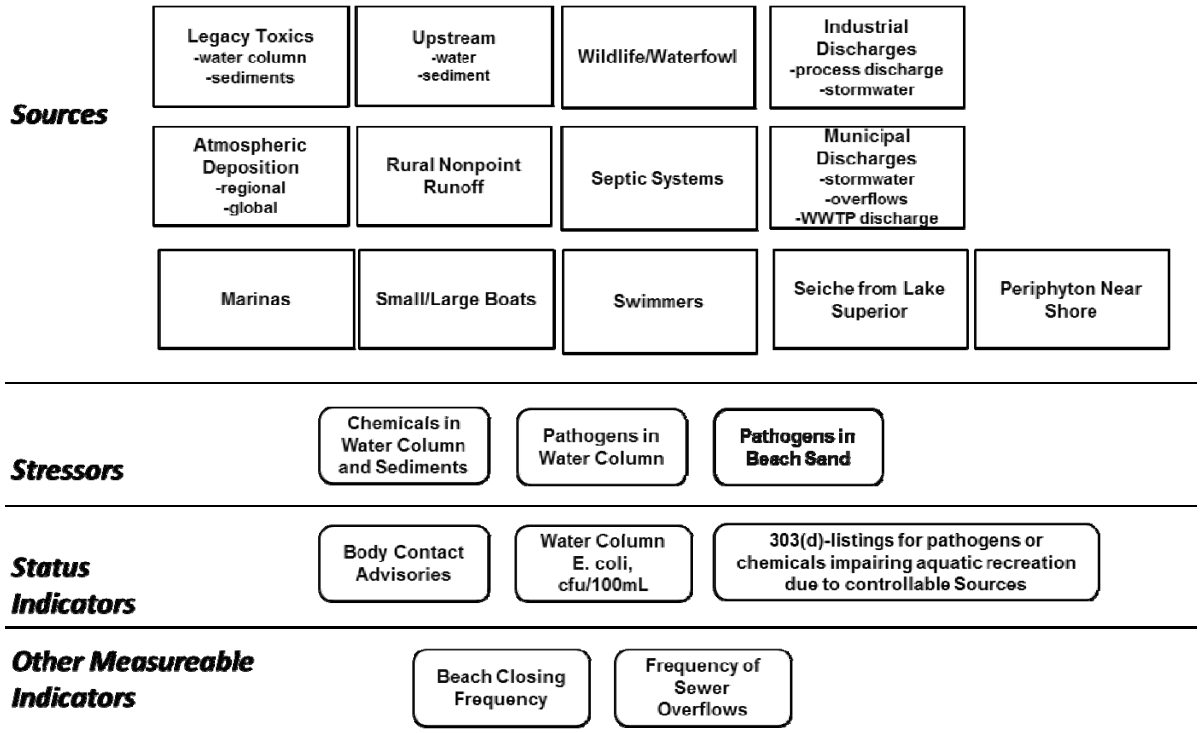


**Figure BUI 7 - 1: Source Stressor Model for the BUI Beach Closings and Body Contact Restrictions.**

Table BUI 7 - 2 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing, and may be local or persist beyond the boundaries of the SLRAOC.

### Table BUI 7 - 2: Description of Source Types.

| Source | Description |
|---|---|
| **Legacy Toxics in Water Column and Sediments** | Historical discharges of toxics[1] to the AOC that occurred from municipal and industrial operations |
| **Industrial Discharges** | Permitted industrial water discharges within the AOC |
| **Industrial Discharges** | Permitted industrial stormwater discharges within the AOC |
| **Municipal Discharges** | Municipal WWTP discharges to the AOC |
| **Municipal Discharges** | Municipal overflows from WWTPs and their collection systems within the AOC |
| **Rural Nonpoint Runoff** | Stormwater runoff from regulated municipal separate storm sewer systems (MS4s) and construction in the AOC |
| | Runoff from non-regulated rural areas within the AOC, including silviculture, agriculture, animal waste, feedlots |
| **Septic Systems** | Septic systems serving homes and businesses in areas not served by a municipal wastewater treatment plant |
| **Swimmers** | Swimmers at beaches can contribute to pathogens through swimming with soiled diapers, defecation while swimming, and improper diaper disposal |
| **Upstream** | Loading of water and sediment into the AOC from areas upstream of the AOC boundary |
| **Wildlife/Waterfowl** | Wildlife and waterfowl in the estuary can contribute pathogens through defecation |
| **Small/Large Boats** | Small and large boats can contribute pathogens improper disposal of waste and spills of oil, fuel and other chemical products. |
| **Marinas** | Marinas can contribute pathogens and chemicals in the water column from improper disposal of waste and spills of oil, fuel and other chemical products. |
| **Seiche from Lake Superior** | Seiche movement of water from Lake Superior can contribute pathogens and chemicals in the water column from sources outside the AOC. |
| **Periphyton nearshore** | This type of algae can function as both a source and a sink of *E. coli.* It can be an indicator of elevated nutrients. |

[1]Toxics for this BUI are defined as specific to the contaminated sites for which body contact advisories have been posted.

## Description of Stressors:

Pathogens can be loaded to the water column through sewer overflows, the presence of wildlife and waterfowl, failing septic systems, municipal WWTPs, and swimmers. Beach sand can serve as a source of pathogens to the water column when pathogens are directly deposited to beaches.

Body contact advisories are posted when contamination at legacy sites in the AOC are thought to pose a risk to human health. Chemicals in the water column and sediments that result in 303(d)listings for chemicals impairing aquatic recreation can come from numerous sources and can be chemical-dependent.

## Measureable Indicators: Beach Closings and Body Contact Restrictions

The BUI Team has identified indicators of stress that can be measured to assess the status of BUI. These qualitative and quantitative metrics provide the basis for measuring the progress towards delisting a BUI 7 - 4. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily imperative information.

### Table BUI 7 - 3: Status Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Pathogens in the water column** | E. coli, colony forming units/100mL | <235 *E. coli* colony forming units/100 ml or 5-sample average during a 30-day period <126 colony forming units/100 ml |
| **Body contact advisories** | Posted signs at contaminated sites | Zero |
| **303(d)-listings for pathogens or chemicals impairing aquatic recreation in the AOC** | Presence on most recent 303(d) lists for MN and WI | None |
| | | or,<br>compliance with TMDL developed to address impairments |
| | | or,<br>TMDL study or source assessment determines cause of impairment is due to non-controllable sources or sources outside of the AOC |

### Table BUI 7 - 4: Other Measureable Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Beach closing frequency** | As determined by WDNR and MDH beach monitoring programs[1] | None attributed to controllable sources within the AOC |
| **Frequency of sewer overflows** | As reported by City of Superior, City of Duluth, and WLSSD | Declining trend as actions identified in sewer overflow plans are implemented |

[1]In Minnesota, "Water Contact Not Recommended" advisories are posted if a single water sample exceeds 235 *E. coli* colonies/100 ml, or if a 5-sample average during a 30-day period exceeds 126 colonies/100 ml. In Wisconsin, an *E. coli* level of 235 colonies/100 ml leads to issuance of a beach advisory, while a concentration greater than 1,000 colonies/100 ml yields a beach closure.

## Final Delisting Target: Beach Closings and Body Contact Restrictions

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (reference), is:

- *Sources of stormwater and wastewater discharge to the St. Louis River Area of Concern have been identified and measures to reduce the risk of human exposures to disease causing microorganisms have been implemented.*
- *There are no body contact advisories due to the presence of harmful chemicals at contaminated sites.*
- *No water bodies within the AOC are included on the list of non-attaining waters due to controllable sources of disease causing microorganisms or chemicals in the most recent State of Wisconsin and State of Minnesota Section 303(d) programs.*

## Current Conditions: Beach Closings and Body Contact Restrictions

The status of assessment of this BUI is reflected in Table BUI 7 - 5, and is based on the most recently available research and monitoring data compiled and reviewed for this BUI Blueprint.

**Table BUI 7 - 5: BUI Current Conditions Status Check.**

| Check | Yes/No/Unknown | Notes |
|---|---|---|
| **Data for status indicators available?** | Yes | To evaluate the indicator related to 303(d)-listings, a source assessment to determine whether sources of bacteria leading to 303(d)-listings are controllable. Data from beach monitoring in MN and WI show *E.coli* concentrations and frequency of beach advisory postings, source has not been completely assessed. |
| **Data for status indicators assessed?** | No | Need to compile AOC beach data |
| **Status indicator targets set?** | Yes | |
| **Status indicator targets met?** | Unknown | Targets are not met for Body Contact Advisories because of presence of no swimming signs in two locations |

## Description of Most Recent Data Sets for Status Indicators:

### *E. coli* and Beach Closing Frequency

Beach monitoring data and beach closing data and information are compiled by the States and available from state websites (www.MNBeaches.org and www.WIBeaches.us) and the U.S. EPA (http://water.epa.gov/type/oceb/beaches/). Figure BUI 7 - 2 shows monitored beaches in the AOC. Table BUI 7 - 6 and BUI 7 - 7 show monitored beaches in the AOC in 2010. Minnesota, MPCA, MDNR, county health departments, and private/public organizations partner to monitor publicly owned beaches along the Lake Superior shoreline. Wisconsin contracts with individual county health departments to conduct routine beach monitoring (UW-Oshkosh students and Northland college students do the actual monitoring). Monitoring frequency in Minnesota is once or twice per week, with

additional monitoring following significant rain events, sanitary sewer overflows, etc.; high-priority Wisconsin beaches are monitored up the five times per week from June –Labor Day during most years. Water samples are tested for *E. coli*, with the following criteria used to determine contact advisories:

- In Minnesota, "Water Contact Not Recommended" advisories are posted if a single water sample exceeds 235 *E. coli* colonies/100 ml, or if a 5-sample average during a 30-day period exceeds 126 colonies/100 ml.
- In Wisconsin, an *E. coli* level of 235 colonies/100 ml leads to issuance of a beach advisory, while a concentration greater than 1,000 colonies/100 ml yields a beach closure.

The Wisconsin website included data through August 2011, while data were available from Minnesota's website through the 2010 monitoring season, which ended in mid-September. EPA's Beach Notification Summary web page (http://water.epa.gov/type/oceb/beaches/seasons_2010_index.cfm ) provides annual summaries for each state, including number of advisories issued, number of days with beach actions, identified sources, etc. This data have not yet been compiled for the beaches within the AOC.

Routine monitoring data from the Minnesota Pollution Control Agency, Wisconsin DNR, and other entities, such as Western Lake Superior Sanitary District (WLSSD) and the City of Superior, are likely available for the St. Louis River, but have not been compiled for the purposes of evaluating BUI delisting.

## Body Contact Advisories

In cases of chemical contamination that poses a health risk from body contact, the state agencies and local health departments work together to evaluate risks and issue advisories, including putting up signage warning about the contamination to discourage recreation in the area. For example, the 1995 RAP progress report recommended that the Douglas County Health Department or City of Superior put up "No Swimming" signs at Hog Island Inlet and Newton Creek following reports of skin and respiratory problems in people who had come in contact with waters in these areas. Wisconsin's Public Participation rules (NR 717.07) require responsible parties to post signs at locations where contaminated media present a direct contact threat to humans. In Minnesota, the State Department of Health is responsible for advisories.

## 303(d) Listings for Pathogens or Chemicals Impairing Aquatic Recreation in the AOC

Every two years, U.S. EPA requires states to submit a list of impaired waters as required by section 303(d) of the Clean Water Act. Based on federal requirements in 40 CFR 130.7, states must:

1. Identify the waters that require TMDLs (total maximum daily loads);
2. Rank, or prioritize, those waters taking into consideration the water uses and severity of the pollution problem;
3. Identify the pollutant(s) causing or expected to cause violations of the applicable water quality standards; and
4. Identify the waters targeted for TMDL development in the next two years.

The most recent available 303(d) list for Minnesota and Wisconsin are the 2012 draft lists.

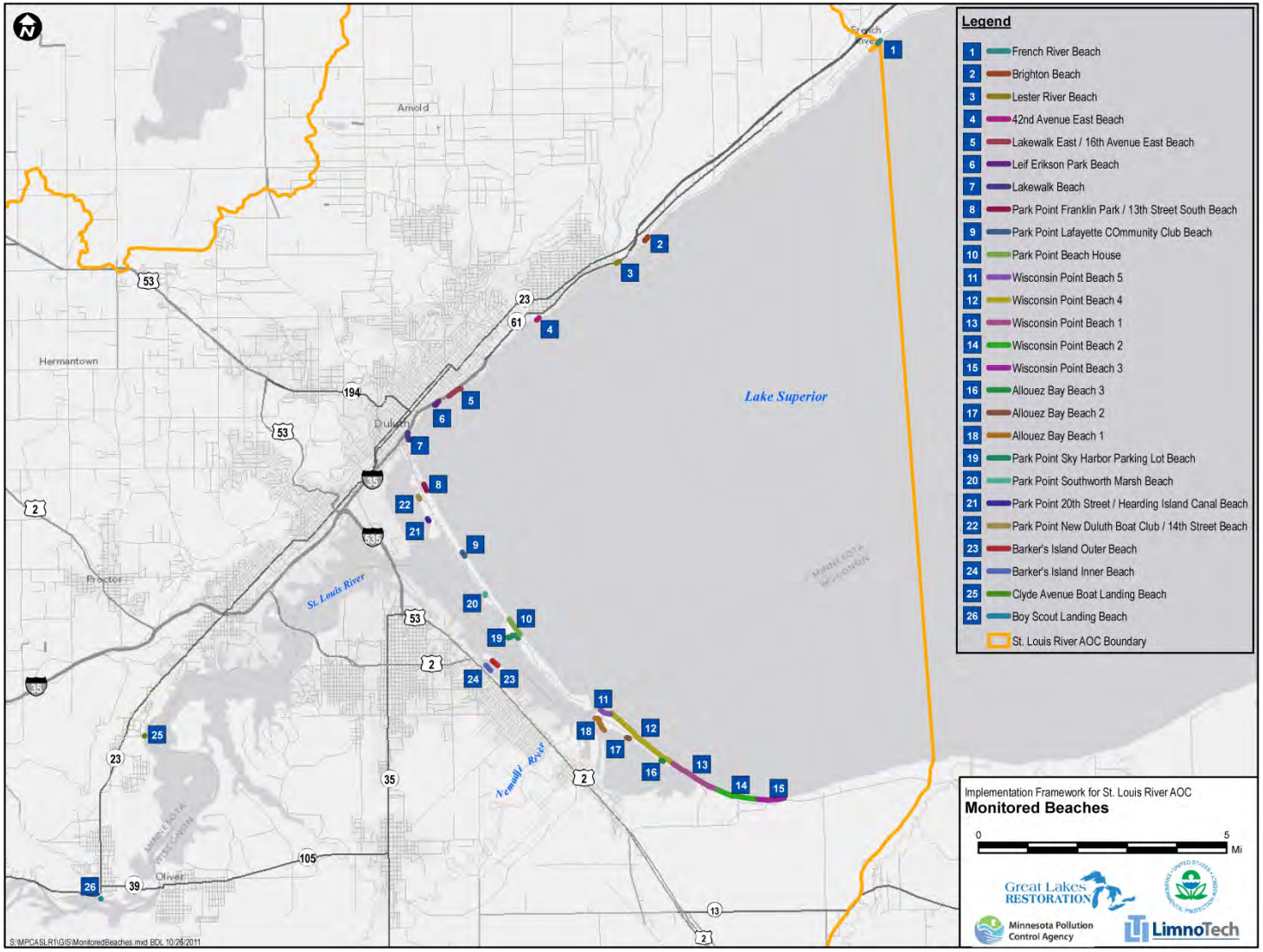


**Figure BUI 7 - 2: Monitored Beaches in the St. Louis River Area of Concern.**

## Current Conditions for Status Indicators:

### *E. coli*

*E. coli* data for the AOC have not yet been compiled or assessed. The raw data need to be put into some combined format and assessed.

### Body Contact Advisories

Remediation of contaminated sediments in Newton Creek and Hog Island Inlet has reduced PAH levels in the sediment, and it appears the area no longer poses unacceptable risks to human health (WDNR 2010). "No Swimming" signs have been removed from this area. There are currently "No Swimming" signs posted for Crawford Creek in the vicinity of Kopper's Industries and at the U.S. Steel Superfund site because of contamination present at these sites. A sign also remains at Stryker Bay.

### 303(d) Listings for Pathogens or Chemicals Impairing Aquatic Recreation in the AOC

The St. Louis River/St. Louis Bay, from the mouth of St. Louis Bay at Blatnik Bridge to the Duluth Ship Channel, is listed on the Minnesota 303(d) list (MPCA, n.d.) as having recreational uses impaired by fecal coliform. This segment has been on the 303(d) list since 2006, with a Total Maximum Daily Load (TMDL) targeted for completion in 2019. Wisconsin lists recreational restriction impairments for Wisconsin Point Beach #2 because of *E. coli* (WDNR, n.d.). This area has been on the 303(d) list since 2008, and is considered low priority. Barker's Island Inner Beach has been proposed for delisting. 303(d) listings in both states for toxic chemicals relate to beneficial uses other than aquatic recreation.

### Beach Closing Frequency

Tables BUI 7 - 6 and BUI 7 - 7 summarize the beach closing data for 2010 as reported to U.S. EPA. In 2010, seven Wisconsin beaches within the AOC had a total of 10 closures and 19 contamination advisories, all casued by elevated *E. coli*. These actions and advisories added up to a total of 59 days during the swimming season. Seven Minnesota beaches within the AOC had 10 contamination advisories in 2010, with a total duration of 48 days. These closures were all caused by elevated bacteria, with sources listed as unknown.

## Table BUI 7 - 6: Wisconsin Beach Closing Summary, 2010.

| Beach Name | Action type | Action start date | Action end date | Action duration (Days) | Action source(s) |
|---|---|---|---|---|---|
| **Allouez Bay Beach 3** | Contamination Advisory | 6/25/2010 | 6/26/2010 | 2 | UNKNOWN |
| **Barker's Island Inner Beach** | Closure | 7/29/2010 | 7/29/2010 | 1 | UNKNOWN |
| **Barker's Island Inner Beach** | Contamination Advisory | 8/10/2010 | 8/10/2010 | 1 | UNKNOWN |
| **Wisconsin Point Beach 1** | Closure | 6/27/2010 | 6/27/2010 | 1 | UNKNOWN |
| **Wisconsin Point Beach 1** | Closure | 7/7/2010 | 7/7/2010 | 1 | UNKNOWN |
| **Wisconsin Point Beach 1** | Closure | 7/14/2010 | 7/15/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 1** | Contamination Advisory | 6/7/2010 | 6/8/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 1** | Contamination Advisory | 6/16/2010 | 6/18/2010 | 3 | UNKNOWN |
| **Wisconsin Point Beach 1** | Contamination Advisory | 6/25/2010 | 6/26/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 1** | Contamination Advisory | 6/28/2010 | 6/29/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 1** | Contamination Advisory | 8/10/2010 | 8/10/2010 | 1 | UNKNOWN |
| **Wisconsin Point Beach 2** | Closure | 6/27/2010 | 6/28/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 2** | Closure | 7/10/2010 | 7/10/2010 | 1 | UNKNOWN |
| **Wisconsin Point Beach 2** | Closure | 7/13/2010 | 7/14/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 2** | Closure | 7/29/2010 | 7/31/2010 | 3 | UNKNOWN |
| **Wisconsin Point Beach 2** | Contamination Advisory | 6/16/2010 | 6/18/2010 | 3 | UNKNOWN |
| **Wisconsin Point Beach 2** | Contamination Advisory | 6/25/2010 | 6/26/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 2** | Contamination Advisory | 7/15/2010 | 7/17/2010 | 3 | UNKNOWN |
| **Wisconsin Point Beach 2** | Contamination Advisory | 8/3/2010 | 8/6/2010 | 4 | UNKNOWN |
| **Wisconsin Point Beach 2** | Contamination Advisory | 8/10/2010 | 8/10/2010 | 1 | UNKNOWN |
| **Wisconsin Point Beach 3** | Closure | 7/29/2010 | 7/30/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 3** | Contamination Advisory | 6/16/2010 | 6/18/2010 | 3 | UNKNOWN |
| **Wisconsin Point Beach 3** | Contamination Advisory | 7/22/2010 | 7/25/2010 | 4 | UNKNOWN |
| **Wisconsin Point Beach 3** | Contamination Advisory | 7/31/2010 | 8/1/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 3** | Contamination Advisory | 8/11/2010 | 8/12/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 4** | Closure | 6/18/2010 | 6/18/2010 | 1 | UNKNOWN |
| **Wisconsin Point Beach 4** | Contamination Advisory | 6/16/2010 | 6/17/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 4** | Contamination Advisory | 7/15/2010 | 7/16/2010 | 2 | UNKNOWN |
| **Wisconsin Point Beach 5** | Contamination Advisory | 6/16/2010 | 6/17/2010 | 2 | UNKNOWN |

Source: Wisconsin 2010 Swimming Season Update **http://water.epa.gov/type/oceb/beaches/seasons_2010_wi.cfm**

### Table BUI 7 - 7: Minnesota Beach Closing Summary, 2010.

| Beach Name | Action type | Action start date | Action end date | Action duration (Days) | Action source(s) |
|---|---|---|---|---|---|
| **Clyde Avenue Boat Landing Beach** | Contamination Advisory | 9/8/2010 | 9/10/2010 | 2 | UNKNOWN |
| **Clyde Avenue Boat Landing Beach** | Contamination Advisory | 9/14/2010 | 9/16/2010 | 3 | UNKNOWN |
| **Lakewalk Beach** | Contamination Advisory | 9/16/2010 | 9/17/2010 | 1 | UNKNOWN |
| **Lakewalk East / 16th Avenue East Beach** | Contamination Advisory | 8/24/2010 | 8/26/2010 | 2 | UNKNOWN |
| **Leif Erikson Park Beach** | Contamination Advisory | 8/20/2010 | 8/24/2010 | 4 | UNKNOWN |
| **Park Point 20th Street / Hearding Island Canal Beach** | Contamination Advisory | 8/20/2010 | 8/24/2010 | 4 | UNKNOWN |
| **Park Point 20th Street / Hearding Island Canal Beach** | Contamination Advisory | 9/2/2010 | 9/17/2010 | 15 | UNKNOWN |
| **Park Point New Duluth Boat Club / 14th Street Beach** | Contamination Advisory | 8/20/2010 | 8/24/2010 | 4 | UNKNOWN |
| **Park Point Sky Harbor Parking Lot Beach** | Contamination Advisory | 8/26/2010 | 8/31/2010 | 5 | UNKNOWN |
| **Park Point Sky Harbor Parking Lot Beach** | Contamination Advisory | 9/2/2010 | 9/10/2010 | 8 | UNKNOWN |

Source: Minnesota 2010 Swimming Season Update http://water.epa.gov/type/oceb/beaches/seasons_2010_mn.cfm

## Information Gaps: Beach Closings and Body Contact Restrictions

- Available *E. coli* data for monitored beaches and routine monitoring locations within the AOC must be compiled and assessed to determine whether it is associated with events such as sewage overflows or other related events that may cause high *E. coli* numbers.
- The process for posting body contact advisories caused by contaminated sites in the AOC must be determined.
- The final delisting target for this BUI lists states, “No water bodies within the AOC are included on the list of non-attaining waters due to controllable sources of disease-causing microorganisms or chemicals in the most recent State of Wisconsin and State of Minnesota Section 303(d) programs.” To make the determination of whether this target is met, a source assessment must be completed to identify the causes of bacterial contamination in the listed segments in the AOC.
- DNA of *E. coli* needs to be assessed to determine whether the *E. coli* is from human or non –human sources.
- Comparison information between the dates of beach advisories and sewage overflows.
- Current status of other controllable sources, marinas, boats, and septic systems.
- What are current regulations concerning marinas and boats, and who enforces them?

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions included in this list include those selected to address data and information gaps, monitoring and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table BUI 7 - 9, followed by a supplementary table key.

## Table BUI 7 - 9: Sequential List of Prioritized Actions: Beach Closings and Body Contact Restrictions.

| Project Sequence | Project Title | Description of Action and Rationale | Location Indicate waterbody, site name, or other geographic reference | Type of Action Enter number(s) from table key, separated by commas | BUI(s) Involved Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration Enter "Ongoing" for actions that will occur continue over time | Estimated cost See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DNA Source Tracking | DNA finger printing of *E. coli* sources. Expand the number of sites where source tracking is done, include stormwater outfalls | SLR Beach monitoring sites | 1,2,3,4, | 7 | pathogens in water column | pathogens | Jun-12 | Sep-13 | 20K | none | Funding for sampling personnel/ lab analysis |
| 1 | Combining Beach Monitoring data/Assessment. | Assessing multi-year summaries, co-relation with rainfall events, tracking improved or worse conditions at beach advisories sites.Comparing beach closures/advisories vs. overflows/heavy rain fall dates. | Watershed | 3,4,5 | 7 | pathogens in water column | Pathogens | 2012 | 2013 | $ | none | Research personnel such as grad student |
| 2 | Reducing Superior sanitary overflows | Continue to implement projects that help to reduce sanitary overflows in Superior | Superior | 12,14 | 7 | Pathogens in water column | Pathogens | On-going | On-going | $$$$$$ | EPA/state | Personnel to research |
| 2 | Reducing Duluth/WLSSD sanitary overflows | Continue to implement projects that help to reduce sanitary overflows in Duluth | Duluth/ WLSSD | 8,12,13,14 | 7 | Pathogens in water column | pathogens | ongoing | End of 2012 | $$$$$$ | EPA/State | Funding for completion of all projects |
| 3 | USX Remediation | Compile and assess information on the USX Site (MPCA, NRDA settlement, etc.). Document cleanup needs and what restoration work, if any, has been done. | MN/WI | 1,2,3,4,5,6,7,8,9,10,11,12,14 | 8 | Body contact advisories | All | Unable to determine | Unable to determine | $$$$$$$ | yes - 404, 401, wetlands, etc. | Personnel to make a project plan, form partnerships, procure permits, hire contractors, and conduct restoration and remediation. |
| 3 | Future Identified Hot Spots | Compile and assess information on any future hot spots that have been determined through sediment assessment. Document cleanup needs and what restoration work, if any, has been done. | MN/WI | 1,2,3,4,5,6,7,8,9,10,11,12,14 | 8 | Body Contact advisories | all | Unable to determine | Unable to Determine | $$$$$ | yes - 404, 401, wetlands, etc. | Personnel to make a project plan, form partnerships, procure permits, hire contractors, and conduct restoration and remediation. |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Clean Marinas In Minnesota Clean Marinas In Wisconsin | Use Clean Marinas Best Management Practices handbook for each state to help designate marinas on the MN and WI sides of the SLR estuary – Barker's Island already signed up | SLR estuary | 10,14 | 7 | pathogens in water column/body contact | Oil, bilge water, soaps, debris, chemicals, nutrients | 2011 | Ongoing | $ | none | Personnel for working with SLR marinas to sign them up for the Clean Marinas program. Partner with WI DNR. Funding to purchase Clean Marinas BMP handbooks. |
| 4 | Urban Nonpoint Education and Best Management Practices | Continue educating the public on best management practices for reducing non point sources of pollution | SLR Estuary | 10, 14 | 7 | pathogens in water column/body contact | Oil, soaps, debris, chemicals, nutrients | Continuing | On going | $ | none | RSPT resource to provide public outreach |
| 5 | Assess compliance rates/education programs and ordinances in regard to septic systems<br>Mapping of locations of risk areas | Collect information on non-compliance rates of septic systems in AOC. Get septic information in the hands of people who have septics Determine County Septic Ordinances/<br>Septic Inspection Assessment -County<br>Septic systems in use education/outreach<br>Determine septic systems still in use in area of WLSSD<br>Data of septic systems failure/in compliance | Watershed | 3,4,14 | 7 | pathogens in water column | leaking septic systems | 12-Jun | Ongoing | $$ | none | Personnel to research, review what is already being done and try to augment. |
| 6 | Body contact Advisories signs | Determine who posts no body contact signs at USX, Stryker Bay and identifying the standard procedures for posting and removing such signs. | MN/WI | 11 | 7 | chemicals in water column | Chemicals | On-going | Ongoing as needed | $ | Local permit | MPCA/ WI DNR |
| 7 | Assessing reduction in wastewater discharges from vessels | Gather and assess data regarding wastewater discharges from vessel in the harbors | Estuary | 3,4,11 | 7 | pathogensand chemicals in water column | Pathogens/chemicals | On going | ongoing | $ | none | |
| 8 | Literature Review of Beach Research | Compile national research information *E. coli* found on beaches | National | 3,4 | 7 | pathogen in water column | Pathogens | 2012 | 2013 | $ | none | Research personnel such as a graduate student |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | Swimmers & Beach user education (once a year) | Conduct annual beach user education effort on proper beach etiquette while on the beach and in the water that will help reduce the presence of *E. coli.* | Watershed | 14 | 7 | Pathogens in water column | pathogens | On-going | On going | $ | none | Educator such as Sea Grant, RPST |

## Key for Sequential List of Prioritized Actions:

Reference numbers for "Type of Action":

1. Monitoring program development
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = <$5M

Reference numbers for BUIs:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Beach Closings and Body Contact Restrictions

Additional analysis and testing through bacterial source tracking is needed to confirm sources of *E. coli* within the AOC. It is anticipated that this sampling could begin in the summer of 2012 with analysis and reporting completed by the end of 2013. The key dependency for this project is obtaining funding for the sampling personnel and lab analysis as well as advancing previous research conducting by Randall Hicks, NRRI.

The City of Duluth and Western Lake Superior Sanitary District (WLSSD) are subject to a Consent Decree with the United States Environmental Protection Agency (EPA) and the Minnesota Pollution Control Agency (MPCA) that mandates the elimination of all overflow points within the sanitary sewer systems of both entities by 2016. Both entities anticipate meeting this timeline and have already spent millions of dollars implementing projects that eliminate untreated wastewater from entering the St. Louis River and Lake Superior. The City of Superior is in the process of reducing sanitary sewer overflows through more effective management of stormwater run-off into their combined sanitary/stormwater sewer system.

A large project that is crucial for achieving the removal of this BUI, as it relates to body contact, is the remediation of the USX site. It is difficult at this time to estimate a cost or timeline for this project. The first action that needs to occur is a comprehensive assessment of the information that has already been documented at the site to identify what cleanup work remains and what restoration work, if any, has already been completed.

A project that could potentially begin in the summer of 2012 is working with the Clean Marinas programs in Minnesota and Wisconsin to recognize participating marinas in both states as Clean Marinas. The Barker's Island Marina in Superior Wisconsin is an example of a Clean Marina that is involved with the program. This would be a relatively low cost project to implement; however, the personnel to carry out the project would need to be identified.

A final project that would start in 2012 would be to complete an assessment of noncompliant septic systems within the AOC and map areas of high risk. The goal of the assessment would be to provide educational materials to residents with septic systems on the proper management and maintenance of a septic system. Again, this would be a low-cost project, but personnel to conduct the research would need to be identified along with a funding source. The MPCA has a staff person, Barb McCarthy (218-302-6647, who has septic information for Minnesota.

## Ongoing Monitoring Needs: Beach Closings and Body Contact Restrictions

The St. Louis River AOC has a number of beach monitoring data sets. Through the Minnesota Lake Superior Beach Monitoring Program, almost 10 years of beach monitoring has been completed on 14 recreational beach sites within the AOC. The EPA's fiscal year 2013 budget removes funding for this program. If this data set is to be kept relevant and useful, funding will need to be found for beach monitoring. In addition, the Beach Monitoring Program tests only for *E. coli* levels in nearshore waters. No testing is done to determine the sources of the bacteria. The BUI team recommends that DNA "fingerprint" sampling be done on problem beaches to identify, and address if possible, sources of bacteria to those beaches. This work could be done in conjunction with sanitary surveys of the beach area and also with TMDL studies conducted within the AOC.

There are body contact restrictions in place at two former industrial sites within the AOC. These sites will be monitored into the future as part of the cleanup process, and particular attention should be paid to the monitoring of water and sediments for the safety of water recreators. Information on the USX and Stryker Bay sites should be compiled and assessed for understanding of additional cleanup needs and risks to human health.

In addition to taking water samples, data should be gathered regarding the compliance rates of individual septic systems. County compliance rates, as well as the level of regulation of these systems, could add valuable information to the body of knowledge regarding sources of bacteria to AOC waters. Also, the BUI team recommends the compilation and assessment of data that will show vessel wastewater discharge incidents to the harbors.

## Future Issues or Concerns: Beach Closings and Body Contact Restrictions

### Beach Closings:

- DNA source tracking will likely show that birds and other wildlife are a major source of the spikes in *E. coli* concentrations that cause beach closings. This source is outside the scope of the AOC program, but it will continue to cause beach closings indefinitely, even after BUI targets have been met. Future issues may include working on ways to control bird and wildlife access at swimming beaches.
- Climate change may cause an increase in major storm events, and the extra runoff will mean more sanitary sewer overflows from the City of Superior's combined sewer system, as well as flashier runoff from the landscape, both of which will continue to cause beach closings due to high *E. coli* concentrations. Larger storm events may also lead to more frequent stirring of sediments, which will release *E. coli* into the water column.
- Other sources of *E. coli* outside the scope of the AOC program include sediments and periphyton, both of which are natural sinks of *E. coli* that release the bacteria through time and are difficult to control.
- Future concerns include maintaining funding both for DNA source tracking as the DNA library expands, and continued beach monitoring on both the Wisconsin and Minnesota sides of the AOC.

- Funding, inspection, and enforcement will need to be ongoing to ensure that vessels and marinas are in compliance with practices that prevent *E. coli* releases.
- Septic systems that may be functioning properly now may fail at some time in the future. Therefore, it will be necessary to track septic system maintenance and compliance to prevent these from being a source of *E. coli* in the water.

## Body Contact Restrictions:

- As more hotspots of contaminated sediment are found in the future in the AOC, more swimmable areas may have body contact restrictions put on them. This may also be the case if further research shows links between low concentrations of contaminants and human health.
- Climate change may cause an increase in major storm events, which increases the likelihood of chemicals being released from contaminated and possibly even remediated areas.
- Any new industry that establishes itself within the AOC must adhere to all permit requirements and monitoring schedules to prevent further contamination of the AOC that could lead to body contact restrictions.
- Another future issue is the length of time it will take for the USX site to be remediated, as delisting this BUI is dependent upon that project.
- Funding, inspection, and enforcement will need to be ongoing to keep vessels and marinas in compliance with practices that prevent releases of harmful chemicals.

## References: Beach Closings and Body Contact Restrictions

Minnesota Pollution Control Agency (MPCA). No date. 2010 Draft 303(d) Impaired Waters List [Data file]. Retrieved from: http://www.pca.state.mn.us/index.php/view-document.html?gid=8260

Minnesota Pollution Control Agency. 2009. St. Louis River Area of Concern Delisting Targets December 2008. Wq-iw1-25.

Wisconsin Department of Natural Resources (WDNR). 2010 Draft 303(d) Impaired Waters List [Data file]. Retrieved from: http://dnr.wi.gov/org/water/condition/2010_IR/Attachment_B_Final%20proposed%202010%20Impaired%20Waters%20List.xls

Wisconsin Department of Natural Resources (WNDR). 2010. St. Louis and Lower Nemadji River Watershed Management Plan. 2010 Water Quality Management Update.

# BUI 8 Blueprint: Degradation of Aesthetics

This section contains the BUI Blueprint for Degradation of Aesthetics. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below, followed by a Summary Statement for this BUI developed by the Team.

## BUI Team Membership

- Julene Boe, SLRA
- Cynthia Hakala, MDH
- Kari Jacobson-Hedin, Fond du Lac Band of Lake Superior Chippewa
- Brandon Kohlts, WLSSD
- Brittany Story, MPCA
- Jenny Thoreson, City of Superior Environmental Services Division

## BUI Team Summary Statement

The aesthetic condition of the river is much better than when this beneficial use impairment was included in the Area of Concern in the 1980s.

The only major action that needs to be done is the cleanup of the USX superfund site. Observations of oil seeping have been reported in this area.

An observation of foam in the area of the dam was reported to the St Louis River Alliance as a part of the survey conducted in September 2011. Since no information has been located on past analysis of foam collected and tested from the St Louis River AOC, the BUI team recommended that further research be completed to determine the composition of foam in northern rivers and to provide that information in the BUI delisting drafts.

It was agreed that efforts need to made to search for further information regarding the status of aesthetics since 2008, when the delisting target for aesthetics was established, from other sources such as:

- Complaint logs of federal, state and local agencies.
- Aerial photos of the estuary from different years to make comparisons of the river's aesthetics.
- Video interviews of local residents made in the 1980s and in more recent years for the purpose of tracking improvements in the river's aesthetics.
- Spill reports and responses (MPCA & WDNR).
- A listing of material handling regulations that exist now that did not exist in the 1970s (prior to the RAP I).

## Rationale for Listing: Degradation of Aesthetics

When any substance in water produces a persistent objectionable deposit, unnatural color or turbidity, or unnatural odor (e.g., oil slick surface scum), the beneficial use of the waterbody is considered impaired. Data specific to this BUI were generally lacking, but anecdotal information was deemed sufficient to make the impairment determination.

The Stage I RAP noted that a systematic collection of data should be conducted to determine specific locations, sources, and types of degradation. Specific aesthetic concerns that were mentioned in the Stage I RAP and subsequent progress reports include:

- Oil, chemical, and tar residue on the water's surface at Hog Island Inlet and Stryker Bay.
- Smells emanating from the sediments and water of Newton Creek and Hog Island Inlet.
- Grain and grain dust blowing into the water of St. Louis and Superior Bays as a result of ship loading operations. This has caused grain to wash up on the shore, and created a layer of black, anaerobic sediment on the bottom of the bay as the grain decomposes.
- Accumulations of foam were found on the river near Fond du Lac and at other locations downstream of Cloquet.

**Stage I RAP Rationale for Listing**

The aesthetic values of the St. Louis River AOC are impaired in some locations. A systematic collection of evidence and data is recommended to determine the specific locations of degraded areas and the sources and types of degrading materials (i.e., oil slicks, chemical and tar residues, taconite pellets on shorelines, rotting grain scum on water surface, etc.). Hog Island Inlet and Stryker Bay are two areas that have had repeated reports of oil, chemical, and tar residues on the water's surface. Complaints have also been registered about smells emanating from the sediments and water of Newton Creek and Hog Island Inlet (MPCA,WDNR Complaint Logs 1980-1990). Shoreline aesthetics will be addressed separately and will be remediated through actions taken with riparian interests.

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 8 - 1. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

**Table BUI 8 - 1: Timeline of Actions: Degradation of Aesthetics.**

| Year | Action |
|---|---|
| 1958 | City of Superior WWTP begin operation with primary treatment |
| 1975 | City of Superior sewer separation project, separating approximately 50% of the City's sewers |
| 1975 | City of Superior's construction of 3 combined sewage overflow treatment plants |
| 1977 | Upgrade to Superior's WWTP to provide secondary sewage treatment |
| 1978 | WLSSD begins operation |
| **1983** | U.S. Steel site was placed on the National Priorities List under CERCLA |
| **1984** | U.S. Steel site was placed on the State of Minnesota's Superfund list |
| 1992 | BUI Listed in Stage I Remedial Action Plan |
| 1993 | |
| 1994 | |
| 1995 | Hog Island/Newton Creek: WDNR found that ecological impacts associated with contamination were severe |
| 1996 | Hog Island/Newton Creek: Murphy Oil Agreed with WDNR to clean up the upstream impundment area and provide $200,000 towards cleanup |
| 1997 | |
| 1998 | Installation of new sewer line and diversion structure along E 2nd St in Superior, which eliminated most sewer bypasses along E 2nd St corridor. |
| | Installation of 2 storage facilities at Lift Stations 5 and 7 in Superior, which provided storage for 450,000 and 900,000 gallons of sewage, respectively. |
| | Replacement and relocation of failing Faxon Creek interceptor in Superior, eliminating a major source of inflow into the sanitary sewer. |
| 1999 | Implementation of the Sanitary Sewer Collection System Cleaning and Inspection Program in Superior with a goal of cleaning and inspecting 100% of sewers every 5 years. |
| 1999 | Installation of an automation and control system in Superior, which allows staff to monitor and respond to potential overflow problems before they occur. |
| 2000 | Implementation of a GIS program in Superior for mapping sewer lines to provide a greater understanding of the system and improved response capabilities. |
| 2001 | |
| 2002 | Foam reported by residents of Water Street in Duluth News Tribune article about St. Louis River flooding. June 25 |

| Year | Action |
|---|---|
| 2003 | Newton creek/Hog Island: Four thousand cubic yards of contaminated sediments and floodplain soils were removed from segments of Newton Creek. |
| | Initiation of the Stormwater Flood Control Program in Superior, to help address basement backups during wet weather events. |
| | WLSSD hired a consulting firm to study the effectiveness of the inflow/infiltration program in the eastern end of the city. The firm found a "significant reduction" in stormwater flow to the sewers. |
| | First season of Lake Superior Beach monitoring program by MPCA. |
| 2004 | |
| 2005 | Sediment cleanup at Hog Island/Newton Creek Complete |
| 2005 | Installation of a sewage storage facility at Lift Station 6 in Superior |
| 2005 | Installation of the South Superior Wet Detention Basin in Superior |
| 2006 | |
| 2007 | |
| 2008 | |
| 2009 | Consent decree filed for City of Duluth and WLSSD sewer overflow control |
| 2010 | Completion of Superior's South Superior Phase II Project, which included the installation of separate storm sewers, redirecting stormwater out of the combined sewers. |
| | Completion of the Billings Park wet detention basin and storm sewer separation project in Superior. |
| 2011 | EPA issues vessels general permit with rules on discharges to water for commercial vessels. Fines given to vessels or fueling terminals with obvious smells or visible oil on water or nearby land. Vessels must notify Coast Guard of spills. |
| | Coast Guard has records of accident reports involving spills on commercial vessels in the AOC for the last decade. The majority of recreational spills go unreported. |
| | Wisconsin's Clean Marinas Guidebook available online. Wisconsin began designating marinas under their program in 2011. Barker's Island Marina pledged to pursue Clean Marina designation on Feb 8, 2011 and in the meantime is working to keep their marina free of chemicals, nutrients and debris. |
| | Potentially harmful chemicals used to clean boats in marinas are not regulated |
| 2012 | Minnesota's Clean Marinas BMP book available early 2012. Gives guidance on fueling, bilge, rules for certification, etc. |
| | Minnesota will begin designating Clean Marinas statewide in spring 2012. Funding is available to designate DNR harbors first. |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 8 - 1) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Degradation of Aesthetics

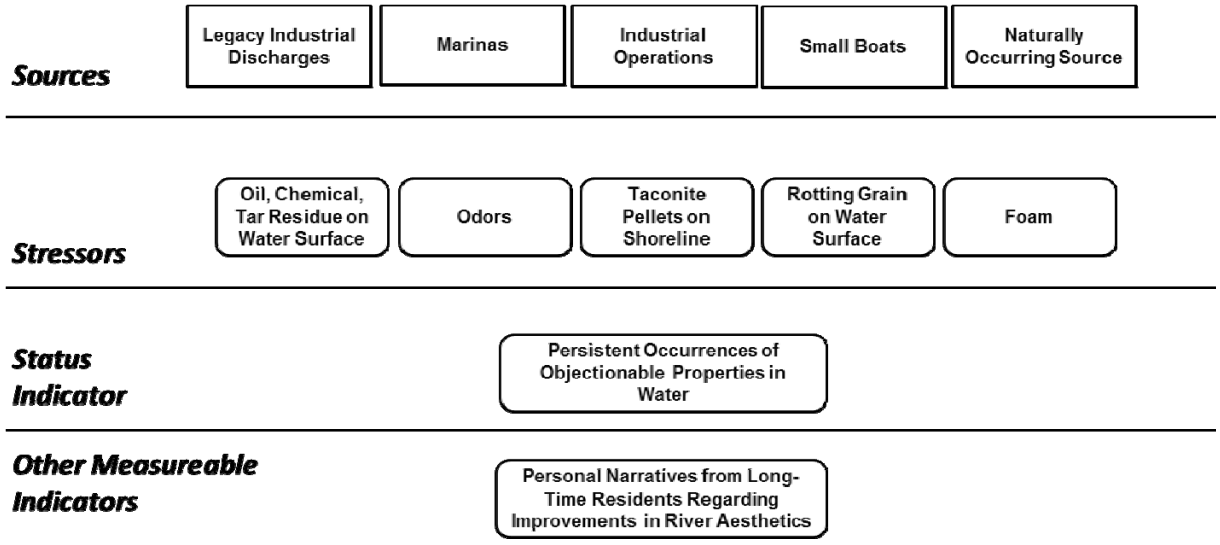


**Figure BUI 8 - 1: Source Stressor Model for the BUI Degradation of Aesthetics.**

Table BUI 8 - 2 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing, and may be local or persist beyond the boundaries of the SLRAOC.

### Table BUI 8 - 2: Description of Sources.

| Source | Description |
|---|---|
| **Legacy industrial discharges** | Historical discharges of contaminants to the AOC that occurred from industrial operations |
| **Industrial Operations** | Ship loading operations in the harbor |
| **Marinas** | Aesthetic pollution sources from marinas include improper disposal of waste and spills of oil, gasoline, and other chemical products |
| **Naturally Occurring Source** | Foam on the river downstream of Cloquet was tested and identified as originating from a naturally occurring source[1] |
| **Small Boats** | Aesthetic pollution sources from small boats include improper disposal of waste and spills of oil, gasoline, and other chemical products |

[1]2001 RAP Progress Report

## Description of Stressors:

At the time the Stage 1 Remedial Action Plan (SLRCAC, 1992) was written, oil, chemical, and tar residues and odors were reported at contaminated sites within the AOC. Industrial operations contributed grain dust on the water surface that has settled into the sediments in some locations, as well as taconite pellets on shorelines. Accumulations of foam were observed on the river downstream of Cloquet. Operations of marinas and small boats have been identified as possible sources of objectionable properties in water.

## Measureable Indicators: Degradation of Aesthetics

The BUI Team has identified indicators of stress that can be measured to assess the status of BUI. These qualitative and quantitative metrics provide the basis for measuring the progress towards delisting a BUI. The status indicators and other measurable indicators for this BUI are presented in Tables BUI 8 - 3 and BUI 8 - 4, respectively. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily imperative information.

### Table BUI 8 - 3: Status Indicators.

| Indicator | Definitions | Target |
|---|---|---|
| **Persistent occurrences of objectionable properties in water** | "Objectionable" is defined as odor, oil or chemical residue, floatables, or bulk materials from industrial activities<br><br>"Persistent occurrences" is defined as objectionable properties that occur more than two times per year and are greater than ten days in duration. | No reported occurrences during the past year |

### Table BUI 8 - 4: Other Measureable Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Personal narratives from long-time residents regarding improvements in river aesthetics** | Video interviews or transcribed narratives | Interviews completed |

## Final Delisting Target: Degradation of Aesthetics

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (MPCA, 2009), is:

> *There are no verified persistent occurrences of objectionable properties in the surface waters of St. Louis River Estuary during the previous five year period. "Persistent occurrences" are defined as objectionable properties that occur more than two times per year and are greater than ten days in duration.*

## Current Conditions: Degradation of Aesthetics

The status of assessment of this BUI is reflected in Table BUI 8 - 5, and is based on the most recently available research and monitoring data compiled and reviewed for this BUI Blueprint.

**Table BUI 8 - 5: Current Conditions Status Check.**

| Check | Yes/No/Unknown | Notes |
|---|---|---|
| **Data for status indicators available?** | Yes | SLRA Survey logs from regular users have not yet obtained. |
| **Data for status indicators assessed?** | No | Boat launch and public meeting survey results have been collected and tabulated, but not analyzed with respect to targets; volunteer logs not yet received. |
| **Status indicator targets set?** | Yes | |
| **Status indicator targets met?** | Unknown | |

## Description of Most Recent Data Sets for Status Indicators:

### Persistent Occurrences of Objectionable Properties in Water

Members of the St. Louis River Alliance (SLRA) conducted surveys of users at boat launches in the AOC regarding river aesthetics on September 10 and 17, 2011. On each date, surveys were conducted at boat launches in Minnesota and Wisconsin (Figure BUI 8 - 2). In addition, two public meetings were held to gather further surveys: September 21 in Wisconsin and September 22, 2011 in Minnesota.

Survey questions covered the following information:

- Area of the river used
- Date of most recent activity on the river
- Frequency of recreational use of the river
- Historic time period of recreational use of the river (years of use)
- Improvements in river aesthetics over time for long time users
- Observations of objectionable substances on the river
- Frequency of observation of objectionable substances
- Relative concern regarding observation of objectionable substances
- Whether observations of objectionable substances were reported to a government agency

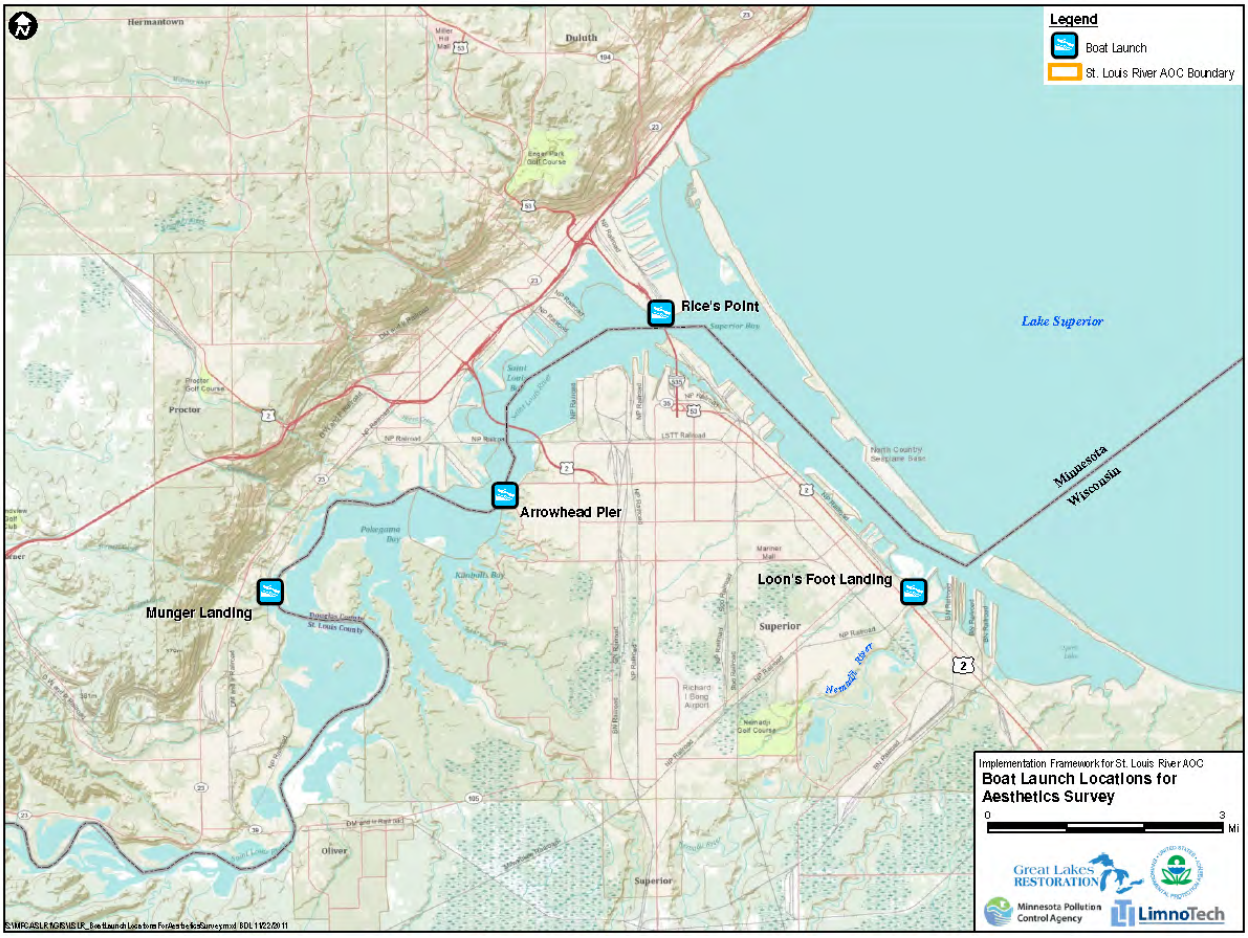


**Figure BUI 8 - 2: Boat Launch Locations for SLRA Aesthetics Survey.**

In addition the surveys, SLRA provided logs to six volunteers who use the river regularly. Volunteers were asked to record the following information on the logs:

- Date
- Location
- Presence of:
    - oil, chemical or tar residues
    - grain or grain dust
    - taconite
    - foam
- Other observations

Volunteers using the logs were requested to contact the SLRA if any of the substances above were observed more than twice in one week.

## Current Conditions for Status Indicators:

### Persistent Occurrences of Objectionable Properties in Water

Survey data from the boat launch visits and public meetings were compiled by the SLRA. A total of 19 surveys were collected at boat launches; three surveys were collected at the public meetings. Survey responses have not been analyzed with respect to meeting targets for this BUI. Volunteer logs have not yet been returned to the SLRA.

## Information Gaps: Degradation of Aesthetics

- Follow up testing of foam—cannot find past lab analysis of foam. Look into research of foam stating that it is naturally occurring. Will include research on subject rather than samples.
- Record of harbor complaint logs.
- Documented regulations regarding cargo handling and vessel discharges as well as marina BMP
- What other information is necessary to support delisting? Recording narratives of long-time AOC residents regarding improvements in river aesthetics has been suggested as an indicator to support delisting this BUI.
- Conduct a follow-up survey of public observations of the current condition of aesthetics.
- A compilation of materials handling regulations by both Minnesota and Wisconsin (and any federal requirements) that are in place now and compliance, including Clean Marina activity, should be part of the documentation that this BUI could be removed.
- Incorporate Remedial work done on Stryker Bay/ Slip 6/ and Slip 7 into the removal drafts.
- Equalize timeline comments on wastewater treatment plants for both Duluth and Superior. Example: Get more highlights from WLSSD.
- List NPDES permit requirements in estuary and watershed (MPCA).
- Compile air quality data on particulates in AOC to show decrease (MPCA/WDNR).

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions included in this list include those selected to address data and information gaps, monitoring and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table BUI 8 - 5, followed by a supplementary table key.

## Table BUI 8 - 5: Sequential List of Prioritized Actions: Degradation of Aesthetics.

| Project Sequence | Project Title | Description of Action and Rationale | Location Indicate waterbody, site name, or other geographic reference | Type of Action Enter number(s) from table key, separated by commas | BUI(s) Involved Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration Enter "Ongoing" for actions that will occur continue over time | Estimated cost See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | USX Remediation | Compile and assess information on the USX site (MPCA, NRDA settlement, etc.) Document cleanup efforts and what restoration work has been done, if any. | MN/WI | 1,2,3,4,5,6,7,8,9,10,11,12,14 | all | Persistent occurrences of objectionable properties in water, body contact advisories | All | Unable to determine | Unable to determine | $$$$$$ | yes, 404,401,wetlands, etc | Personnel to make a project plan, form partnerships, procure permits, hire contractors, and conduct restoration and remediation work. Funding |
| 2 | NPDES permitting regulations | List MPCA/WDNR regulations regarding NPDES permits and standards. List of permitees in watershed. | MN/WI | 3,11 | 6,7,8 | Persistent occurrences of objectionable properties in water. | Industrial operations (odors, chemical, and foam) | 2013 | 2013 | $ | None | Personnel to review NPDES regulations. |
| | Compile Air Data | Compile and assess air data for particulate matter in the AOC. Look for a decrease over time to get at the taconite/grain dust issue. | MN/WI | 3.4.11 | 8 | Persistent occurrences of objectionable properties in water. | Industrial Operations (rotting grain) | 2013 | 2013 | $ | None | Personnel to review data in MN and WI |
| 2 | Determine the need to collect and test foam from below the Fond du Lac dam, and other complaints of persistent foam | Determine if there have been two or more reported occurrences in one year of the presence of foam lasting more than five days. Conduct literature review of research on foam in rivers similar to St. Louis. Include publications and appendices. | SLR below the dam | 2,3,4 | 8 | Persistent occurrences of objectionable properties in water. | Foam | 2012 | 2012 | $ | none | Personnel for research. |
| 3 | Survey public users of the river. | Develop an appropriate sampling protocol for surveying public observations of the current condition of aesthetics. The results of this sampling provide measureable results that can be used to determine if any of the conditions listed for this BUI still exist. | At boat launches and marinas in MN and WI on the SLR | 1,2,3,4, | 8 | Persistent occurrences of objectionable properties in water | All | 2013 | 2013 | $ | None | Personnel for conducting and compiling surveys. |
| 3 | Use surveys information to direct monitoring | Follow up on substances that have been reported by river users to determine the type and extent of reported substances | SLR at location where aesthetic issues have been noted on surveys | 1,2,3,4, | 8 | Persistent occurrences of objectionable properties in water | All | 2012 | 2012 | $ | None | Personnel for follow up activity, boat to get to noted locations on the river |
| 4 | Clean Marina MN & WI | Use clean Marina BPM handbook to help designate marinas in SLR estuary. WI has handbook. MN is coming out with one. Marinas will pass them out to boaters. | SLR Estuary | 10,14 | 8 | Persistent occurrences of objectionable properties in water. | oil, bilge water, soap, debris, chemicals, nutrients | 2012 | On going | $ | None | Personnel for working with SLR marinas to sign them up for the Clean Marinas program. Partner with MN DNR. Funding to purchase Clean Marinas BMP handbooks. |

| Project Sequence | Project Title | Description of Action and Rationale | Location<br>Indicate waterbody, site name, or other geographic reference | Type of Action<br>Enter number(s) from table key, separated by commas | BUI(s) Involved<br>Enter number(s) from table key, separated by commas | Indicator(s) Involved | Source or Stressor Involved | Start Date | Duration<br>Enter "Ongoing" for actions that will occur continue over time | Estimated cost<br>See key above and enter appropriate "$" level based on best professional judgment | Permitting requirements | Important resources needed (landowner, project leader, etc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | Coast Guard logs of illicit commercial vessel discharges and reports of spills in the SLR AOC and review cargo handling regulations | Compile and assess Coast Guard spill logs showing a decrease in discharges of listed substances over time with stricter regulations like the Vessel General Permit. Determine improvements in handling cargo such as grain and taconite cargos | Illicit discharges and spill logs for the SLR within the AOC | 3,4,11 | 8 | Persistent occurrences of objectionable properties in water. | All | June 2012 | Aug 2012 | $ | None | Permission from the Coast Guard for access to their logs. Personnel for reviewing complaint logs |
| 5 | Compile logs of complaints from other state agencies regarding reports of substances listed in the Aesthetics BUI | Compile logs in both Minnesota and Wisconsin to show a decrease in aesthetics complaints by public or private entities over time. | SLR Estuary | 3,4 | 8 | Persistent occurrences of objectionable properties in water. | All | June 2012 | Sept 2012 | $ | None | Personnel for reviewing and assessing logs from state agencies. |
| 6 | Video vignettes of public observations of aesthetics in the estuary | Compare video interviews from the past to the present to document any observed improvement in aesthetics. | SLR Estuary | 2,3,4 | 8 | Personal narratives from long-time residents regarding improvements in river aesthetics | All | June 2012 | Sept 2102 | $ | None | Personnel for viewing and assessing past video recordings. |
| 8 | Aerial Photo Analysis | Compare aerial photos of sites known to have aesthetic problems, such as USX, Stryker Bay and Hog Island. Document changes over time. | SLR Estuary | 2,3,4 | 8 | Persistent occurrences of objectionable properties in water. | All | June 2012 | Oct 2012 | $ | None | Personnel for reviewing aerial images and assessing changes to river aesthetics over time. |

## Key for Sequential List of Prioritized Actions

Reference numbers for "Type of Action":

1. Monitoring program development
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = <$5M

Reference numbers for BUIs:

1. Fish Consumption Advisories
2. Degraded Fish and Wildlife Populations
3. Fish Tumors and Deformities
4. Degradation of Benthos
5. Restrictions on Dredging
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings and Body Contact
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Degradation of Aesthetics

Significant improvements have been made on the aesthetics of the St. Louis River since its AOC listing in 1989. Two contaminated sites have been placed on the National Priorities List under CERCLA in MN. Cleanups of the contaminated sights on the list are to be, or have been, remediated and are eventually to be restored. Cleanup of SLIDRT site is completed. The Wisconsin site listed in the Stage I RAP, Hog Island/Newton Creek, had remediation completed in 2005.

Major improvements have also been made on sanitary sewers in the cities of Duluth and Superior, and continuous projects will keep improving control of overflows with goals to eliminate overflows in years to come. These improvements are noted on the aesthetics timeline.

Oil, chemical, tar, grain dust, and emanating smells have either completely diminished or have become a minimal concern on the aesthetics of the river. One contributing factor remaining is possible oil sheens from the future remediation site USX. This site is a Superfund Site that will be addressed in the near future at an estimated amount of $50 million dollars.

The estimated costs of the Degradation of Aesthetics removal had been estimated to be < $80,000. This amount excludes the cleanup of the USX superfund site.

The estimated cost of < $80,000 would be used to:

- Perform a river user survey and use the information to direct future monitoring needs.
- Implement the practice of Clean Marina BMPs in the estuary.
- Compile and review Coast Guard logs of spills in the estuary and review cargo handling operating procedures.
- Compile and review complaint logs in agencies in MN and WI that document listed substance complaints.
- Compile existing materials handling regulations.
- Assemble video vignettes of public observations concerning the previous and present state of the estuary.
- Compare historical photos documented to recent aerial images.

The estimated timeline excluding the USX cleanup is October 2013. If the USX remediation is included, the time is an estimation of 2020.

## Ongoing Monitoring Needs: Degradation of Aesthetics

There should be little need for ongoing monitoring for aesthetics once this has been removed. Programs are in place at MPCA and WDNR to address any reported occurrences and rapid spill responses. The named substances have not been reported for several years because of regulations that have improved of cargo handling and other means that have reduced the occurrences of these substances. Any reoccurrence of any of these substances should be dealt with if and when they occur.

## Future Issues or Concerns: Degradation of Aesthetics

While the substances that caused this beneficial use impairment may no longer be a problem, there may be other issues that may negatively affect the aesthetics. As the river improves there will be an increase in public use of the river for boating, fishing, and other recreational uses that may increase debris on the river, which is an issue in most urban areas. Also, an increase in commercial and residential development along the river may also affect the aesthetics with debris blown into and other pollutants such as oil/detergents washed into the river through stormwater points.

## References: Degradation of Aesthetics

Minnesota Pollution Control Agency. 2009. St. Louis River Area of Concern Delisting Targets December 2008. Wq-iw1-25.

St. Louis River Citizens Action Committee (SLRCAC). 1992. St. Louis River System Remedial Action Plan. Stage One.

# BUI 9 Blueprint: Loss of Fish and Wildlife Habitat

This section contains the BUI Blueprint for Loss of Fish and Wildlife Habitat. The blueprint is organized into the major components of each BUI Blueprint as described in the introduction to this appendix. The BUI Team members and their affiliations are listed below, followed by a Summary Statement for this BUI developed by the Team.

## BUI Team Membership

- John Lindgren, MDNR
- Rick Gitar, Fond du Lac Band of Lake Superior Chippewa
- Ted Angradi, U.S. EPA Mid-Continent Ecology Division
- Joshua Bailley, Audubon Minnesota
- Pat Collins, US Fish and Wildlife Service
- Joel Hoffman, U.S. EPA Mid-Continent Ecology Division
- Nancy Larson, WDNR
- Marth Minchak, MDNR
- Daryl Peterson, Minnesota Land Trust
- Shon Schooler, Lake Superior NERR
- Rich Staffon, MDNR
- Fred Strand, WDNR
- Dan Weber, US Department of Agriculture

## BUI Team Summary Statement

The team focused on the task of transforming the information contained in the Lower St. Louis River Habitat Plan (Habitat Plan; SLRA, 2011) into the Beneficial Use Impairment (BUI) Blueprint format of the St. Louis River AOC implementation Framework. The Habitat Plan identified 37 conservation targets in six broad categories. Conservation targets, which define critical elements of biological diversity, were defined for all of the aquatic habitats and plant communities of the Lower St. Louis River and surrounding uplands. The Habitat Plan identified five major threats to the conservation targets (habitat loss, sedimentation, invasive species introduction, exposure to contaminated sediments and degradation of water quality), which correspond to the “sources” in the source/stressor model. The Habitat Plan Implementation Strategies (projects), which are the means to mitigate the described threats, were integrated into the BUI blueprint’s “Sequential List of Prioritized Actions.”

The team acknowledged that impacts to the conservation targets by sources (threats) and resulting stressors have been reduced since the passing of the Clean Water Act and the establishment of the Western Lake Superior Sanitary District (WLSSD) in 1979. Local resource professionals have observed slow but steady improvements to the habitat quality of the conservation targets. However, it was also acknowledged that there is a strong need to identify and monitor status and trends in measureable indicators that can quantifiably define progress towards delisting this BUI. As a result of projects recently initiated by local resource management agencies and several others identified in the information gaps section in this blueprint, there will soon be an integrated, multi-level GIS-based tool to

quantify progress towards delisting. Populating the "timeline of actions" and the "prioritized actions" tables also highlighted the substantial progress that has already been accomplished by resource management agencies towards reducing the threats and moving the AOC towards delisting.

## Rationale for Listing: Loss of Fish and Wildlife Habitat

When fish and wildlife management goals have not been met as a result of loss of fish and wildlife habitat because of a perturbation in the physical, chemical, or biological integrity of the Boundary Waters, including wetlands, the beneficial use of the waterbody is considered impaired. Fish and wildlife habitat in the AOC was determined to be threatened by development, exotic vegetation, and likely by contaminated sediments and high sedimentation rates.

There was little specific information documenting the cumulative loss of fish and wildlife habitat in the AOC. However, a number of factors were cited in the Stage I RAP related to impairment of use:

- Habitat within the estuary has been extensively altered. Over 3,000 acres of marsh and open water had been filled in the lower estuary (below the former Arrowhead Bridge), and roughly 4,000 acres of the estuary has been dredged based on Wisconsin Department of Natural Resources estimates.
- USACE Section 404 permit recoreds for three counties that lie partly within the watershed documented a net loss of nearly 440 acres of wetlands between 1981 and 1991.
- The proliferation of purple loosestrife, an exotic plant introduced from Europe, led to a decline in the quality of wetland habitat. No specific impacts were documented within the estuary, but purple loosestrife has the potential to

**Stage I RAP Rationale for Listing**

In the past, fish habitat in the estuary was degraded because of impaired water quality. Currently, contaminated sediments may cause habitat degradation in several areas of the river system. Habitat degradation from sediment contamination has been documented in two areas: Stryker Bay (Interlake Superfund site vicinity), and Newton Creek/ Hog Island Inlet of Superior Bay. High rates of sedimentation in the estuary during the 20th century, with ensuing turbidity and reduced light penetration, may limit macrophyte growth and therefore limit fish and wildlife habitat. Habitat loss from sedimentation has not been documented for specific areas. Wetland habitat is being degraded by the infestation of purple loosestrife. Fish and wildlife populations have not yet been noticeably affected by this infestation, but the potential exists if the loosestrife continues to spread.

The St. Louis River estuary has relatively large areas of undeveloped shoreline and wetland habitats, compared with many other Great Lakes Areas of Concern. Protection of these habitats is important to the stability of fish and wildlife communities. Critical habitats for some important fish and wildlife species have been identified and should be protected from loss through development or other degradation. Identification of important and critical habitats in the river system will be a continuing activity through the RAP and other planning efforts.

crowd out existing vegetation, reduce food and cover for wildlife, and eliminate access to fish spawning habitat.

- Degradation of the benthic community and the presence of contaminated sediments likely led to impairment of biological habitat for fish and wildlife. For example, Stryker Bay appeared to have a degraded benthic community (MPCA 1990), and this area was poorly utilized by game fish (Spurrier 1991).
- Erosion from the watershed resulted in suspended red clay turbidity in the lower river and estuary. High turbidity and color may limit algal and macrophyte growth. Sedimentation also affects benthic communities, but there was insufficient information to assess potential impacts within the AOC.
- A habitat characterization study (Spurrier 1991) found that the lower St. Louis Bay provided important nursery areas for young of the year game fish, and the upper estuary had important areas for adult game fish and forage species. Areas near the Interlake Superfund Site and Stryker Bay were rated as less than desirable for adult and young of the year game fish.

A timeline of the actions related to this BUI was developed by the BUI Team and is presented in Table BUI 9 - 1. These actions consist of a historical record of events that contributed to the listing of each BUI; local, state, and federal actions associated with the continuation or mitigation of impairments; stakeholder involvement; and future planned implementation actions for delisting the BUI. The timeline should not be considered exhaustive.

**Table BUI 9 - 1: Timeline of Actions: Loss of Fish and Wildlife Habitat.**

| Year | Actions | Agents |
|---|---|---|
| 1978 | Herding Island WMA (29.2 acres) established | MNDNR |
| 1979 | WLSSD online | WLSSD |
| | Interstate Island WMA (6.3 acres) established | MNDNR |
| 1982 | Draft management plans developed for Herding and Interstate WMAs | MDNR |
| 1983 | | |
| 1984 | | |
| 1985 | | |
| 1986 | | |
| 1987 | Interstate Island habitat restoration | MDNR, WDNR |
| | Interlake Superfund site | Interlake |
| 1988 | | |
| 1989 | | |
| 1990 | | |
| 1991 | Creation of DMMP | Harbor Tech Adv Comm |
| 1992 | | |
| 1993 | | |
| 1994 | | |
| 1995 | Biocontrol of purple loosestrife initiated | MDNR, 4H, Girl Scouts |
| | St. Louis/Red River Stream bank Protection Area aquired | WDNR |

| Year | Actions | Agents |
|---|---|---|
| | Park Point beach grass restoration | Park Point Community Club |
| | Riparian land acquisition on St. Louis River | MDNR, MN Power |
| | St. Louis River Wild Rice Restoration | Fond du Lac |
| 1996 | Grassy Point restoration | MDNR |
| 1997 | | |
| 1998 | Park Point forest preservation (SNA) | MDNR, MN Land Trust |
| | Miller Creek restoration | Miller Ck Task Force |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | Oliver Marsh preservation | Douglas Co, TNC |
| | Lower St. Louis River Habitat Plan finalized | St. Louis River AOC |
| | Buckthorn control | SLRA, City of Duluth |
| | Southworth Marsh protection on Park Point | City of Duluth |
| 2003 | | |
| 2004 | Piping plover habitat restoration on Wisconsin Point | WDNR |
| | Lower St. Louis River Estuary Wild Rice Restoration Pilot | SLRCAC Habitat Work Group |
| 2005 | Hog Island remediation/restoration | Douglas Co, WDNR, EPA, City of Superior |
| | Magney-Snively DNAP preservation | City of Duluth |
| | FERC relicensing of St. Louis River dam/reservoir system | FERC |
| 2006 | | |
| 2007 | | |
| 2008 | Bluff Creek watershed land preservation | WW Land Trust |
| | Upper Nemadji watershed protection | Douglas Co. |
| 2009 | Fond du Lac channel restoration | MDNR |
| | Lake Superior NERR Management Plan | LS NERR, UWS |
| | Central Park Creek habitat restoration | City of Superior |
| | Sturgeon spawning habitat created downstream of Fond du Lac Dam | TNC, MDNR |
| 2010 | Clough Island preservation | TNC, WDNR |
| | Tallus Island habitat restoration | Interlake |
| 2011 | Spirit Island preservation | Fond du Lac |
| | Tree planting on cold water streams | Duluth Stream Corp |
| | Phragmites control | Douglas Co. |
| 2012 | Management guidance docs completed for Herding/Interstate WMAs | MNDNR |

Each BUI results from multiple sources that exert varying degrees and types of stress on a particular beneficial use. Consequently, the sources, stressors, and indicators of those stressors are intricately related. The source/stressor model (Figure BUI 9 - 1) was developed as a conceptual representation of the sources and stressors for this BUI and appropriate indicators for assessing the condition of this BUI. The status indicators are intended to represent the primary indicators of BUI condition, while other measurable indicators provide supporting, but not imperative, information for assessing the BUI. The source/stressor model was developed based on existing knowledge and the expertise of the BUI Team.

## Source/Stressor Model: Loss of Fish and Wildlife Habitat

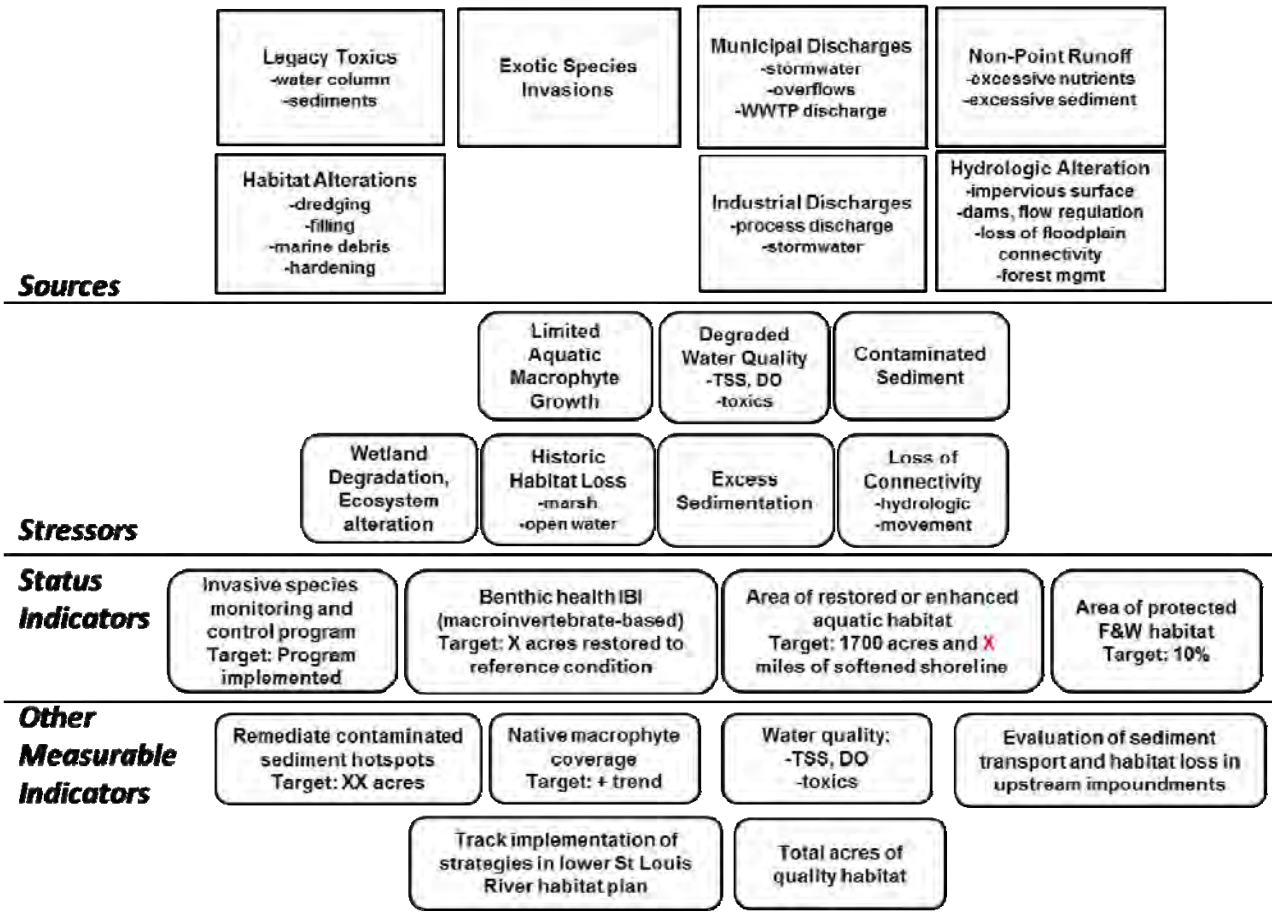


**Figure BUI 9 - 1: Source Stressor Model for the BUI Loss of Fish and Wildlife Habitat.**

Table BUI 9 - 2 provides a description of the various sources that impact this BUI. Sources may be historical or ongoing, and may be local or persist beyond the boundaries of the SLRAOC.

### Table BUI 9 - 2: Description of Source Types.

| Source | Description |
|---|---|
| **Legacy Toxics in Sediments and Water Column** | Historical discharges of toxics[1] to the AOC that occurred from municipal and industrial operations, potential for ongoing resuspension and redistribution |
| **Habitat Alterations** | Habitat alterations include destruction of habitat through dredging, filling, marine debris, historic industrial discharges, and shoreline hardening |
| **Industrial Discharges** | Permitted industrial water discharges within the AOC |
| | Permitted industrial stormwater discharges within the AOC |
| **Nonnative Invasive Species Invasions** | Includes invasions of terrestrial and aquatic species, including those resulting from ballast water discharges and regional introductions |
| **Municipal Discharges** | Municipal WWTP discharges to the AOC |
| | Municipal overflows from WWTPs and their collection systems within the AOC |
| | Stormwater runoff from regulated municipal separate storm sewer systems (MS4s) and construction in the AOC; this includes both sewered and un-sewered urban runoff |
| **Nonpoint Runoff** | Runoff from non-regulated rural areas within the AOC, including residential, silviculture, agriculture, animal waste, feedlots and erosion; resulting in excessive nutrients and sediments |
| **Hydrologic Alteration** | Altering of natural hydrologic regime through increased impervious surfaces from development, the presence of dams and flow regulation associated with them, loss of floodplain connectivity, and forest management |

[1]Specific toxic chemicals of concern will be defined on a site by site basis once characterization of sediments in the AOC is complete.

## Description of Stressors:

The cumulative impact of the identified source types (threats) has resulted in impairments to critical fish and wildlife habitat within the AOC (Table BUI 9 - 3). Prior to establishment of WLSSD in 1979, identified sources of stress were severely limiting the biological functions of fish and wildlife habitat. Presence of contaminated sediments, degradation of water quality by industrial and urban discharges, and excessive sedimentation limited the ability of the ecosystem to support aquatic plants. Other ecological functions and ecosystem services were similarly impaired. Stressors in developed portions of the AOC also resulted in hardening of shorelines and alteration of benthic composition within the littoral zone as a result of industrial and urban runoff. Stressors to habitat within the industrialized portion of the AOC persist and will require mitigating actions. Impacts of several stressors to habitat within the less developed portion of the AOC began to improve after establishment of WLSSD, but are still acute at specific sites such as the U.S. Steel Superfund Site and some of the bays that supported historical sawmill operations. Introduction of new nonnative invasive plants and animals has slowed in recent

years, and resource professionals speculate that negative impacts of exotic species have been dampened by improvements in habitat quality, which has resulted in the increased abundance of native species. Although hydrologic alteration continues to be a significant stressor within the AOC, regulation of Minnesota Power's hydroelectric facilities and the implementation of stormwater management have reduced some of the impacts to the estuary.

### Table BUI 9 - 3: Description of Stressors.

| Stressor | Description |
|---|---|
| **Limited Aquatic Macrophyte Growth** | Negative impacts to the biological function of the benthos resulting from ongoing legacy contamination, industrial runoff, and marine debris limit the ability of benthic substrate to support the growth of aquatic plants. |
| **Wetland Degradation, Ecosystem Alteration** | Negative impacts to the biological function of the benthos from ongoing legacy contamination, industrial runoff, exotic species and marine debris limit the ability of the benthos to support the growth of aquatic plants. Terrestrial habitats negatively impacted by urban and industrial development |
| **Historic Habitat Loss** | Terrestrial and aquatic habitat functions negatively impacted by historic industrial and urban development. |
| **Degraded Water Quality** | Contaminated sediments, suspended sediments, and organic sediments historically deposited or continually being discharged into the AOC, impairing fish and wildlife habitat and reducing biological productivity. |
| **Excess Sedimentation** | Excess suspended sediments reduce light penetration, decrease algal and higher plant photosynthesis, and affect visual predators and their prey. Sediment loading smothers habitat and mechanically abrades sensitive tissues of aquatic organisms (e.g., gills). Increased transportation of nutrients, adsorptive contaminants, and organic matter contributes to oxygen depletion as it decays. |
| **Contaminated Sediment** | Legacy contamination limits the ability of the benthos to support healthy biological functions, including benthic macroinvertebrates and aquatic macrophytes. |
| **Loss of Connectivity** | Human alterations to hydrologic connectivity limit natural sediment transport resulting in both sediment starvation and excessive sedimentation. Interruption of connectivity also negatively impacts movement of fish and wildlife populations. |

## Final Delisting Target: Loss of Fish and Wildlife Habitat

The Final Delisting Target for this BUI, as established by stakeholders in 2008 (MPCA, 2009), is:

> *State resource management agencies concur, in consultation with their federal, tribal, local, and nonprofit partners, that a reasonable amount of fish and wildlife habitat, given the presence of industrial development in the estuary, that is currently degraded is enhanced, rehabilitated, and protected against further loss of habitat.*
>
> *The following benchmarks could be used as an interim guide:*
>
> - *All contaminated sediment hotspots within the AOC have been identified, implementation actions to remediate contaminated sites have been completed; and*
> - *Programs are in place to discourage further proliferation and to prevent further introduction of non-native invasive species; and*
> - *At least 50% of known degraded aquatic habitat acreage (approx. 1700 acres) is rehabilitated through implementation of projects, such as those outlined in the Lower St. Louis River Habitat Plan (SLRCAC, 2002), Appendix 9 – Habitat Plan Implementation Strategy Worksheets (SLRCAC, 2009); and*
> - *Additional aquatic or hydrologically connected habitat throughout the AOC watershed has been successfully protected and rehabilitated sufficiently to maintain healthy fish and wildlife populations through implementation of projects, such as those outlined in the Lower St. Louis River Habitat Plan (SLRCAC, 2002), Appendix 9 – Habitat Plan Implementation Strategy Worksheets (SLRCAC, 2009).*

## Measureable Indicators: Loss of Fish and Wildlife Habitat

The Final Delisting Target for this BUI, as established by stakeholders in 2008, describes a process that leads to delisting through concurrence between State resource management agencies in consultation with other AOC partners. In the absence of defined and measureable indicators, benchmarks were identified that could be used as an interim guide, while more precise measures were developed. The team identified four primary status indicators and six other measureable indicators to quantify progress towards delisting Loss of Fish and Wildlife Habitat as a BUI of the St. Louis River AOC.

The BUI Team has identified indicators of stress that can be measured to assess the status of BUI. These qualitative and quantitative metrics provide the basis for measuring the progress towards delisting a BUI. The status indicators and other measurable indicators for this BUI are presented in Tables BUI 9 - 4 and BUI 9 - 5, respectively. As described above, the status indicators can be considered the primary indicators of BUI condition, while other measureable indicators provide supporting, but not necessarily, imperative information.

### Table BUI 9 - 4: Status Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **1. Invasive Species Monitoring and Control Program** | Program implemented | Yes |
| **2. Benthic Health IBI (macroinvertebrate-based)** | Acres restored to reference condition | **X** acres (indicator target will be based on GIS analysis currently being completed by AOC partners) |
| **3. Area of restored or enhanced aquatic habitat** | Acres and shoreline miles | 1,700 acres of aquatic habitat (interim target) and **X** miles of de-hardened shoreline (both indicator targets will be based on GIS analysis currently being completed by AOC partners) |
| **4. Area of protected fish and wildlife habitat** | Acres of riparian parcels | Establish target percentage of available riparian land (immediately adjacent to the estuary) in long-term protection |

### Table BUI 9 - 5: Other Measureable Indicators.

| Indicator | Measurement Basis | Target |
|---|---|---|
| **Remediate contaminated sediment hotspots** | Acres | **X** acres (based on GIS analysis of identified hotspots) |
| **Native macrophyte coverage** | Acres | Target defined-based GIS analysis currently being completed by AOC partners |
| **Water quality (total suspended solids, dissolved oxygen and toxics)** | Benchmarks established for each water quality indicator | Water quality exceeds identified benchmark at index locations for all water quality indicators |
| **Evaluation of sediment transport and habitat loss in upstream impoundments** | Study complete | Yes |
| **Track implementation of strategies in lower St. Louis River Habitat Plan** | Projects Completed | All projects identified in the roadmap as critical to delisting this BUI are completed |
| **Area of high quality habitat** | Acres | Concurrence by resource managers that area of quality habitat has been restored or protected based on previously defined indicators |

## Current Conditions: Loss of Fish and Wildlife Habitat

The status of assessment of this BUI is reflected in Table BUI 9 - 6 and is based on the most recently available research and monitoring data compiled and reviewed for this BUI Blueprint.

### Table BUI 9 - 6: BUI Current Conditions Status Check.

| Check | Yes/No/Unknown | Notes |
|---|---|---|
| **Data for status indicators available?** | Data available for almost all indicators | Almost all necessary datasets are available or are currently being collected |
| **Data for status indicators assessed?** | Status of assessment is variable depending on the dataset | Although a substantial amount of assessment work has been or soon will be completed, a relatively small amount of funding support would result in the assessment of almost all critical datasets. |
| **Status indicator targets set?** | Most indicators do not yet have targets established | A relatively small amount of funding support would result in available datasets being synthesized into targets for status and other measureable indicators |
| **Status indicator targets met?** | No indicator targets have been met | Completion of the worked defined in previous three sections will result in a detailed process to assess to progress towards meeting the status and other measureable indicators |

### Background Information:

The Team identified datasets and pathways for addressing each status indicator. They also identified the current condition of the datasets and needs associated with utilizing them as measures of progress towards delisting. It was understood that additional datasets exist that correlate to "Other Measureable Indicators." Although these datasets were not defined as primary measures of progress towards delisting, they should continue to be incorporated into the decision making process as funding and staff availability allow.

## Current Conditions for Status Indicators:

### Invasive Species Monitoring and Control Program

- ***Monitoring Program:***
  - USEPA and USFWS have conducted nonnative invasive species early detection monitoring in the estuary.
  - USEPA and USFWS currently have funding through GLRI to implement an exotics monitoring program (multi-gear/annual) in the estuary. This is a Great Lakes-wide effort. There is a Regional Red List of exotic species called GLANSIS. The program will develop monitoring strategies, sampling frequency and target sampling locations. Fisheries staff from Fond du Lac assist in these efforts.
  - This is only a monitoring program and will not result in a rapid action response to newly identified exotic species.
  - Needs: Because the program is funded by GLRI, it is subject to termination by the removal of financial support.
  - Timeline: The program will be ongoing dependent upon funding.

- ***Nonnative Invasive Species Action Plan:***
  - The Plan will most likely be developed through collaboration between NERR, USEPA, FWS and Sea Grant and referencing the Lake Superior Complete Aquatic Invasive Species Prevention Plan. Funding will be needed to support accomplishment.
  - The Plan should identify how to reduce the risk of the AOC being a vector for movement of nonnative invasive species to inland waters and other estuaries.
  - The Plan should develop a framework for a rapid response to newly identified species that resource management professionals can utilize to determine most appropriate actions. Plan should be relatively short (15 – 20 pages).
  - Needs: Funding. Determine how the ballast water initiative fits into the AOC plan for exotic monitoring and response. Need to determine the handling of species identified in the Delisting Targets from those that have been introduced after.
  - Timeline: The plan could be completed within 1.5 years if funding is acquired.

## Benthic Health IBI

- *Datasets Associated With Indicator:*
  - *USEPA* – 140 data points collected in 2005 and 2006. The data points were spatially balanced with a random design from Fond du Lac to Lake Superior. Approximately 240 species were identified from this dataset.
  - *MPCA* – Samples of the benthos were collected concurrently with sediment cores collected by MPCA for contaminated sediment analysis over the last few years. The samples are being retained by USEPA (EPA-MED), but have not been analyzed.
  - *40th and 21st Remediation to Restoration (R2R) Process* – Samples for analysis of benthic macroinvertebrates were collected and analyzed at R to R sites as part of the USFWS funded Ecological Design Modeling project.
- *Needs:* Acquire funding for the processing of samples collected during MPCA contaminated sediment sampling. Develop a team to synthesize and collate all the datasets. There is also a need to develop an analysis of improved benthic condition/area as a result of removing point source pollution (WLSSD) and completion of projects such as Hog Island, SLRIDT and Tallas Island to define the baseline and current situation.
- *Synthesis:* Develop a GIS-based map of the entire estuary and determine current conditions. The development of a map/model that integrates substrate type, sediment chemistry, and benthic macroinvertebrate community composition across the estuary could enable predictions be made to: 1) anticipate improvements in BMI community conditions following remediation and restoration project; 2) quantify where and how much BMI community conditions in the estuary are negatively impacted by chemical and physical impairments; 3) identify suitable quantitative delisting targets; and 4) make conclusions about when they are met.
- *Timeline:* If an AOC team is formed to accomplish this task, a benthic IBI target could be established by the end of winter 2012/2013.

## Area of Restored or Enhanced Aquatic Habitat

- *Datasets Associated with Indicator:* Acres of wetland restored and distance of shoreline softened. Additionally, distance or area of transition zones restored or established may be used as an indicator.
  - *MDNR 2010 Point-Intercept Study*: Approximately 680 data points, distributed at 200-meter intervals from the Harbor to the Fond du Lac Dam. These data have been analyzed by MDNR through their standard lake assessment process and NRRI as part of a contract for Ecological Design Modeling for the 40th Avenue West Remediation to Restoration Project.
  - *MDNR 2011 OrthorRectification of Hearding Map*: The Hearding Map was ortho-rectified as a task associated with the QAPP process for Phase I of the Radio Tower Bay Marine Debris Removal Project. The product will provide a historical base map for the planning and design of remediation and restoration projects in the AOC.

- *USEPA/FDL Hydro Acoustic Vegetation and Substrate Mapping*: Mapping of substrates was begun by Fond du Lac Resource Management in 2010. USEPA will complete an extensive survey of substrate and vegetation using hydro acoustic gear in 2012.
- *MN/WI Coastal Programs Oblique Aerial Photography*: The Minnesota and Wisconsin Coastal Programs gathered oblique aerial photograph for coastal areas, including the St. Louis River AOC, in 2007.
- *USEPA Oblique and Plainview Photography Assessment of Wetland* Types: USEPA is completing a wetland assessment of the aquatic and riparian portions of the estuary using existing plainview and oblique photography. Work will be completed in 2012.
- *LIDAR Data* – Some LIDAR data of the St. Louis River estuary were collected in conjunction with an assessment of the North Shore of Lake Superior.

- *Needs:* Establish a team of local resource professionals from partnering agencies to compile the existing and new data layers into a GIS-based map. Funding may need to be identified to accomplish the task. There is also a need to summarize habitat restoration realized as a result of past remediation and restoration projects (Grassy Point, Hog Island, SLRIDT, Tallas Island, sturgeon spawning habitat). Habitat projects that have been implemented or are underway in the estuary are shown on Figure BUI 9 - 2.

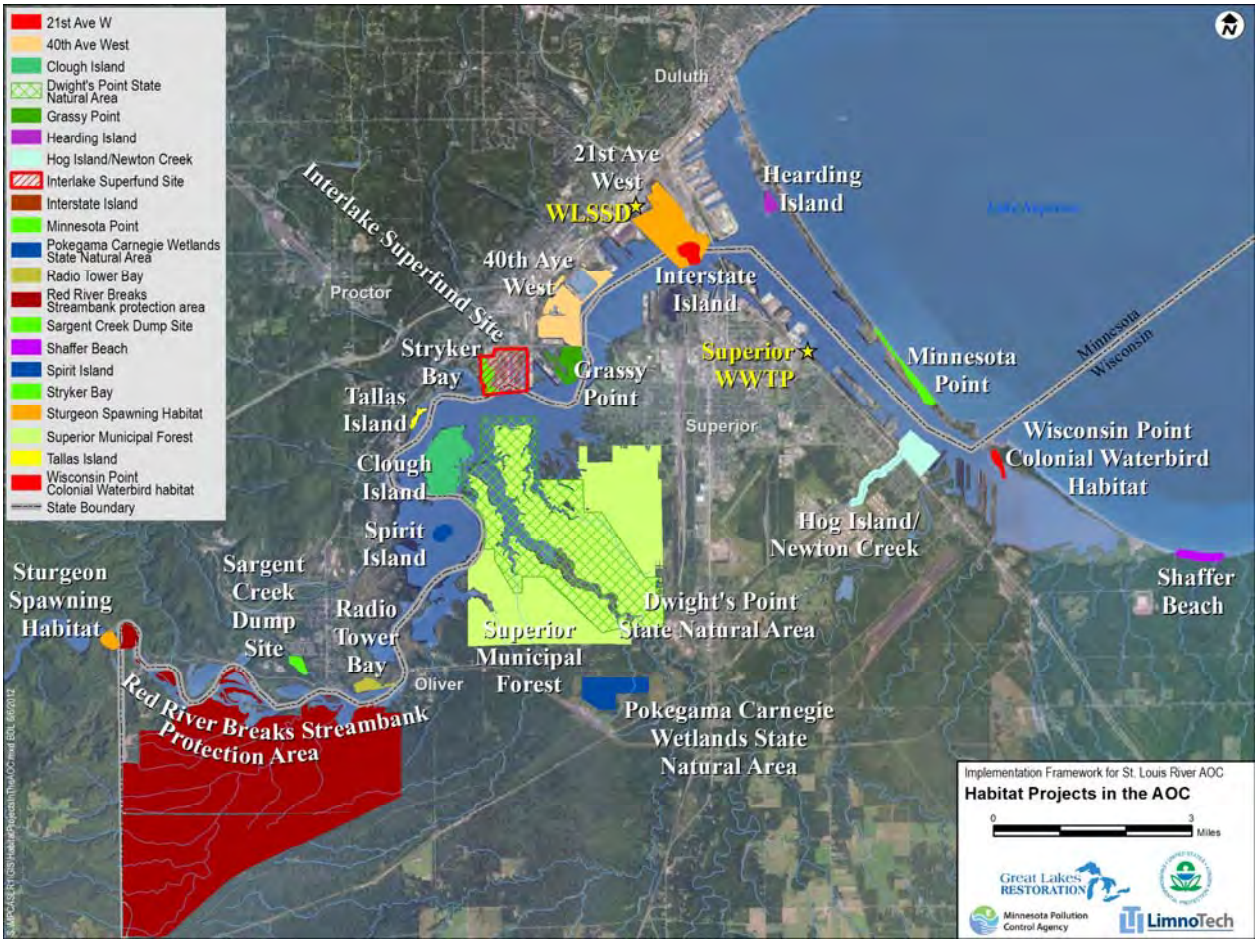


**Figure BUI 9 - 2: Habitat Projects Implemented or Underway in the AOC.**

- *Synthesis:* The product of the work will be GIS-based maps that will provide the context for establishing and refining targets for this BUI. The wetland restoration/enhancement target will be more clearly defined. Additionally, targets for healthy soft shoreline and healthy littoral depth transition zones may be established.
- *Timeline:* If an AOC team is formed to accomplish this task, the development of the GIS products and the establishment and refining of targets could be accomplished by the end of winter 2012/2013.

## Area of Protected Fish and Wildlife Habitat

- *Datasets Associated with Indicator:* Develop a target for percent of available land in long-term protection. Identify ownership of parcels within 500 meters of the estuary from Fond du Lac dam to Lake Superior.
- *State DNRs and Local Municipalities*: These entities possess the data that will be needed to determine ownership. Need to summarize the existing information.

- *Needs*: Identify who will summarize the information and produce a GIS-based product. Duluth Community GIS can most likely accomplish the work.
- *Synthesis:* Summarize existing data and produce a GIS-based map of ownership of riparian parcels adjacent to the AOC from Fond du Lac dam to Lake Superior.
- *Timeline*: If funding is identified, the task could be completed by the fall or winter of 2012/2013.

The BUI Team has identified information gaps for this BUI that are described in Table BUI 9 - 7. The responsible parties, timeline, and funding requirement for obtaining this information are also presented.

### Table BUI 9 - 7: Information Gaps: Loss of Fish and Wildlife Habitat.

| | Description | Responsibility | Timeline | Funding |
|---|---|---|---|---|
| **1** | Annual long-term exotics species monitoring program | EPA/FWS/NERR | 2012 | Monitoring will continue dependent on GLRI funding |
| **2** | Invasive species rapid response action plan | DNRs/EPA/FWS/NERR | 2013 | Completed locally with support from AOC partners – capacity limited |
| **3** | Process side by side MPCA benthic samples | EPA/NRRI/MPCA | 2014 | Funding need from GLRI |
| **4** | Benthic health IBI indices and target | AOC partners EPA/PCA/DNRs | 2012/2013 | none required |
| **5** | GIS map of benthic condition - areas | AOC partners | 2012/2013 | Completed locally with support from AOC partners – capacity limited |
| **6** | GIS map of all vegetation types - areas | AOC partners/EPA | 2012/2013 | Completed locally with support from AOC partners – capacity limited |
| **7** | Wetland target - more accurate | Local AOC partners | 2012/2013 | none required |
| **8** | GIS map of contaminated sediments - areas | AOC partners/PCA/WDNR/EPA | 2013/2014 | Completed locally with support from AOC partners – capacity limited |
| **9** | Contaminated sediments target | AOC partners/PCA/WDNR | 2013/2014 | none required |
| **10** | GIS map of past and present R and R - areas | AOC partners/DNRs | 2012/2013 | Completed locally with support from AOC partners – capacity limited |
| **11** | GIS map of available parcels adjacent to AOC | AOC partners | 2012/2013 | Completed locally with support from AOC partners – capacity limited |
| **12** | Habitat protection target | AOC partners | 2012/2013 | none required |
| **13** | GIS map of shoreline - hard, soft, historical | AOC partners/EPA | 2012/2013 | Completed by EPA |
| **14** | Soft shoreline target | Local AOC partners | 2012/2013 | none required |
| **15** | Transition zone target | Local AOC partners | 2012/2013 | none required |
| **16** | Spill contingency plan | Local AOC partners | 2013/2014 | Completed locally with support from AOC partners – capacity limited |
| **17** | Upland habitat maps and habitat quality analysis | AOC partners/DNRs/EPA | 2013/2014 | Completed locally with support from AOC partners – capacity limited |

The BUI Team developed the following list of priority actions agreed as important to address this BUI. Actions included in this list include those selected to address data and information gaps, monitoring and assessment to confirm BUI condition, and actions to address existing sources or stressors. The Sequential List of Prioritized Actions for this BUI is presented in Table 10.8 followed by a supplementary table key.

## Table BUI 9 - 8: Sequential List of Prioritized Actions: Loss of Fish and Wildlife Habitat.

Note: For this BUI, project sequence is defined as follows:

1. Project complete (on-going monitoring necessary)
2. Project ongoing or in progress
3. Project is next priority

| **Project Sequence** | **Project Title** | **Description of Action and Rationale** | **Location** Indicate waterbody, site name, or other geographic reference | **Type of Action** Enter number(s) from table key, separated by commas | **BUI(s) Involved** Enter number(s) from table key, separated by commas | **Indicator(s) Involved** | **Source or Stressor Involved** | **Start Date** | **Duration** Enter "Ongoing" for actions that will occur continue over time | **Estimated cost** See key above and enter appropriate "$" level based on best professional judgment | **Permitting requirements** | **Important resources needed (landowner, project leader, etc)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2-6. Upper estuary flats, Spirit Island | Purchase and preserve island | Lower St. Louis River macrosite | 6, 7, 9 | 2, 9 | Area of protected fish and wildlife habitat | Wetland degradation and ecosystem alteration; Historic habitat loss | Spirit Island purchase in 2011 | Completed | $$ | None required | Completed |
| 1 | 2-10. Sheltered bay, shallow wetlands - Tallas Bay | Restore wetland complex behind Tallas Island to pre-1961 condition | Lower St. Louis River macrosite | 6, 7, 9 | 2, 4, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | Limited aquatic macrophyte growth; Wetland degradation and ecosystem alteration; Historic habitat loss; Excess sedimentation; Loss of connectivity | 2010 | Completed | $$$$$ | Permitted through SLRIDT Superfund process | Completed |
| 1 | 2-16. Sheltered bay, shallow wetlands - hog island inlet | Remediation to Restoration (R to R) project | Superior Bay macrosite | 6, 7, 8, 9 | 1, 2, 3, 4, 5, 6, 7, 8, 9 | All four indicators | All except loss of connectivity | 2007 | 2012 | $$$$$$ | NA | Completed |
| 1 | 2-20. Fond du Lac dam - flow/spawning habitat | Remove non-native rock structure and enhance lake sturgeon, walleye and smallmouth bass spawning habitat through placement of riffles across river | Lower St. Louis River macrosite | 6, 7 | 2, 9 | Area of restored or enhanced aquatic habitat | Wetland degradation and ecosystem alteration | 2009 | Completed | $$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Completed |
| 1 | 2-21. Lake sturgeon rehabilitation | Re-establish naturally reproducing lake sturgeon population, protect and enhance critical habitat and produce promotional materials | All macrosites below dam | 2, 3, 4, 5, 6, 7, 9, 10, 13, 14 | 1, 2, 3, 4, 5, 6, 8, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | Limited aquatic macrophyte growth; Wetland degradation and ecosystem alteration; Historic habitat loss; Excess sedimentation | 1983 | Mostly completed | $$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO (for Fond du Lac riffle project) | Ongoing monitoring |

| **Project Sequence** | **Project Title** | **Description of Action and Rationale** | **Location** Indicate waterbody, site name, or other geographic reference | **Type of Action** Enter number(s) from table key, separated by commas | **BUI(s) Involved** Enter number(s) from table key, separated by commas | **Indicator(s) Involved** | **Source or Stressor Involved** | **Start Date** | **Duration** Enter "Ongoing" for actions that will occur continue over time | **Estimated cost** See key above and enter appropriate "$" level based on best professional judgment | **Permitting requirements** | **Important resources needed (landowner, project leader, etc)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1-3. Large riverine reach - Nemadji corridor land protection | Protect riparian corridor of the Nemadji River and its tributaries | Throughout Nemadji River watershed (Wisconsin and Minnesota) | 9 | 2, 6, 9 | Area of protected fish and wildlife habitat | Wetland degradation and ecosystem alteration; Historic habitat loss; Excess sedimentation; Loss of connectivity | Check date of first preservation purchase | Ongoing | $$$$$ | None required | Identify threatened and available parcels adjacent to river and within watershed |
| 2 | 1-4. Clay-influenced tribs; south shore tribs land protection | Protect watersheds of clay influenced tributaries to the St. Louis River estuary | Superior Bay macrosite, St. Louis Bay macrosite, Lower St. Louis River macrosite | 9 | 2, 6, 9 | Area of protected fish and wildlife habitat | Wetland degradation and ecosystem alteration; Historic habitat loss; Excess sedimentation; Loss of connectivity | Check date of first preservation purchase | Ongoing | $$$$$ | None required | Identify threatened and available parcels adjacent to rivers and within watersheds |
| 2 | 1-5. Upper estuary flat; Spirit Lake islands | Protect islands within Spirit Lake | Lake Superior macrosite | 9 | 2, 9 | Area of protected fish and wildlife habitat | Wetland degradation and ecosystem alteration; Historic habitat loss | 2011 purchase of Spirit Island. Any earlier? | Ongoing | $$ | None required | Identify ownership and pursue purchase if available |
| 2 | 2-1. Barrier beach and dune communities - WI point | Protect and restore dune communities | Lake Superior macrosite | 6, 7, 9, 12 | 2, 9 | Area of restored or enhanced terrestrial habitat; Area of protected fish and wildlife habitat, invasive species control. | Historic habitat loss, | Planning project 2010, past access improvements over couple of decades | planning effort to be completed 2012, implementation ongoing | $$$$$ | USACE, WIDNR, Douglas County, EAW, SHPO | MPE (money, people, equipment) |
| 2 | 2-2. Bay mouth bar community - dune pine forest, MN/WI point | Remove non-native plants from pine forest. | Lake Superior macrosite | 6, 7 | 2, 9 | Area of restored or enhanced terrestrial habitat; Area of protected fish and wildlife habitat, invasive species control. | Historic habitat loss, | 2011 - MN; 2010 - planning stages - WI | ongoing | $$$$ | if herbicides are used, Dept of Ag. | MPE (money, people, equipment) |
| 2 | 2-4. Upland conifer upland and hardwood forests; Clough Island | Restore degraded forest habitat | Lower St. Louis River macrosite | 6, 7 | 2, 9 | Area of restored or enhanced terrestrial habitat; Area of protected fish and wildlife habitat, invasive species control. | Historic habitat loss, | 2012 | | $$$ | SHPO | Time, people |

| **Project Sequence** | **Project Title** | **Description of Action and Rationale** | **Location** Indicate waterbody, site name, or other geographic reference | **Type of Action** Enter number(s) from table key, separated by commas | **BUI(s) Involved** Enter number(s) from table key, separated by commas | **Indicator(s) Involved** | **Source or Stressor Involved** | **Start Date** | **Duration** Enter "Ongoing" for actions that will occur continue over time | **Estimated cost** See key above and enter appropriate "$" level based on best professional judgment | **Permitting requirements** | **Important resources needed (landowner, project leader, etc)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2-5. Sheltered bay, shallow wetland - Clough Island | Restore degraded wetland habitat | Lower St. Louis River macrosite | 6, 7, 9 | 2, 9 | Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat, invasive species control. | Historic habitat loss, | 2012 | | $$$ | WIDNR, USACE | Time, people |
| 2 | 2-7. Sheltered bay, shallow wetlands, Spirit Lake | Remediate contaminated sediments and restore emergent wetlands | Lower St. Louis River macrosite | 6, 7, 8 | 1, 2, 3, 4, 5, 6, 8, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All seven stressors except loss of connectivity | Year of upland remedy completion at USX | Completed by 2018 | $$$$$$ | Superfund process; USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Agencies require personnel resources to engage in Superfund process |
| 2 | 2-9. Sheltered bay, shallow wetlands - 40th Avenue West Remediation to Restoration Project | Remediate contaminated sediments and restore habitat | St. Louis Bay macrosite | 6, 7, 8, 9 | 1, 2, 3, 4, 5, 6, 8, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All seven stressors except loss of connectivity | 2010 | 2018 | $$$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Agency process support and additional financial support |
| 2 | 2-11. Sheltered bay, shallow wetlands - radio tower bay | Remove non-native material and restore optimum bathymetry | Lower St. Louis River macrosite | 6, 7, 9, 14 | 2, 4, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | Limited aquatic macrophyte growth; Wetland degradation and ecosystem alteration; Historic habitat loss | 2011 | 4 years | $$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Federal funding applied for but not yet received |
| 2 | 2-13. Sheltered bay, shallow wetlands - emergent wetland restoration | Identify existing wetland resources and substrates and determine methods to accomplish two or three wetland restoration projects | All macrosites below dam | 1, 2, 3, 4, 5, 6, 7, 8, 9 | 2, 4, 5, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All except loss of connectivity | Unknown | 3 - 5 years | $$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 2 | 2-14. Sheltered bay, shallow wetlands - wild rice | Restore wild rice beds | All macrosites below dam | 6, 7, | 2, 4, 6, 9 | Benthic health IBI; area of restored or enhanced aquatic habitat. | Limited aquatic macrophyte growth; Wetland degradation and ecosystem alteration; Historic habitat loss | 1995 | Ongoing | $$$$ | MNDNR & WIDNR - aquatic veg permits | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 2 | 2-15. Industrially influenced bay - "all in" | Remediate contaminated sediments and restore habitat (R to R sites) | Lower St. Louis River macrosite, St. Louis Bay macrosite, Superior Bay macrosite | 6, 7, 8, 9 | 1, 2, 3, 4, 5, 6, 8, 9 | All four indicators | All seven stressors | 2007 | ongoing | $$$$$$$ | oh yeah | Ongoing project management; Potential project needs to be more thoroughly scoped and funding needs to be identified |

| **Project Sequence** | **Project Title** | **Description of Action and Rationale** | **Location** Indicate waterbody, site name, or other geographic reference | **Type of Action** Enter number(s) from table key, separated by commas | **BUI(s) Involved** Enter number(s) from table key, separated by commas | **Indicator(s) Involved** | **Source or Stressor Involved** | **Start Date** | **Duration** Enter "Ongoing" for actions that will occur continue over time | **Estimated cost** See key above and enter appropriate "$" level based on best professional judgment | **Permitting requirements** | **Important resources needed (landowner, project leader, etc)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2-19. Fish habitat - Kingsbury Creek | Reduce sedimentation to Kingsbury Bay, restore stream channel, enhance connectivity and protect riparian corridor | Lower St. Louis River macrosite | 6, 7, 9, | 2, 6, 9 | Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife hbitat | Wetland degradation and ecosystem alteration; Excess sedimentation; Loss of connectivity | 2010 | 2 - 6 years | $$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 2 | 2-23. Nesting bird habitat - WI point | Vegetation management, education/outreach - people management | Lake Superior macrosite, Superior Bay Macrsite | 6, 9, 10, 14 | 2, 9 | area of restored or enhanced habitat | Historic habitat loss, | 1982 | ongoing | $$ | WIDNR | project leader, funding |
| 2 | 2-24. City of Superior coastal wetland protection | Map and characterize coastal wetlands and values, watersheds | Superior Bay Macrosite, St. Louis Bay macrosite | 5, 11, 12, 13, 14 | 2, 6, 9 | Area of protected fish and wildlife habitat | wetland degradation, excess sedimentation, historic habitat loss, degraded water quality | 2005 | completed plan and study, implementaiton ongoing | $$$$ | None required | MPE (money, people, equipment) |
| 2 | 2-27. Grassy Point | Remove non-native material and restore optimum bathymetry | Lower St. Louis River macrosite | 6, 7, 8, 9, 14 | 2, 4, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All seven stressors except Excess sedimentation; and Loss of connectivity | 2011 | 2 - 5 years | $$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 2 | 2-28. Sheltered bay, shallow wetlands - 21st Avenue West Remediation to Restoration Project | Remediate contaminated sediments and restore habitat | St. Louis Bay macrosite | 6, 7, 8, 9 | 1, 2, 3, 4, 5, 6, 8, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All seven stressors except loss of connectivity | 2010 | 2018 | $$$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Agency process support and additional financial support |
| 2 | 6-1. Improve stormwater mgmt - map storm system | Complete storm shed mapping of all watersheds flowing into estuary | All macrosites below dam | 3, 4, 5, 6, 7, 11, 12, 13, 14 | 2, 4, 5, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat | All except loss of connectivity | Not identified | 2 - 4 years | $$$ | None required | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 2 | 8-1. Fish habitat - Knowlton Creek | Reduce runoff and sediment transport within watershed and restore cold-water stream habitat | Lower St. Louis River macrosite | 6, 7, 9 | 2, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | Wetland degradation and ecosystem alteration; Historic habitat loss; Loss of connectivity | 2011 | 2 - 5 years | $$$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Additional funding |
| 2 | 12-1. Restore natural drainage systems/-processes - Clough Island nearshore veg | Eliminate sediment transport from Clough Island to peripheral wetlands | Lower St. Louis River macrosite | 6, 7 | 2, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat | Wetland degradation and ecosystem alteration; Historic habitat loss; Loss of connectivity | 2012 | 2 - 5 years | $$$$ | WIDNR, USACE | Agency capacity |
| 2 | 14-1. Ballast water discharge rules | Eliminate introduction of new exotic species through ballast water discharge | All macrosites below dam | 1, 10, 11, 13 | 2, 9 | Invasive species monitoring and control | Wetland degradation and ecosystem alteration; Historic habitat loss | 2011 | Ongoing | $$$$$$ | Federal and State | Political process and funding |

| **Project Sequence** | **Project Title** | **Description of Action and Rationale** | **Location** Indicate waterbody, site name, or other geographic reference | **Type of Action** Enter number(s) from table key, separated by commas | **BUI(s) Involved** Enter number(s) from table key, separated by commas | **Indicator(s) Involved** | **Source or Stressor Involved** | **Start Date** | **Duration** Enter "Ongoing" for actions that will occur continue over time | **Estimated cost** See key above and enter appropriate "$" level based on best professional judgment | **Permitting requirements** | **Important resources needed (landowner, project leader, etc)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Long-term exotics monitoring program | Project currently funded by GLRI and being implemented by EPA, FWS and NERR | All macrosites below dam | 1,2,3,4 | 2,9 | Invasive species monitoring and control program | Wetland degradation, ecosystem alteration | 2012 | Ongoing | $$$ | None required | Will be completed and maintained if funding continues. |
| 2 | GIS map of all vegetation types - areas | Develop a GIS-based map that will summarize current distribution and diversity of aquatic macrophytes within the estuary. The map and indexed information will assist resource professional during the refining of the target for the wetland indicator. | All macrosites below dam | 5 | 2,4,9 | Native macrophyte coverage | Wetland degradation, ecosystem alteration; Excess sedimentation; Contaminated sediment; Degraded water quality; Limited aquatic macrophyte growth; Historic habitat loss | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | Contaminated sediments target | Develop a delisting target that will represent the point at which contaminated sediments have been remediated to a level to delist the AOC for this indicator. | All macrosites | 4 | 1,2,3,4,5,9 | Remediate contaminated sediment hotspots | Contaminated sediment | 2013/2014 | 1 to 2 years | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 2 | GIS map of shoreline - hard, soft, historical | Develop a GIS-based map that will summarize current condition of shorelines within the AOC. The map and indexed information will assist resource professionals during the refining of the target for the softened shoreline indicator. | All macrosites below dam | 5 | 2,9 | Area of restored or enhanced aquatic habitat (miles of softened shoreline) | Historic habitat loss; future habitat loss | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | 1-1. Baymouth bar communities - MN point | Enroll City of Duluth land on Minnesota Point in Duluth Natural Areas Program | Lake Superior macrosite, Superior Bay Macrosite | 9 | 2, 9 | Area of protected fish and wildlife habitat | Historic habitat loss | Check date of first preservation purchase | Ongoing | $$$$ | | |
| 3 | 1-2. Shallow wetlands, sheltered bays - habitat preservation | Protect shallow wetlands, sheltered bays and adjacent riparian lands | All macrosites below dam | 9 | 2, 9 | Area of protected fish and wildlife habitat | Wetland degradation and ecosystem alteration; Historic habitat loss; Loss of connectivity | Check date of first preservation purchase | Ongoing | $$$$$ | None required | Identify threatened and available parcels adjacent to wetland habitats |
| 3 | 2-3. Barrier beach and dune communities; beach grass study restoration | Restore beach dune community (Develop a source of local beach grass; require local source in restoration work) | Lake Superior macrosite | 6, 7 | 2, 9 | Area of restored or enhanced terrestrial habitat; Area of protected fish and wildlife habitat, invasive species control. | Historic habitat loss, | 1990 | Ongoing | $$$$ | Endangered species permit from MN DNR for beach grass possession or impact | Local grass source - the good stuff |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 2-8. Sheltered bay, shallow wetlands - Mud Lake | Establish more vital connection of wetland and restore wetland habitat including wild rice | Lower St. Louis River macrosite | 6, 7, 8, 9 | 2, 4, 5, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All seven stressors | Not known, perhaps NRDA project associated with SLRIDT or USX | Unknown | $$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped |
| 3 | 2-12. Sheltered bay, shallow wetlands - perch lake | Revitalize biological connection between estuary and Perch Lake | Lower St. Louis River macrosite | 6, 7 | 2, 9 | Area of restored or enhanced aquatic habitat | Wetland degradation and ecosystem alteration; Historic habitat loss; Loss of connectivity | Unknown | 1 - 3 years | $$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 2-17. Industrial slips - maintain | Remediate contaminated sediments and maintain maritime function of estuary slips | Superior Bay macrosite, St. Louis Bay macrosite, Lower St. Louis River macrosite | 8 | 1, 4, 5, 8, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat | Degraded water quality; Wetland degradation and ecosystem alteration; Contaminated sediments; | Unknown | 10 - 25 years | $$$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 2-18. Fish habitat - Keene Creek | Restore wetlands and stream channel below upstream migration barrier and protect riparian corridor where possible | Lower St. Louis River macrosite | 6, 7, 9 | 2, 6, 9 | Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife hbitat | Wetland degradation and ecosystem alteration; Excess sedimentation; Loss of connectivity | 2012 | 2 - 4 years | $$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 2-22. Nesting bird habitat - interstate island | Add sand and gravel to island, control gulls. | St. Louis Bay Macrosite | 6, 7, 9, 10 | 2, 9 | Area of restored or enhanced habitat | Historic habitat loss, | 1985 | Ongoing | $$$ | MN DNR, WI DNR, perhaps USCOE | Project leader, interstate coordination, cooperation from RR, |
| 3 | 2-25. Whitefish question | Potential whitefish rehabilitation | All macrosites below dam | 6 | 2 | NA | Degraded water quality; Wetland degradation and ecosystem alteration; Contaminated sediments; historic habitat loss | investigation began 2005 | Unknown | unknown | None required | Whitefish |
| 3 | 2-26. Preservation of deep water habitat - Mud Lake | Establish deep water | Lower St. Louis River macrosite | 6, 7 | 2, 9 | Area of restored and enhanced aquatic habitat | Historic habitat loss, | 2008 for initial planning | 2-3 years | $$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 2-27. sheltered bay, shallow wetlands - N 5th St wetlands | Identify existing wetland resources and substrates and determine methods to accomplish two or three wetland restoration projects | St. Louis Bay Macrosite | 1, 2, 3, 4, 5, 6, 7, 8, 9 | 2, 4, 5, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All except loss of connectivity | Unknown | 3 - 5 years | $$$$ | USACE, WIDNR, Douglas County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 2-29. Hearding Island, island creation | Establish softened shorelines through island creation | Superior Bay macrosite | 6, 7, 9 | 2, 4, 5, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | Wetland degradation and ecosystem alteration; Historic habitat loss | Not identified | 3 - 5 years | $$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 2-30. Interstate Island, island creation | Establish softened shorelines through island creation in Minnesota waters | St. Louis Bay macrosite | 6, 7, 9 | 2, 4, 5, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | Wetland degradation and ecosystem alteration; Historic habitat loss | Not identified | 3 - 5 years | $$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 2-31. Sheltered bay, shallow wetlands - Kingsbury Bay | Remove sediment and restore sheltered bay to optimum bathymetry | Lower St. Louis River macrosite | 6, 7, 9 | 2, 4, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat | Limited aquatic macrophyte growth; Wetland degradation and ecosystem alteration; Historic habitat loss; Excess sedimentation | Not identified | 1 -3 years | $$$$$ | USACE, MNDNR, MPCA, St. Louis County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 4-1. Reduce peak streamflow - catalog sedimentation rates in sheltered bays | Conduct analysis to determine sediment deposition rates within sheltered bays | All macrosites below dam | 3, 4, 5, 11, 12, 13, 14 | 2, 4, 5, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All except loss of connectivity | Not identified | 1 - 2 years | $$ | None required | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 5-1. Control nonpoint pollution from impervious surfaces, sediment traps | Establish sediment traps at points of critical input on all major tributaries to estuary | All macrosites below dam | 3, 4, 5, 6, 7, 11, 12, 13, 14 | 2, 4, 5, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All except loss of connectivity | Not identified | 5 - 10 years | $$$$$ | USACE, MNDNR, WIDNR, MPCA, St. Louis County, Douglas County, EAW, SHPO | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 7-1. Minimize impacts of ORVs, trail impacts id. | Work together with government agencies and groups to identify and control impacts of ORV's along tributaries to the estuary | All macrosites below dam | 3, 4, 5, 6, 7, 11, 12, 13, 14 | 2, 4, 5, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All except loss of connectivity | Not identified | 1 - 3 years | $$$ | None required | Potential project needs to be more thoroughly scoped and funding needs to be identified |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 7-2. Minimize impacts of recreation boats, id. of no-wake zones | Minimize impacts to wild rice through establishment of no-wake zones | All macrosites below dam | 3, 4, 5, 6, 7, 10, 11, 13, 14 | 2, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | Limited aquatic macrophyte growth; Wetland degradation and ecosystem alteration; Historic habitat loss | Not identified | 2 - 5 years | $$ | None required | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| | 9-1. Increase use of compatible forest mgmt practice, education | Ensure adequate logger/forest management education and promote voluntary forest management practices | AOC wide | 10, 12, 14 | 6, 8, 9 | | | | | | | |
| | 10-1. Enforce monitoring, compliance of env permits | Ensure compliance of environmental permits | AOC wide | 2, 11, 13 | 1, 2, 3, 4, 6, 8, 9 | | | | | | | |
| | 11-1. Modify land-use regulations; City of Duluth UDC | Work with City of Duluth in Unified Development Code | City of Duluth | 10, 12 | 2, 4, 6, 8, 9 | | | | | | | |
| | 11-2. Modify land-regulations; zoning ordinance template | Development and adoption of adequate zoning regulations to protect the goals of the Habitat Plan | AOC wide | 10, 11, 12, 14 | 2, 4, 6, 8, 9 | | | | | | | |
| 3 | 12-2. Restore natural drainage systems/-processes - artificial stream investigation | Inventory existing drainage systems and identify opportunities for restoring natural processes | All macrosites below dam | 3, 4, 5, 11, 12, 13, 14 | 2, 4, 5, 6, 9 | Benthic health IBI; Area of restored or enhanced aquatic habitat; Area of protected fish and wildlife habitat | All except loss of connectivity | Not identified | 2 - 3 years | $$$ | None required | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| 3 | 13-1. Buckthorn removal | Reduce populations of buckthorn in St. Louis River estuary | All macrosites below dam | 6, 7 | 2, 9 | Invasive species monitoring and control; Area of restored or enhanced aquatic habitat | Wetland degradation and ecosystem alteration; Historic habitat loss; Loss of connectivity | 1998 | Ongoing | $$$ | None required | Potential project needs to be more thoroughly scoped and funding needs to be identified |
| | 17-1. Development and implementation of a comprehensive port plan | | | | | | | | | | | |
| 3 | Invasive species rapid response action plan | Develop a plan that will identify the appropriate agency responses to the future introduction of exotic organisms to the AOC. | All macrosites below dam | 10,12 | 2,9 | Invasive species monitoring and control program | Wetland degradation, ecosystem alteration | 2013 | 1 year | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Process side by side MPCA benthic samples | Analyze samples of benthos collected in conjunction with contaminated sediments samples collected by MPCA and USACE over the entire estuary. | All macrosites below dam | 4 | 4, 9 | Benthic health IBI | Wetland degradation, ecosystem alteration; Excess sedimentation; Contaminated sediment; Degraded water quality; Limited aquatic macrophyte growth | 2013 | 2 years | $$$ | None required | Requires a GLRI-related funding source an AOC project manager from MPCA |
| 3 | Benthic health IBI indices and target | Develop a target that will represent the point at which the benthos indicator for the St. Louis River AOC is considered healthy. | All macrosites below dam | 4 | 4, 9 | Benthic health IBI | Wetland degradation, ecosystem alteration; Excess sedimentation; Contaminated sediment; Degraded water quality; Limited aquatic macrophyte growth | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | GIS map of benthic condition - areas | Develop a GIS-based map that will summarize available information and assist resource professionals during development of the target for the benthos indicator. | All macrosites below dam | 5 | 4, 9 | Benthic health IBI | Wetland degradation, ecosystem alteration; Excess sedimentation; Contaminated sediment; Degraded water quality; Limited aquatic macrophyte growth | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Wetland target - more accurate | Incorporate new information on aquatic macrophytes within the estuary currently being summarized to produce a more accurate target for the wetland indicator. | All macrosites below dam | 4 | 2,4,9 | Are of restored or enhanced aquatic habitat | Wetland degradation, ecosystem alteration; Excess sedimentation; Contaminated sediment; Degraded water quality; Limited aquatic macrophyte growth; Historic habitat loss | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | GIS map of contaminated sediments - areas | Develop a GIS-based map that will summarize information on contaminated sediments in the AOC. The map and indexed information will assist resource professionals during the development of a target for the area of contaminated sediments remediated indicator. | All macrosites | 5 | 1, 2, 3, 4, 5, 9 | Remediate contaminated sediment hotspots | Contaminated sediment | 2013/2014 | 1 to 2 years | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | Contaminated sediments target | Develop a delisting target that will represent the point at which contaminated sediments have been remediated to a level to delist the AOC for this indicator. | All macrosites | 4 | 1,2,3,4,5,9 | Remediate contaminated sediment hotspots | Contaminated sediment | 2013/2014 | 1 to 2 years | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | GIS map of past and present R and R - areas | Develop a map of past and present Remediation to Restoration sites | All macrosites below dam | 5 | 1,2,3,4,5,9 | Area of restored or enhanced aquatic habitat | Contaminated sediment; historic habitat loss; wetland degradation, ecosystem alteration; limited aquatic macrophyte growth | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | GIS map of available parcels adjacent to AOC | Develop a GIS-based map that will identify available parcels along the riparian corridor of the AOC to assist resource professionals with the development of a target for the indicator of the percent of riparian area in protection. | All macrosites below dam | 5 | 2,9 | Area of protected fish and wildlife habitat | Future habitat loss | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | Habitat protection target | Develop a target that will represent the percentage available land parcels that are in protection. | All macrosites below dam | 4 | 2,9 | Area of protected F&W habitat | Future habitat loss | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | Soft shoreline target | Develop a target that will represent the length of shoreline within the AOC that are softened and support healthy biological functions. | All macrosites below dam | 4 | 2,9 | Area of restored or enhanced aquatic habitat (miles of softened shoreline) | Historic habitat loss; future habitat loss | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Transition zone target | Develop a target that will represent the surface area of natural transition zones from land to deep water that support healthy biological functions. | All macrosites below dam | 4 | 2,9 | Area of restored or enhanced aquatic habitat | Wetland degradation, ecosystem alteration; historic habitat loss | 2012/2013 | 1 year | $ | None required | Will require a commitment from AOC partners to coordinate and complete. |
| 3 | Spill contingency plan | Develop a plan that will detail agency response to the spills within the AOC. | All macrosites below dam | 10/12 | 2, 4,8, 9 | Benthic health IBI | Degraded water quality; contaminated sediment | 2013/2014 | 1 to 2 years | $$ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |
| 3 | Upland habitat maps and habitat quality analysis | Develop a base map for the upland portion of the AOC that describes the quality and quantity of habitat. | All macrosites | 4 | 2,9 | Total acres of quality habitat | Historic habitat loss; future habitat loss | 2013/2014 | 1 to 2 years | $ | None required | Requires some level of funding and a commitment from AOC partners to coordinate and complete |

## Key for Sequential List of Prioritized Actions

Reference numbers for "Type of Action":

1. Monitoring program development
2. Monitoring/Sampling
3. Data compilation
4. Data assessment
5. GIS analysis
6. Restoration
7. Enhancement
8. Remediation
9. Protection
10. Stewardship and management
11. Regulatory process development or definition
12. Planning effort
13. Enhanced enforcement
14. Education/outreach/workshops

Estimated Costs:

$ = <$10,000
$$ = <$100,000
$$$ = <$500,000
$$$$ = <$1M
$$$$$ = $1 -$5M

Reference numbers for BUIs:

10. Fish Consumption Advisories
11. Degraded Fish and Wildlife Populations
12. Fish Tumors and Deformities
13. Degradation of Benthos
14. Restrictions on Dredging
15. Excessive Loading of Sediments and Nutrients
16. Beach Closings and Body Contact
17. Degradation of Aesthetics
18. Loss of Fish and Wildlife Habitat

## Anticipated Timeline and Costs for Achieving BUI Removal: Loss of Fish and Wildlife Habitat

The Lower St. Louis River Habitat Plan, completed in 2002, contains descriptive and strategic information relative to this BUI. Habitat types (aquatic and terrestrial) within the AOC were described using the best available information and displayed with the best available tools. Actions that are identified in the Habitat Plan's Strategies Implementation Worksheet to mitigate the five major threats were heavily weighted towards the second strategy of "maintaining a list of priority restoration projects and sites." Implementation of the actions will result in unquantified, but considerable, progress towards removing this BUI.

The primary goal of the BUI Blueprint Team was to translate the relatively qualitative information contained in the Habitat Plan into the more clearly quantifiable format of the AOC Framework document and, ultimately, the Stage II RAP. During this process the Team compiled a list of accomplishments, identified measureable indicators of progress, identified information gaps, and translated the projects described in the Habitat Plan Implementation Strategies Worksheets into the Prioritized List of Actions. The team also identified the means by which available data and data that are currently being collected can be synthesized into GIS-based tools to develop the specific targets for measurement of progress towards delisting this BUI.

Because of the complexities of habitat degradation within the AOC, the team suggests that implementing the actions that will lead to removing BUI #9 will take from 10 to 25 years, depending on funding and agency capacity. It is important to realize that the current condition of fish and wildlife habitat in the AOC is adequate to support relatively robust populations of native fish and wildlife populations. However, large areas of the AOC are impaired and provide limited contributions to the biological productivity of the estuary. Although most native fish and wildlife species are present, the absolute productivity of the system is likely far less now than historically. Development of the GIS-based tools to summarize information and lead resource professional towards establishment of targets for the measureable indicators will also allow them to make determinations between historic, current and projected habitat values within the AOC. Given those data gaps, the monetary cost of achieving the targets is difficult to accurately determine, but might range from $150 to 300 million.

## Ongoing Monitoring Needs: Loss of Fish and Wildlife Habitat

A strategy to monitor progress towards removal of BUI #9 as a result of implementing the projects identified in the prioritized list of actions will have to be developed by the AOC partners. Quantifying status relative to a specific measureable indicator will require both capacity (i.e., staff time) and monetary support. Once the targets are established, the AOC partners will determine a means to accomplish these periodic measurements of the metrics that will mark progress toward the target. Measurement of progress once the current baseline is established can also be accomplished through project level measurements funded by project sponsors as part of the required QAPP processes. A surrogate measurement of habitat conditions is the indexing of fish and wildlife populations.

Elements of this strategy include:

- Development of a baseline condition map that includes data relative to overall habitat conditions across the AOC as well as current condition of Status Indicators #2-4.
- Recurring monitoring/assessment of aquatic vegetative communities across the AOC.
- Recurring monitoring/assessment of benthic invertebrate communities across the AOC.
- Recurring updates to the baseline habitat condition map that tracks changes to Status Indicators #2-4.

## Future Issues or Concerns: Loss of Fish and Wildlife Habitat

Several issues and concerns were identified for future consideration of their impact to the delisting efforts and management of the St. Louis River Area of Concern. Other issues not yet understood may arise that could also impact the St. Louis River Area of Concern in the future issues include:

- Potential negative impacts of currently established non-native species.
- Potential negative impacts of non-native species that become established in the future.
- Limited financial and staff time resources at all levels of administration, management, inspection, education, construction, enforcement, and assessment efforts to maintain and continue progress on activities that support delisting the St. Louis River Area of Concern.
- Negative impacts to the land cover and hydrologic processes that shape the St. Louis River and its tributaries. These negative impacts are particularly focused at the base of the watershed, within the AOC.
- Continued increase in the area of impervious surface, which increases runoff and results in negative impacts to water quality and habitat within the AOC.
- Continued increase in number and diversity of landowners in the watershed, which results in potential negative impacts to habitat quality and difficulty in land-use management.
- Uncertain impacts and outcomes associated with global climate change.
- Continued trend of decreased management of water quality pollutants may result in impaired fish and wildlife habitat.
- Future habitat loss through development and industrial activities

## References: Loss of Fish and Wildlife Habitat

Minnesota Pollution Control Agency. 1990. Final Report. Remedial Investigation: St. Louis River Interlake Duluth Tar Site: 97 pages plus appendices.

Minnesota Pollution Control Agency. 2009. St. Louis River Area of Concern Delisting Targets December 2008. Wq-iw1-25.

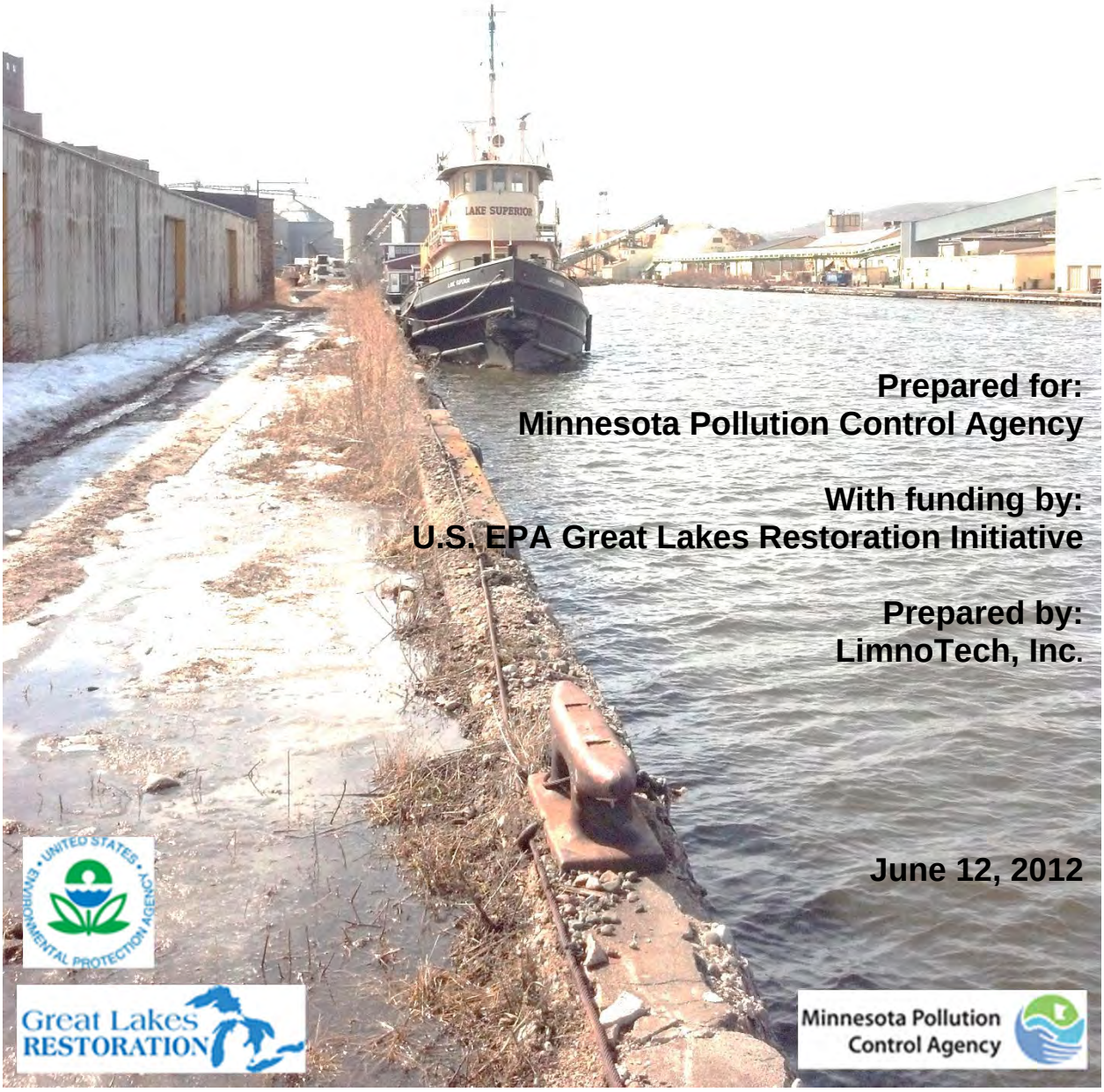
St. Louis River Citizens Action Committee (SLRCAC). 2002. Lower St. Louis River Habitat Plan. May 2002.

St. Louis River Alliance (SLRA). 2011. Lower St. Louis River Habitat Plan, Appendix 9, Strategies Implementation Planning Worksheets. Habitat Workgroup.

Spurrier, J. 1991. Letter from John Spurrier, Fisheries Manager, Minnesota Department of Natural Resources, to Nancy Larson, Wisconsin Remedial Action Plan Coordinator, Wisconsin Department of Natural Resources: 1 page.

# Appendix E: Remediation to Restoration Template

# ST. LOUIS RIVER AREA OF CONCERN
# REMEDIATION TO RESTORATION (R2R) TEMPLATE




**Prepared for:**
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**With funding by:**
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**Prepared by:**
**LimnoTech, Inc.**

**June 12, 2012**

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# Contents

# Introduction

The lower St. Louis River estuary is one of the largest, most complex Areas of Concern (AOC) on the Great Lakes. Historical and current land use practices contribute to a legacy of contaminated sediments, degraded habitat, and challenging nonpoint source pollution issues. The Stage I Remedial Action Plan submitted by the St. Louis River Citizen Action Committee in 1992 (SLRCAC 1992) describes the conditions leading to the nine Beneficial Use Impairments (BUIs) identified in the AOC. Work is currently underway, funded by a Great Lakes Restoration Initiative grant from the U.S. Environmental Protection Agency, to develop the St. Louis River AOC Implementation Framework, which is to be a comprehensive plan for removing the nine BUIs and ultimately achieving AOC delisting.

Opportunities within the estuary for maximizing recreational and natural resource potential have been addressed by a consortium of Minnesota and Wisconsin stakeholders through the Lower St. Louis River Habitat Plan (SLRCAC 2002). This document is intended to facilitate collaborative efforts towards ecological recovery of the estuary by establishing conservation goals applicable to one of the busiest ports on the Great Lakes. The "Strategies Implementation Planning Worksheets" contained within Appendix 9 of the plan (SLRA 2011) define stakeholder-identified projects for restoring habitat in the estuary. The Habitat Plan is the key document guiding restoration efforts within the estuary.

Guided by resource agency objectives, a wealth of regional scientific investigation, and support from public and business interests, the St. Louis River AOC coordinators and partners have recognized the need to further pursue collaborative recovery efforts in an attempt to efficiently meet AOC delisting objectives. Planning and implementing AOC recovery projects with a consistent approach towards information exchange and cross-jurisdictional decision-making is fundamental to a cost-effective recovery process. In an effort to streamline implementation, the states and other collaborative partners are assembling information from multiple sources to inform the site assessment process and determine those areas with high potential for habitat restoration success and protection opportunities. A systematic approach has been adopted that will simultaneously address contaminated sediments and degraded habitat while incorporating desired environmental and economic outcomes. The Remediation to Restoration (R2R) template described in this document utilizes AOC-wide protocols for assessing potential impact from sediment contamination and desired ecological outcomes as established by the Habitat Plan with public awareness and stakeholder support for a more effective overall management of projects necessary to delist the AOC.

Contaminated sediments may be considered the primary limiting factor of quality fish and wildlife habitat in those areas of the St. Louis River estuary that are R2R candidates. However, in order to progress towards restoring impaired beneficial uses within the estuary, desired ecological endpoints for a site must be considered first and foremost. To the extent feasible and practical, remediation of contaminated sediments, as well as other necessary restorative actions, must be evaluated, designed, and implemented in support of the desired ecological endpoint. In this way, R2R is an approach that addresses multiple beneficial use impairments (BUIs) at each applicable project site. Merging objectives

to reach the desired ecological endpoint of a healthy estuarine ecotype, thereby optimizing contribution of restoration efforts to reach BUI delisting targets, is the definition of the R2R process (Figure 1).

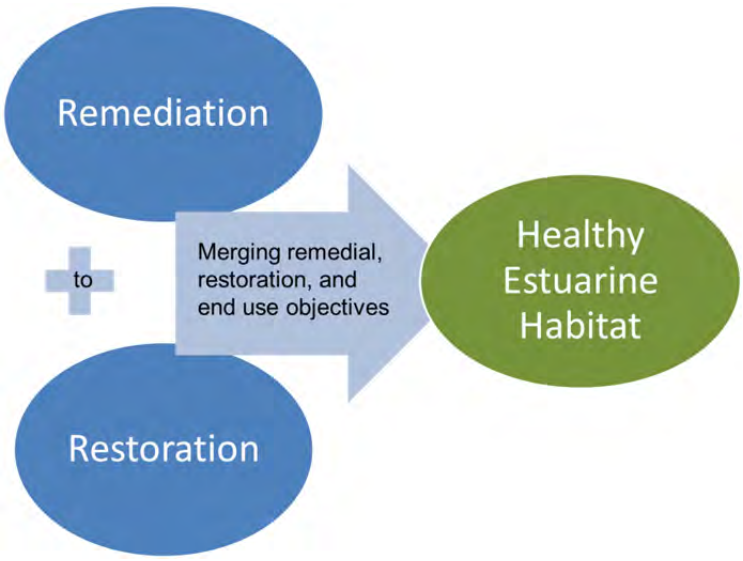


**Figure 1. The Simplified Remediation to Restoration (R2R) Concept**

The process is intended to assure that the base to the food web within the sediments and benthos is sufficient to support thriving populations of native fish and wildlife. It is therefore necessary within the R2R paradigm that the evaluation of contaminated sediment impacts consider not only the threat to human health, but also the threat to the health of the biological community. In order to reach BUI removal and eventual AOC delisting, potential threat to the health of the biological community must be scrutinized at a level that is lower than that typically associated with state remedial programs (i.e., "unacceptable risk"). Impacts to the biological community such as: toxicity to benthic macroinvertebrates (as established in part by the Consensus-Based Sediment Quality Guidelines jointly accepted by Wisconsin and Minnesota for the St. Louis River estuary; WDNR 2003 and Crane and Hennes 2007), bioaccumulation (through consideration of bioavailability), and direct exposure to contaminants through foraging must be evaluated as part of sediment remediation at R2R sites.

The R2R approach applies to a variety of aquatic habitats throughout the AOC as established in the Lower St. Louis River Habitat Plan (SLRCAC, 2002). The conservation goals for each habitat type identified in the plan are specific to existing conditions and desired habitat and end use goals. Therefore, while some ecotypes such as "sheltered bays" may have goals that are more strongly directed at habitat for fish and wildlife, others such as "industrial slips" have goals that address more extensive human use intent for those habitats. By recognizing the habitat-specific conservation goals established by the Habitat Plan, the R2R process applies to a broad range of sites with potentially very different end uses. Some R2R sites may have significant habitat restoration components while the focus of restoring others may be solely on addressing sediment contamination as an impact on the food web with minimal

habitat restoration needs. The focus of this template is on sites within the AOC that are considered "orphan" sites where no identified Responsible Party and no established remedial program is authorized. In these instances, the BUI targets and AOC delisting objectives are the drivers for addressing impairments.

Remediation to Restoration has gained support within the AOC from management partners at MPCA, Wisconsin DNR, Minnesota DNR, Fond du Lac Band of Lake Superior Chippewa, St. Louis River Alliance, U.S. Fish and Wildlife Service, U. S. Environmental Protection Agency, and others as an approach that comprehensively benefits the St. Louis River estuary by directing actions toward projects that maximize progress on BUI removal and ultimately leads to delisting.

This "R2R Template" describes the three major steps of the R2R process, as indicated in Figure 2:

- Site Screening: determine the extent of remediation of contaminated sediment needed at candidate restoration sites based on BUI objectives
- Site Planning: coordinated remedy planning, restoration planning, and end use planning
- Implementation: pre-design sampling , engineering & design, permitting, construction, habitat restoration, post-implementation monitoring, and project evaluation

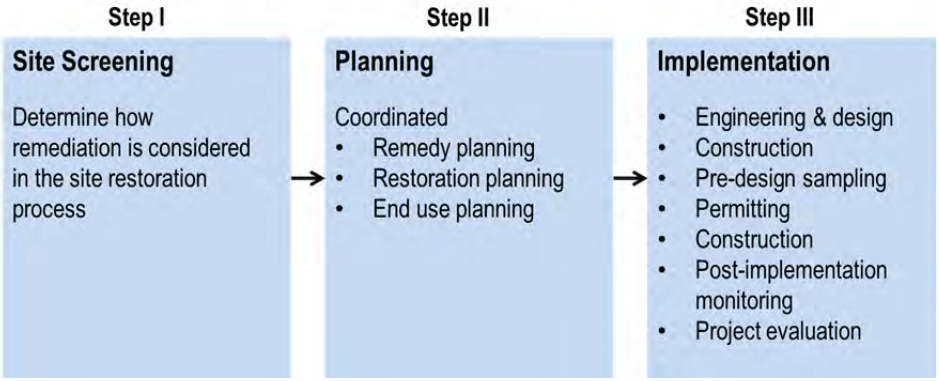


**Figure 2. Major Components of R2R Process**

The R2R template is intended to create a common understanding throughout the decision-making and planning process for those elements that should be considered concurrently when undertaking restoration activities. This template is not intended to be a step-by-step guide, nor is there direct responsibility placed on stakeholders, as those interactions are defined at a project-specific level. Rather this document provides a decision framework that relates the important considerations and relationships between planning phases. A restoration plan for any R2R site guided by this template ensures to all parties that continuity and critical oversight are embedded with remediation recommendations, restoration objectives, and human use needs.

A listing of baseline data needed to support development of an R2R plan for a site is included, starting on page 11 following the template. The R2R framework described in this template is designed to make the best possible use of existing data and site information. A limited set of baseline data is required to perform site screening and planning steps. Further data requirements are focused around key decision points and design requirements, as well as performance monitoring.

# R2R Template

The R2R template is presented in the three major steps, as depicted above in Figure 2:

1. Site Screening process: determination of the need for sediment remediation based on existing baseline data (Figure T-1)
2. Site Planning: coordinated remedy, restoration, and end use planning (Figure T-2)
3. Implementation: pre-design sampling, engineering & design, construction, post-implementation monitoring, and project evaluation (Figure T-3)

Each R2R template step is presented in the following sections, with annotated descriptions of the figure elements indicated by circled letters (i.e. Ⓐ).

## Site Screening

Site Screening focuses on assessing sediment contamination as a limiting factor for quality fish and wildlife. Sediment characterization will be conducted using a bi-state assessment approach for all sites throughout the AOC. Screening sites AOC-wide will provide baseline information to allow implementation actions to be prioritized by habitat potential and remedial needs; thereby continuing the work started by the St. Louis River Alliance Habitat and Sediment Workgroups in the Contaminated Sediments Action Plan (SLRCAC 2007).

"Remedial Assessment Teams" from MPCA and Wisconsin DNR are currently working to develop both the technical methods that will be used to assess sediment data at sites throughout the AOC and the decision framework for determining whether a site will be addressed under the R2R process established by this template or within a designated state remedial program. While each state is developing their own methods, coordination between the two states will occur through convening of the Sediment Technical Team. The Sediment Technical Team is charged with developing an AOC-wide approach and protocols for assessing impact of sediment contamination on biological receptors in order to determine the need for sediment remediation at an R2R site.

Information established in the Site Screening phase will inform prioritization of a site for advancement into the Site Planning phase. *The Site Screening phase is not intended to select sites for advancement within the R2R process.* It is a necessary step prior to site planning to determine the level of regulatory authority (i.e. WDNR or MPCA) involvement required due to the presence of sediment contamination in restoration efforts at a site.

Following site screening, further assessment of site conditions is necessary in the Site Planning phase during which a site-specific restoration plan is developed.

As stated above in the Site Screening component of the R2R template, the need for remediation of contaminated sediments is identified and sites are screened based on the level of remediation required, as shown in Figure 3.

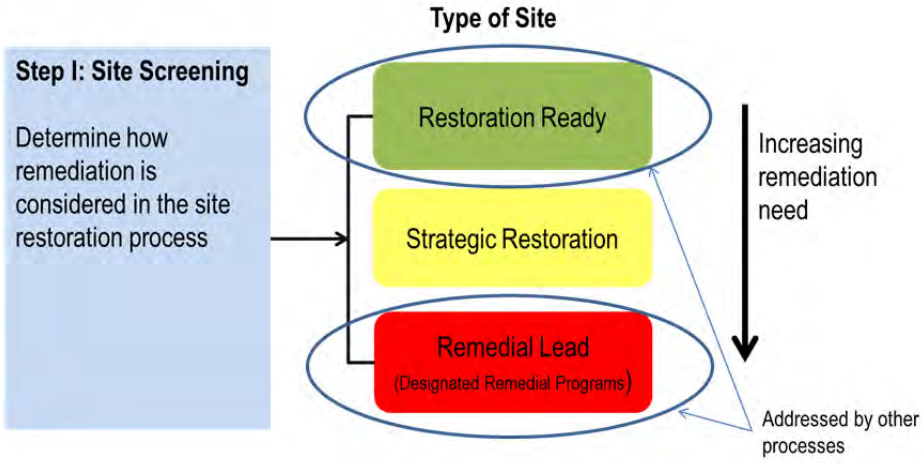


**Figure 3. Overview of Site Screening Template**

Figure 3 introduces a set of colors that has been adopted to identify the general level of sediment contamination present at sites within the AOC:

Green – "Restoration Ready": sediment characterization data indicates no adverse impacts from contaminant concentrations will be realized within the associated biological community and there is no need for remediation of contaminated sediments; other impairments to benthos and substrate may exist. Restoration Ready sites are not included under this template.

Yellow – "Strategic Restoration" (R2R): Levels of sediment contamination present at yellow sites are not deemed to present an "unacceptable risk" to human health and the environment, but may be present at levels that are known or suspected to be impacting the health of the biological community. There are at least two scenarios that may occur for yellow sites: 1) contamination may be present in sediment at the site at levels that would be otherwise unacceptable risk to human health; however, it is buried and overlain by stable sediments considered to pose no threat to the biological community. Restoration efforts at the site must consider the location of the contamination and be designed to protect sediment stability or 2) contamination is ubiquitous in sediments at the site at a level impacting biological receptors, but not posing an unacceptable risk to human health. As such, remedial alternatives must be developed to address contaminant impact on the biological community.

Red – "Remedial Lead": contamination is present in sediments at the site at levels posing an unacceptable risk to human health that trigger dealing with the site under designated state remedial programs. This does not obviate restoration as part of the process for these sites, but it is not being dealt with in this template, as Remedial Lead sites will be subject to a specific regulatory process.

The Site Screening template is presented in Figure T-1. Note that Steps II and III (Site Planning and Implementation) of this R2R template deal only with those sites identified as "yellow" R2R sites in Step I.

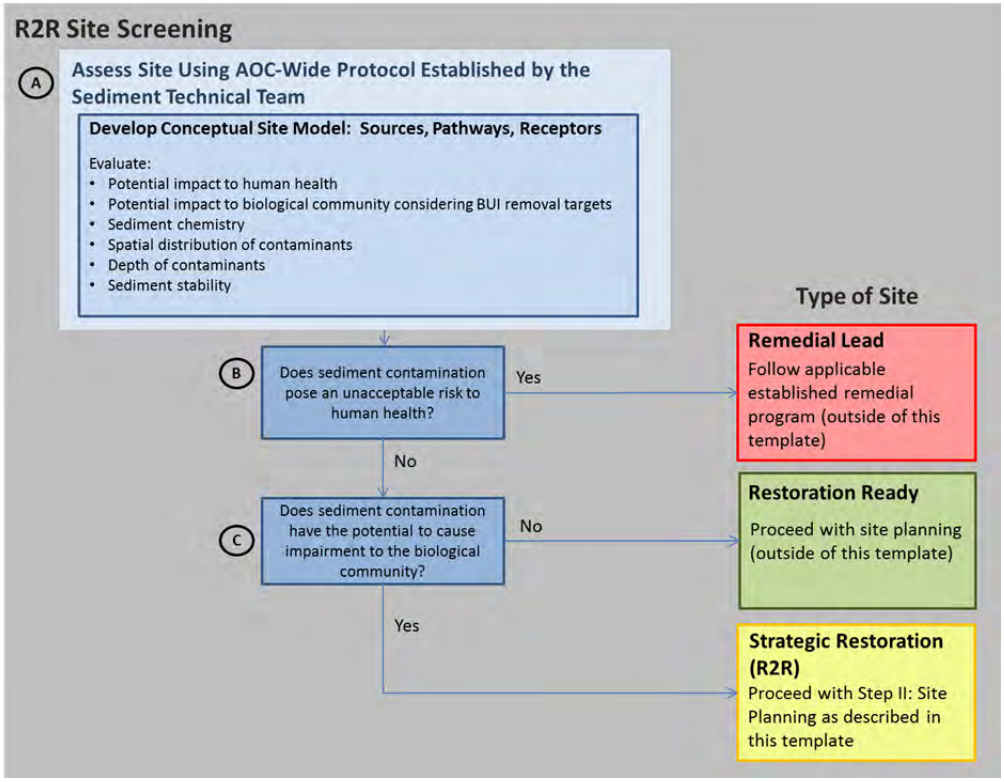


**Figure T-1. Step I: Site Screening**

## Site Screening Template Key:

(A) **Develop Conceptual Site Model.** An important initial step in evaluating sediment contamination at a site is to develop a conceptual site model (CSM) using existing site data. The CSM characterizes sources of contamination, pathways, and receptors that are addressed in remedy, restoration, and end use planning processes that factor in the level of remedial program involvement.

In this stage, the following are evaluated using the approaches and protocols established by the Sediment Technical Team for characterizing the need for remediation at the site:

- Potential impact to human health
- Potential impact to biological community considering BUI removal targets
- Sediment chemistry
- Spatial distribution of contaminants
- Depth of contaminants
- Sediment stability

Contaminants are evaluated on a site level using Consensus-Based Sediment Quality Guidelines (CBSQGs) and other state guidance values. Persistent bioaccumulative toxics (PBTs; i.e., PCBs and mercury) are also evaluated for their impact on fish consumption advice on a larger spatial and temporal scale; this assessment will rely on bioavailability studies being conducted in the estuary.

Refinement of the CSM, including collecting additional data, may be necessary in the Site Planning phase.

(B) The site screening template focuses on the presence or absence of sediment contamination at levels which have the potential to cause impact to humans and the biological community and the characteristics of that contamination. Once the CSM is developed for a site, the information necessary for answering the question "Does sediment contamination pose an unacceptable risk to human health?" has been assessed.

If the answer to this question is "yes", the site is deemed red "Remedial Lead". Site remediation and restoration is led by state remedial teams and follows designated remedial programs.

(C) If the answer to the first question regarding human health is "no", a second question regarding potential impact to the biological community is asked: "Does sediment contamination have the potential to cause impairment to the biological community?"

If the answer is "no", a site is deemed green "Restoration Ready" and may proceed with restoration and end use planning.

If the answer is "yes", a site is deemed yellow "Strategic Restoration (R2R)". Site Planning and Implementation proceed following the process identified in this template.

**Estimated timeframe to complete Step I, Site Screening: 6-18 months.**

## Site Planning

Site Planning simultaneously addresses restoration, remediation, and end use objectives. The primary objective in the site planning process is to develop a plan for the site that streamlines remediation and restoration activities while considering the desired end uses in a plan focused on achieving BUI removal targets.

The Site Planning template is presented in Figure T-2 below.

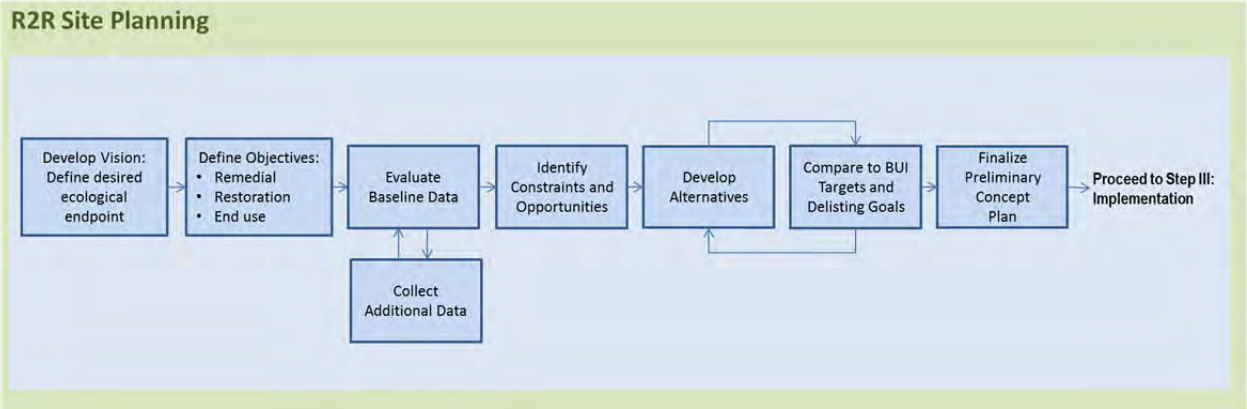


**Figure T-2. Step II: Site Planning**

Site Planning proceeds with the goal of coordinated remedy, restoration, and end use planning. In some instances, the site planning phase may resemble a feasibility study. Site-specific factors, such as the level of sediment contamination present, project partners involved, and desired end uses, may require that the planning phase proceeds with greater emphasis on remedy, restoration, or end use planning. Following are descriptions of each of these planning processes.

Site Planning for R2R sites starts within visioning for the area where the desired ecological endpoint is defined. From this ultimate habitat goal, a set of objectives for remediation, restoration, and end uses at the site are developed. Once objectives are defined, planning proceeds with further evaluation of site data, including refinement of the CSM developed during Site Screening. Design constraints and opportunities are identified, and a set of alternatives are developed and evaluated. An important feedback loop exists, in which alternatives are compared to BUI removal targets and AOC delisting goals. This is to ensure that R2R plans developed for the site focus on actions necessary to achieve AOC delisting. Once an optimized R2R plan has been developed, the site proceeds to the Implementation phase in Step III.

**Remedy Planning**. The focus of Remedy Planning is to screen and select a remedy alternative to address sediment contamination at the site, while coordinating with parallel restoration and end use planning.

The first step of this planning phase is to identify remedy objectives related to desired ecological endpoint for the site. In this step, restoration and end use objectives must be considered such that all objectives are coordinated and aren't mutually exclusive.

The second step is to identify remedy alternatives for the site, evaluating options such as dredging, capping, in-place treatment, monitored natural recovery, and institutional controls. Once a set of alternatives is identified, a comparative analysis occurs. This differs from a typical feasibility study in that restoration and human use needs must be considered in the analysis so that objectives from all three planning efforts are represented. The outcome of the comparative analysis is a selected remedy alternative that has been developed considering restoration and human use needs. Selection of a remedy alternative may require significant time for evaluation, selection, and public input.

**Restoration Planning.** The goal of Restoration Planning through the R2R process on a site-specific scale is to maximize progress toward restoring a select set of beneficial uses (i.e., removing multiple relevant BUIs). While sediment contamination is addressed through Remedy Planning, impacts from other stressors such as poor water quality, low light penetration, substrate alteration, and the presence of marine debris are addressed in the restoration plan.

The first step in Restoration Planning is to define the restoration objectives for the site. This is done based on an evaluation of the historic site conditions, the ultimate habitat goal (ecotype, desired species, etc.), baseline physical, chemical, and biological data, and priority BUI actions identified in the Implementation Framework.

Once restoration objectives have been defined, restoration alternatives are identified and evaluated. Remedy needs and desired and existing human uses are considered in this process. Any considerations that may alter or impede R2R progress must factor into the identification of design constraints and opportunities from the beginning. AOC priorities, in the form of BUI delisting targets and indicators, are considered in the evaluation of restoration alternatives. A feedback loop included in the alternative evaluation aids in developing a site design that focuses on important considerations from the AOC standpoint.

**End Use Planning.** End Use planning considers both existing and desired human use of a site and involves landowners and other site users, depending on property ownership.

In the first step of this planning process, a domain of potential end use opportunities is developed. Existing uses, such as shipping, fishing, recreational trails, and land-side industrial activities, are considered as well as desired uses, such as improved recreational amenities or new commercial uses. Existing planning documents (i.e., land use plans, comprehensive plans, port plans, etc.) are reviewed and, if possible, pertinent elements incorporated into the design. Stakeholders are identified and invited to participate in an organized/controlled process designed to facilitate development of the end use plan

and to create stakeholder buy-in. Key to the end use planning phase is involvement of existing landowners in evaluation of uses and development of alternatives for the site.

Once opportunities are identified, a set of end use alternatives is developed. Relationships among human use and desired beneficial uses are considered, including: whether human uses would negatively impact desired restoration elements (e.g., boating use impacting wild rice beds); whether human uses would enhance beneficial uses at the site; and the potential connections between land-based uses and water-based beneficial uses.

The feasibility of the end use alternatives is evaluated based on factors such as needed infrastructure, economic constraints, affordability, and restoration and remediation needs. The outcome of the feasibility evaluation is a selected end use plan for the site.

**Estimated Timeframe to complete Step II, Site Planning: 6 – 24 months**

## Implementation

Implementation includes the final steps necessary for accomplishing a coordinated R2R design, as well as post-implementation monitoring and project evaluation.

The Implementation template is presented in Figure T-3 below.

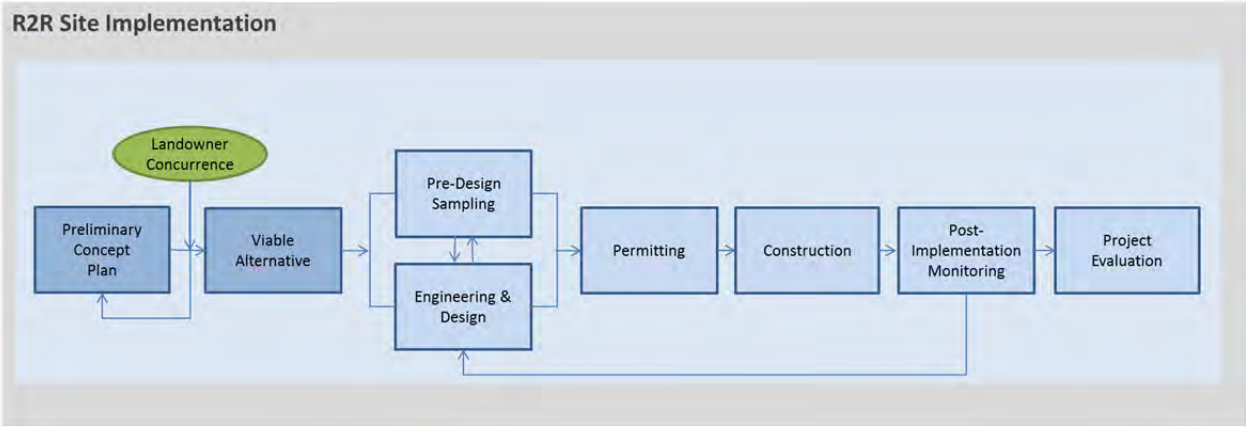


**Figure T-3. Step III: Implementation**

The Implementation phase starts with the coordinated R2R plan resulting from the Site Planning phase. Once final landowner concurrence is achieved, a viable alternative emerges allowing for engineering & design to commence. Generally, pre-design sampling will occur to fill any information or data gaps necessary for final design. Long-term maintenance needs must be considered and accounted for in the design phase, with the optimum design requiring limited future maintenance. Once design is complete, permits are obtained. Implementation of the selected remedy can then proceed in concert with

construction elements of the restoration. In this step, remediation elements are closely coordinated with restoration elements for time and cost efficiencies. Following construction, post-implementation monitoring must occur to evaluate remedy and restoration effectiveness and to identify any maintenance needs for the site. Implementation should be considered an adaptive process, where post-implementation monitoring results may indicate the need for re-engineering or re-design. Post-implementation monitoring feeds project evaluation which involves assessing whether the project results were as planned, including items such as acreages restored, whether objectives were met, whether adequate public input occurred, and the contribution to successful BUI removal.

The entities involved in project implementation and management will be determined on a site-by-site basis during development of project-specific plans.

**Estimated Timeframe to complete Step III, Implementation: 12-60 months.**

## Baseline Data Needs to Support R2R Template

This section presents a listing of the standard set of baseline data needed to develop a plan for restoring a degraded site. The three phases of the R2R template presented in the preceding section rely on baseline data collected to establish the existing chemical, physical, and biological characteristics of the site. In addition, information on human use and inputs, termed "public involvement", is a vital part of the planning process.

As mentioned previously, the R2R framework described in this template is designed to make the best possible use of existing data and site information. It should be noted that use of data collected within the estuary for other purposes (e.g., research, routine monitoring programs) is encouraged. A limited set of baseline data is required to perform site screening and planning steps as indicated by those data under "minimum" below. Further data requirements are focused around key decision points and design requirements, as well as performance monitoring. Data indicated under "additional" below are not necessarily required, but are considered useful in developing site understanding and remedy/restoration designs, depending on the specific site.

### Physical Data

Minimum:

- Project boundaries
- Land survey, including topography
- Existing infrastructure and easements
- Land/sediment ownership
- Habitat type (s)
- Bathymetry
- Water levels
- Sediment/Substrate characteristics
- Sediment coring logs

- Historical land use/aerial photography
- Hydrology and watershed contributions
- Buffer areas

Additional (site-specific):

- Hydrodynamic data: flows, velocities
- Hydrodynamic model
- Wind-wave model predictions
- Water column physical data: total suspended solids, suspended sediment concentration (SSC), bedload measurements
- Sediment transport model
- Sediment erodibility measurements
- Bed evolution data: scour, deposition rates
- Sediment bed imaging: sidescan sonar, sub-bottom profiling
- Radioisotope dated sediment cores
- Groundwater flow and contribution

## Chemical Data

Minimum:

- Sediment contaminant concentrations: – surface and vertical profiles
- Water column contaminant concentrations, including partitioning between dissolved and particulate phases where data is available
- Upstream and point source loads of contaminants of concern and sediments

Additional (site-specific):

- Bioavailability
- Sediment toxicity data, baseline ecological risk assessment
- Other chemical data relevant to exposure and toxicity: acid volatile sulfide, total organic carbon
- Human health exposure study (risk assessment)
- Any TMDL implementation strategies and long-term monitoring

## Biological Data

Minimum:

- Benthic macroinvertebrate community
- Fish habitat types
- Aquatic and terrestrial vegetation
- Invasive species assessment
- Threatened and endangered species

Additional (site-specific):

- Bioavailability
- Birds
- Herpetology
- Algae
- Paleolimnology
- Insects
- Species objectives
- Ecological structure and function analysis

## Public Involvement

Minimum:

- BUI-specific stakeholder input
- Citizen and landowner input
- Recreational uses
- Project sponsor
- Land use plans
- Access issues
- Shipping needs
- Historic preservation
- Archeological surveys
- Statute changes
- Funding development
- Responsible party
- Local government officials

**Estimated timeframe to complete Baseline Data collection: 6-18 months.**

# References

Crane, Judy and Steve Hennes. February 2007. Guidance for theUse and Application of Sediment Quality Targets for the Protection of Sediment-Swelling Organisms in Minnesota. Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency

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Wisconsin Department of Natural Resources (WDNR). 2003. Consensus-Based Sediment Quality Guidelines; Recommendations for Use & Application Interim Guidance. Developed by the Contaminated Sediment Standing Team. WT-732 2003

# Appendix F: St. Louis River Area of Concern Sediment Characterization: Final Report

# St. Louis River Area of Concern Sediment Characterization: Final Report

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# St. Louis River Area of Concern Sediment Characterization

**Final**

**Prepared for:**
**Minnesota Pollution Control Agency**

**July 11, 2013**

To: Whom it may concern
From: Diane Desotelle, St. Louis River Area of Concern Coordinator
Minnesota Pollution Control Agency

Date: February 22, 2016

RE: Data Quality Disclaimer for this Report – St. Louis River Area of Concern Sediment Characterization: Final Report. LimnoTech. July 11, 2013.

The United States Environmental Protection Agency (USEPA), Great Lakes National Program Office (GLNPO) has notified MPCA that at this time the USEPA is unsure of the quality of the Polycyclic Aromatic Hydrocarbon (PAH) and Organic Carbon values in the report, Sediment Assessment Report – Revision 1, St. Louis Bay by Weston Solutions, Inc., July 2012. This does not mean the data is of poor quality, but the quality is unknown at this time. The USEPA is conducting audits to determine the quality of the data, and will notify the MPCA when they have made a final determination. Therefore the sediment assessment area chemistry characterization for assessment areas 40, 41, 43, 44, 45, 47, 58, 59, 60, and 63 of this report are of unknown quality for PAHs and Organic Carbon values.

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# 1 Introduction

The Minnesota Pollution Control Agency (MPCA) and Wisconsin Department of Natural Resources (WDNR) are two of the agencies currently working together to implement a comprehensive long-term plan to delist the St. Louis River Area of Concern (SLR AOC). Many of the Beneficial Use Impairments (BUIs) in the AOC are linked to the presence of sediment contaminants. The St. Louis River Sediment Characterization Project was undertaken to evaluate and summarize the levels of sediment contaminants throughout the AOC based on the significant amount of existing sediment contaminant data. This work was done to support the MPCA and WDNR in defining the general level of remedial action needed for sites across the AOC to support BUI removal strategies. It is important to note that the characterization was based solely on sediment contaminant data; multiple lines of evidence are used by the states when conducting site-specific investigations.

Teams of staff from MPCA and WDNR determined protocols for sediment characterization, dictated particular datasets to be used in the analysis, and oversaw development of project deliverables. These teams were termed the Minnesota Remedial Assessment Team (MNRAT) and Wisconsin Sediment Assessment Team (WISAT); together the teams constitute the Sediment Technical Team.

As part of the project, the AOC was divided into Sediment Assessment Areas (SAAs) for purposes of evaluation and to assist in the prioritization of remediation and restoration activities.

The work-products developed as part of the Sediment Characterization project were:

- Sediment Assessment Area Chemistry Characterization or “dashboards”
- Maps of sediment contaminants for multiple depth intervals
- Database queries to assist MPCA and WDNR in conducting independent analysis of the sediment contaminant levels in the AOC
- A memorandum describing a systematic approach to assign remedial categories to each SAA for Minnesota

This report documents the development of these work products. The dashboards, maps, and remedial categorization memorandum are included as appendices.

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# 2
# Dataset Description

## 2.1 Description of the Phase VII Database

The Minnesota Pollution Control Agency (MPCA), in cooperation with other agencies, including the Wisconsin Department of Natural Resources, updated the existing Phase VI St. Louis River Area of Concern Sediment and Biological Database. The Phase VI database included 53 studies with sediment chemistry results, dating back to 1992.Updates included incorporating database structural enhancements, eight new sediment-quality datasets, and four biological datasets to create Phase VII of the database. The sediment chemistry datasets added to create the Phase VII database were:

- St. Louis Bay 40th Ave, 2010
- Hog Island Post Remediation, 2006
- Howards Bay – St. Louis River AOC, 2010
- Lower St. Louis River, 2011
- Spirit Lake, 2011
- Upper St. Louis River, 2011
- St. Louis River WDNR Wisconsin Sampling, 2007
- St. Louis River Mud Lake/Radio Tower Bay, MPCA Sediment Chemistry, 2008

## 2.2 Sediment Assessment Area Delineation

Draft polygons representing the SAAs were received in GIS layers from MPCA and WDNR. The two datasets were merged and boundary lines were edited to achieve a seamless coverage of the AOC. Some assessment area names were edited to ensure uniqueness and an ID numbering scheme was established. Larger groups of assessment areas, called Geographic Zones, were established. The designated Geographic Zones are:

- Lake Superior
- Allouez Bay
- Superior Bay
- St. Louis Bay
- Lower St. Louis River
- Middle St. Louis River
- Upper S. Louis River
- Koppers/Crawford Creek

In total, 120 SAAs were delineated – 77 in Minnesota and 43 in Wisconsin. The decision was made to treat the Federal Navigation Channel separately. SAA borders were drawn to coincide with the navigation channel. Of the 120 SAAs, 18 are in the navigation channel.

## 2.3 Datasets Selected by Minnesota and Wisconsin

Not every dataset in the Phase VII database was used in the sediment chemistry characterizations. For Minnesota, two major sediment contaminant sampling efforts were undertaken in 2010 and 2011 by the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. Sampling was conducted according to a plan developed by MPCA to provide a screening level evaluation of sediment contamination across the Minnesota-side of the AOC. Therefore, MPCA decided to use primarily these recently collected samples for the sediment characterizations. MPCA staff conducted an evaluation and made decisions regarding the appropriate studies to use for each SAA. Table 1 shows the studies used for each SAA in Minnesota.

Fewer recently collected samples are available on the Wisconsin side of the AOC. WDNR made the decision to use all available samples for the sediment characterizations, with the exception of samples that represented pre-remedial conditions in Hog Island Inlet and at the SLRIDT Superfund Site.

**Table 1. Studies used for each Minnesota Sediment Assessment Area**

| SAA ID | SAA/ Study ID | R-EMAP Study, 1995 (4) | R-EMAP Study, 1996 (6) | MN Slip Sed. Remediation Scoping, 1999 (9) | Assessment Study of Slip C, 1997 (10) | Minnesota Slip Samples, 1998 (11) | ENSR Mercury Study, 1995 (18) | Cloquet Reservoirs Study 1992-93 (19) | Service Intlk WPIIIA, 2001 (42) | Bay West Intlk Supplemental 2001 (44) | Bay West Intlk Reconnaissance 2001 (45) | Reference Sites, 2001 (46) | SLRIDT Reference Sites SEG 2004 (51) | Minnesota Slip MPCA 2004 (52) | USS Superfund Site URS 2003 (54) | Superior Bay-21st Ave. ACOE, 2008&10 (67) | St. Louis Bay 40th Ave. EPA, 2010 (69) | Lower St. Louis River ACOE, 2011 (72) | Spirit Lake EPA, 2011 (73) | Upper St. Louis River EPA, 2011 (74) | Bay West NRDA Study Mud Lake & Radio (76) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Superior Bay (Minnesota) | | | | | | | | | | | | | | | ● | | | | | |
| 18 | Hearding Island | | | | | | | | | | | | | | | ● | | | | | |
| 19 | North Park Point Bayside | | | | | | | | | | | | | | | ● | | | | | |
| 20 | Minnesota Slip | | | ● | | ● | | | | | | | | ● | | | | | | | |
| 21 | Slip 2 | | | | | | | | | | | | | | | ● | | | | | |
| 22 | Slip 3 | | | | | | | | | | | | | | | ● | | | | | |
| 23 | Slip C | | | | ● | | | | | | | | | | | ● | | | | | |
| 24 | General Mills Elevator A Slip | | | | | | | | | | | | | | | ● | | | | | |
| 25 | Cargill Elevator B1 Slip | | | | | | | | | | | | | | | ● | | | | | |

| SAA ID | SAA/ Study ID | 4 | 6 | 9 | 10 | 11 | 18 | 19 | 42 | 44 | 45 | 46 | 51 | 52 | 54 | 67 | 69 | 72 | 73 | 74 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | Cargill Elevator B2 / Northland Pier Slip | | | | | | | | | | | | | | | ● | | | | | |
| 27 | Northland Pier / AGP Slip | | | | | | | | | | | | | | | ● | | | | | |
| 28 | Azcon Corp / Duluth Seaway Port Authority Garfield Slip C | | | | | | | | | | | | | | | ● | | | | | |
| 29 | Duluth Seaway Port Authority Garfield Slip D / Clure Public Marine Terminal Berth 1 | | | | | | | | | | | | | | | ● | | | | | |
| 30 | Rices Point Off-Channel East | | | | | | | | | | | | | | | ● | | | | | |
| 36 | Rices Point Off-Channel West | | | | | | | | | | | | | | | | | | | | |
| 37 | Slip near 21st Ave W | | | | | | | | | | | | | | | ● | | | | | |
| 38 | 21st Avenue | | | | | | | | | | | | | | | ● | | | | | |
| 40 | Bay NE of Canadian National / DM&IR | | | | | | | | | | | | | | | ● | | | | | |
| 41 | Interstate Island Flats | | | | | | | | | | | | | | | | | | | | |
| 43 | DM&IR | | | | | | | | | | | | | | | | ● | | | | |
| 44 | Hibbard | | | | | | | | | | | | | | | | ● | | | | |
| 45 | Bay NE Side of Erie Pier | | | | | | | | | | | | | | | | ● | | | | |

| SAA ID | SAA/ Study ID | 4 | 6 | 9 | 10 | 11 | 18 | 19 | 42 | 44 | 45 | 46 | 51 | 52 | 54 | 67 | 69 | 72 | 73 | 74 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58 | Erie Pier Slip | | | | | | | | | | | | | | | | ● | | | | |
| 59 | Ponds behind Erie Pier | | | | | | | | | | | | | | | | ● | | | | |
| 60 | Coffee Ground | | | | | | | | | | | | | | | | ● | | | | |
| 63 | Grassy Point | | | | | | | | | | | | | | | | ● | | | | |
| 66 | C. Reiss Coal Dock Slip | | | | | | | | | | | | | | | | ● | | | | |
| 67 | Bay between C. Reiss and SLRIDT 7 / W. Grassy Point Estuary Flats | | | | | | | | | | | | | | | | ● | | | | |
| 70 | Kingsbury Bay | | | | | | | | | | | | | | | | | | | | |
| 71 | Tallas Island | | | | | | | | | | | | | | | | ● | | | | |
| 74 | Tallas Island NC | | | | | | | | | | | | | | | | ● | | | | |
| 75 | Riverside Marina | | | | | | | | | | | | | | | | | | | | |
| 76 | U.S. Steel Superfund Site | | | | | | | | ● | ● | ● | ● | ● | | | | | ● | | | |
| 78 | Spirit Lake / Devils Elbow | | | | | | | | | | | | | | | | | ● | | | |
| 80 | Steelton Bay | | | | | | | | | | | | | | | | | ● | | | |
| 81 | New Duluth Stretch | | | | | | | | | | | | | | | | | ● | | | |

| SAA ID | SAA/ Study ID | 4 | 6 | 9 | 10 | 11 | 18 | 19 | 42 | 44 | 45 | 46 | 51 | 52 | 54 | 67 | 69 | 72 | 73 | 74 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 82 | Mud Lake East | | | | | | | | | | | | | | | | | | ● | | |
| 83 | Mud Lake West | | | | | | | | | | | | | | ● | | | ● | | | |
| 84 | Lower St. Louis River | | | | | | | | | | | | | | | | | ● | | | |
| 85 | Cedar Yard Bay (Radio Tower Bay) | | | | | | | | | | | | | | | | | ● | | | |
| 88 | New Duluth Bay | | | | | | | | | | | | | | | | | ● | | | ● |
| 89 | North Bay | | | | | | | | | | | | | | | | | ● | | | |
| 90 | Fond du Lac Stretch | | | | | | | | | | | | | | | | | ● | | | |
| 91 | Perch Lake | | | | | | | | | | | | | | | | | ● | | | ● |
| 92 | Rask Bay | | | | | | | | | | | | | | | | | ● | | | |
| 93 | Chambers Grove Reach | | | | | | | | | ● | ● | | | | | | | ● | | | |
| 94 | Fond du Lac Reservoir | | | | | | | | | | | | | | | | | ● | | | |
| 95 | Lower Jay Cooke State Park Reach | | | | | | | | | | | | | | | | | ● | | | |
| 96 | Middle Jay Cooke State Park Reach | | | | | | | | | | | | | | | | | ● | | | |
| 99 | Thomson Reservoir | | | | | | | | | | | | | | | | | ● | | | |

| SAA ID | SAA/ Study ID | 4 | 6 | 9 | 10 | 11 | 18 | 19 | 42 | 44 | 45 | 46 | 51 | 52 | 54 | 67 | 69 | 72 | 73 | 74 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | Forbay Reservoir | ● | ● | | | | | ● | | | | | | | | | | | | ● | |
| 101 | Scanlon to Thomson Whitewater Reach | | | | | | | | | | | | | | | | | | | ● | |
| 102 | Scanlon Reservoir | | | | | | | | | | | | | | | | | | | ● | |
| 103 | NW Paper Company Reach | | | | | | | | | | | | | | | | | | | | |
| 104 | Cloquet Reservoir | | | | | | | | | | | | | | | | | | | | |
| 105 | Knife Falls Reservoir | ● | | | | | ● | ● | | | | | | | | | | | | | |
| 106 | Spafford Park Reach | ● | ● | | | | ● | ● | | | | | | | | | | | | | |
| 107 | Fond du Lac Indian Reservation Reach | | | | | | | | | | | | | | | | | | | ● | |

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# 3
# Data Treatment Protocol

## 3.1 Protocol Development

A series of protocols were developed to determine appropriate approaches to data handling. The protocols were developed over the course of the project, starting at the project kickoff in October 2012 through the submittal of the draft work products delivered on April 1, 2013.

Meetings were held with the MNRAT and WISAT teams on October 15, 2012 to discuss the sediment characterization reports and to gather initial thoughts on characterization process protocols. At those meetings, it was suggested that more informed protocols could be developed after LimnoTech had the opportunity to work with the data, perform initial calculations, and develop example dashboard reports.

Additional data handling protocols were discussed over the course of several conference calls with the Sediment Technical Team.

The focus of sediment characterization efforts for the project was comparison to Consensus Based Sediment Quality Guidelines (CBSQs) established for the St. Louis River to represent levels of sediment contaminants that are toxic to benthic organisms. While Minnesota and Wisconsin each apply the CBSQs with slightly different approaches, the contaminant levels represented by the CBSQs for each state are generally the same.

The protocols used to develop the work products associated with the SLR Sediment Characterization project are as follows:

- For CBSQs, Level 1 and Level 2 Sediment Quality Targets (SQTs) were taken from Guidance for the Use and Application of Sediment Quality Targets for the Protection of Sediment-dwelling Organisms in Minnesota (Crane and Hennes, 2007). Threshold effect concentration (TEC), midpoint effect concentration (MEC), and probable effect concentration (PEC) values were taken from Consensus-Based Sediment Quality Guidelines Recommendations for Use & Application Interim Guidance (WDNR, 2003).
- Total polycyclic aromatic hydrocarbon (PAH) values were calculated using the 13 priority PAHs:
  - Acenapthene
  - Acenapthylene
  - Anthracene
  - Fluorene
  - 2-methylnaphthalene
  - Naphthalene
  - Phenanthrene
  - Benz(a)anthracene
  - Benzo(a)pyrene
  - Chrysene
  - Dibenz(a,h)anthracene
  - Fluoranthene
  - Pyrene
- Metals values were preferentially based on total metal measurements. For samples without a total metals measurement, the simultaneously extracted metal value was substituted.
- Total polychlorinated biphenyls (PCBs) were preferentially calculated as congener sums. For samples without a PCB congener measurement, the sum of Aroclors was substituted.

- Tetrachlorinated dibenzo-p-dioxin (TCDD) Toxic Equivalents (TEQ) values are calculated using Fish Ecological Risk Toxic Equivalency Factors (TEFs) based on 1998 World Health Organization (WHO).
- Contaminant concentrations were not normalized to total organic carbon (TOC) for any applications.
- Sediment samples were assigned to a single depth interval where the highest fraction of the sample occurs. Samples were assigned to the following depth intervals:
  - 0-15 cm (surface samples)
  - 15-50 cm
  - 50-100 cm
  - >100 cm
- Values below the detection limit were treated as follows:
  - TCDD TEQ values were calculated using a Kaplan-Meier estimator
  - PCB sums were calculated assuming non-detects are equal to zero
  - Metal concentrations were replaced with :
    - Half the detection limit, if greater than 40% of measurements from the study are below detection limits
    - The detection limit, if less than 40% of measurements from the study are below detection limits
  - PAH values were estimated based on log-log regressions with other PAH compounds – the predictors and R-squared values for each of the PAH17 compound are presented in Table 2.

**Table 2. Predictors and R-squared values for regressions used to substitute for PAH17 compounds below the detection limits**

| PAH Compound | Best predictor among PAH with <20% non-detect | R-squared |
|---|---|---|
| 2-methylnaphthalene | Phenanthrene | 0.92 |
| Acenapthene | Pyrene | 0.46 |
| Acenapthylene | Benzo(a)pyrene | 0.91 |
| Anthracene | Fluoranthene | 0.94 |
| Benz(a)anthracene | Benzo(g,h,i)perylene | 0.96 |
| Benzo(a)pyrene | Benz(a)anthracene | 0.93 |
| Benzo(b)fluoranthene | Benzo(g,h,i)perylene | 0.98 |
| Benzo(g,h,i)perylene | Benz(a)anthracene | 0.96 |
| Benzo(k)fluoranthene | Chrysene | 0.66 |
| Chrysene | Benzo(g,h,i)perylene | 0.95 |
| Dibenz(a,h)anthracene | Benz(a)anthracene | 0.97 |
| Fluoranthene | Phenanthrene | 0.98 |
| Fluorene | Phenanthrene | 0.99 |
| Indeno(1,2,3-c,d)pyrene | Benzo(a)pyrene | 0.86 |
| Naphthalene | Benzo(a)pyrene | 0.87 |
| Phenanthrene | Fluoranthene | 0.98 |
| Pyrene | Fluoranthene | 0.98 |

# 4
# Description of Deliverable

## 4.1 Sediment Assessment Area Dashboards

A series of chemistry characterizations or "dashboards" were developed for each of the St. Louis River SAAs. The dashboards were generated to provide screening-level displays of the sediment contaminant data available for individual assessment areas within the St. Louis River Area of Concern. They are intended to assist in decision -making related to restoration initiatives. However, they do not provide a final remedial category designation. The dashboards include the following components:

**Mean Probable Effects Quotient (PEC-Q) Range Energy Star Diagram** - The Mean PEC-Q is an integrated measurement of mixtures of sediment contaminants (metals, Total PAH, and Total PCB). It is an average of sediment chemical concentrations divided by their corresponding PECs or Level 2 SQTs. The graphic shows the mean of the Mean PEC-Q values for surface samples (0-15 cm) and subsurface samples (>15 cm) on a range of 0 to 1. The Minnesota diagrams are shown in a blue color scale, while the Wisconsin diagrams are shown using a red, yellow, and green scale.

**Map of Core Locations** - The map shows the locations of the available samples in the assessment area. Samples used to create the summary graphics are color coded based on the surface Mean PEC-Q. Areas of water depth greater than 8 feet are also shown, based on bathymetry data from U.S EPA (2006).

**Study Information** - This section lists the available studies for the SAA. The studies are divided into sediment chemistry studies used in the assessment, additional available sediment chemistry studies, and available biological studies.

**Core profiles** - The vertical profiles show color coded levels of Mean PEC-Q values and mercury concentrations from individual samples. Green indicates that the values are less than the Level 1 SQT or TEC, yellow shows that the values are greater than the Level 1 SQT or TEC but less than the Level 2 SQT or PEC, and red shows levels greater than the Level 2 SQT of PEC.

**Data Summary** – The data summary presents a table with a count of stations, samples, and results for several categories of sediment chemistry parameters: metals (without mercury), mercury, PCBs, PAHs, polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F), pesticides, other chemicals, total organic carbon, and grain size distribution.

**Bar Plots of Sediment Quality Target Exceedances** - The bar plots show the percentages of surface samples exceeding Level 1 or TEC and Level 2 SQT or PEC for a number of parameters. Surface samples are limited to those that start at the surface and where the majority of the sample is found at a depth less than 15 cm.

**Distributions of Contaminant Concentrations** - The distributions of total PAHs, total PCBs, mercury, and PCDD/F toxic equivalents at various depths are shown with box-and-whisker plots. The Minnesota plots use a logarithmic scale and the Wisconsin plots use a linear scale.

## 4.2 Contaminant Concentration Maps

A series of maps were created to compare the levels of sediment contaminants to the CBSQGs. Because these maps were originally based on a request from the WISAT, the Wisconsin terminology for the CBSQGs was used. Samples were color-coded based on their concentrations compared to the TEC, MEC, and PEC.

The maps were created for the following parameters:

- Mean PEC-Q
- Total PCBs
- Total PAHs
- Mercury
- Lead
- TCDD toxic equivalents in wildlife

The maps were generated for each Geographic Zone for the 0-15 cm, 15-50 cm, 50-100 cm, and greater than 100 cm depth intervals. The maps are included as Appendix B of this report. The samples used to generate these maps are based on the same preferred studies described in Section 2.2 of this report.

## 4.3 Database Queries

As part of the Sediment Characterization project, a series of queries were added to the Phase VII database to assist MPCA and WDNR personnel in conducting additional investigations of the sediment contaminant levels in the AOC. Information related to the queries is stored in the query log table (aaa – QUERY_LOG) in the Phase VII database.

The queries added to the Phase VII database include:

- Total PAH13 –the sum of 13 priority PAH compounds (Crane and Hennes, 2007).
- Total PAH17–the sum of 17 EPA target PAH compounds
- Total PCBs (congeners)- the sum of PCBs for samples with congener and homolog results
- Total PCBs (Aroclors) – the sum of PCBs for samples with Aroclor results
- TCDD TEQ wildlife – TCDD Toxic Equivalent using 17 PCDD/F congeners and WHO-98 toxic equivalent factors (TEFs) for wildlife
- TCDD TEQ human health - TCDD Toxic Equivalent calculated using 17 PCDD/F congeners and WHO-98 toxic equivalent factors (TEFs) for wildlife
- Mean PEC-Q –Mean PEC-Q calculated based on methodology described in Guidance for the Use and Application of Sediment Quality Targets for the Protection of Sediment-dwelling Organisms in Minnesota (Crane and Hennes, 2007).
- Metals PEC-Q – metals component of Mean PEC-Q
- PCB PEC-Q– Total PCB component of Mean PEC-Q
- PAH13 PEC-Q - Total PAH component of Mean PEC-Q based 13 priority PAHs
- SeQI by sample –Canadian Sediment Quality Index (SeQI) for each sample (CCME, 2007)
- SeQI by assessment area- Canadian Sediment Quality Index (SeQI) for each assessment area (CCME, 2007)
- Total PAH34- the sum of 34 PAH compounds
- BaP PAH – Benzo(a)pyrene equivalent toxicity based on Minnesota Department of Health Guidance (MDH, 2001).

- PAH_ESB13 – Equilibrium Partitioning Sediment Benchmark for PAH13 based on method described in Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures (EPA, 2003)
- PAH_ESB34– Equilibrium Partitioning Sediment Benchmark for PAH34
- PEC-Q PAH17 - PAH component of Mean PEC-Q based on 17 EPA target PAH compounds
- PEC-Q PAH34 - PAH component of Mean PEC-Q based on 34 PAH compounds

The calculated values resulting from the queries were also added to the chemistry results table (ptbl-CHEM) to be usable with MPCA Tableau applications.

## 4.4 Remedial Categorization Memorandum

As part of the Remedial Action Plan (RAP) process for the St. Louis River AOC, LimnoTech was asked by MPCA to categorize SAAs in Minnesota to assist in prioritizing future remediation and restoration activities. The levels of legacy contaminants St. Louis River AOC sediments in Minnesota are well characterized due to extensive sample collection efforts in 2010 and 2011, as well as many years of previous data collection efforts. As described above, the data from recent sampling efforts has recently been compiled and added to the St. Louis River AOC Phase VII database. The available data is sufficient to perform a screening-level analysis to prioritize SAAs within the AOC for remediation efforts based on BUIs linked with sediment contamination. The color scale developed by the MNRAT was adopted for the evaluation:

- Purple - Remedial action complete, monitoring of effectiveness underway or complete.
- Red - Remedial action needed.
- Red-Gray - Additional characterization and assessment needed to determine if remedial action is necessary.
- Yellow - Remediation generally not warranted but management actions must consider the presence of contaminants, especially bioaccumulative contaminants.
- Green - No known contamination. No remedial actions planned.
- Gray - Limited or no samples, but additional characterization and assessment are not needed.

The following approach was used to designate remedial categories for each of the Minnesota SAAs:

- Designations from MNRAT based on site specific knowledge were used as a basis for Red and Red-Gray SAAs.
- SAAs were designated as gray if the sampling data was sparse (fewer than 10 total samples and less than 1 sample per 20 acres).
- Screening level evaluations for three BUIs linked to sediment contamination were used to determine if additional SAAs should be categorized as Red.
- Assessment areas at the low end of the distribution of benthic toxicity screening parameters were categorized as Green.
- All SAAs that were not designated as Red, Green, Red-Gray, or Gray, were designated Yellow.

Table 3 presents the final color designations for each SAA in Minnesota. Further details about the selection of remedial categories for Minnesota is provided in Appendix C. WDNR independently evaluated the SAAs in Wisconsin to determine appropriate remedial categories. The WDNR designations are presented in Table 4. The remedial designations for both states are shown in Figures 1 through 7.

**Table 3. Color designation for each of the Minnesota Sediment Assessment Areas in the St. Louis River AOC**

| SAAID | SAA Name | Color Designation |
|---|---|---|
| 1 | Lake Superior - Minnesota | Gray |
| 3 | Minnesota Pocket | Gray |
| 10 | Superior Bay - Minnesota | Yellow |
| 18 | Hearding Island | Yellow |
| 19 | North Park Point Bayside | Yellow |
| 20 | Minnesota Slip | Red |
| 21 | Slip 2 | Red |
| 22 | Slip 3 | Red-gray |
| 23 | Slip C | Red |
| 24 | General Mills Elevator A Slip | Yellow |
| 25 | Cargill Elevator B1 Slip | Yellow |
| 26 | Cargill Elevator B2 / Northland Pier Slip | Yellow |
| 27 | Northland Pier / AGP Slip | Red |
| 28 | Azcon Corp / Duluth Seaway Port Authority Garfield Slip C | Red |
| 29 | Duluth Seaway Port Authority Garfield Slip D / Clure Public Marine Terminal Berth 1 | Red-gray |
| 30 | Rices Point Off-Channel East | Red-gray |
| 31 | Duluth Harbor Basin Off-Channel | Gray |
| 36 | Rices Point Off-Channel West | Yellow |
| 37 | Slip near 21st Ave W | Red-gray |
| 38 | 21st Avenue | Yellow |
| 39 | Interstate Island Off-Channel | Gray |
| 40 | Bay NE of Canadian National / DM&IR | Green |
| 41 | Interstate Island Flats | Green |
| 43 | DM&IR | Yellow |
| 44 | Hibbard | Yellow |
| 45 | Bay NE Side of Erie Pier | Green |
| 58 | Erie Pier Slip | Green |
| 59 | Ponds behind Erie Pier | Red-gray |
| 60 | Coffee Ground | Yellow |
| 63 | Grassy Point | Yellow |
| 65 | Belknap Flats | Gray |
| 66 | C. Reiss Coal Dock Slip | Yellow |
| 67 | Bay between C. Reiss and SLRIDT 7 / W. Grassy Point Estuary Flats | Yellow |
| 68 | SLRIDT Superfund Site | Purple |
| 70 | Kingsbury Bay | Yellow |
| 71.1 | Tallas Island | Yellow |

| SAAID | SAA Name | Color Designation |
|---|---|---|
| 71.2 | Kingsbury Bay | Yellow |
| 75.1 | Riverside Marina | Yellow |
| 75.2 | Munger Landing | Red |
| 76 | U.S. Steel Superfund Site | Red |
| 78 | Spirit Lake / Devils Elbow | Yellow |
| 80 | Steelton Bay | Green |
| 81 | New Duluth Stretch | green |
| 82 | Mud Lake East | Yellow |
| 83 | Mud Lake West | Red |
| 84 | Middle St. Louis River - Minnesota | Green |
| 85 | Cedar Yard Bay (Radio Tower Bay) | Yellow |
| 88 | New Duluth Bay | Yellow |
| 89 | North Bay | Yellow |
| 90 | Fond du Lac Stretch | Green |
| 91 | Perch Lake | Yellow |
| 92 | Rask Bay | Green |
| 93 | Chambers Grove Reach | Gray |
| 94 | Fond du Lac Reservoir | Gray |
| 95 | Lower Jay Cooke State Park Reach | Green |
| 96 | Middle Jay Cooke State Park Reach | Gray |
| 97 | Oldenburg Point Rapids Reach | Gray |
| 98 | Lower Thomson Reach | Gray |
| 99 | Thomson Reservoir | Red-gray |
| 10 | Forbay Reservoir | Gray |
| 101 | Scanlon to Thomson Whitewater Reach | Yellow |
| 102 | Scanlon Reservoir | Red-gray |
| 103 | NW Paper Company Reach | Yellow |
| 104 | Cloquet Reservoir | Yellow |
| 105 | Knife Falls Reservoir | Yellow |
| 106 | Spafford Park Reach | Yellow |
| 107 | Fond du Lac Indian Reservation Reach | Green |

**Table 4. Color designation for each of the Wisconsin Sediment Assessment Areas in the St. Louis River AOC**

| SAAID | SAA Name | Color Designation |
|---|---|---|
| 2 | Lake Superior - Wisconsin | Green |
| 5 | Superior Bay - Wisconsin | Yellow |
| 5.2 | Superior Bay Mouth | Green |
| 6 | Allouez Bay | Green |
| 7 | Bunge Dock Slip | Yellow |
| 8 | Burlington Northern Docks | Yellow |
| 9 | Nemadji River Mouth / Loonsfoot Landing | Yellow |
| 11 | Newton Creek / Hog Island Inlet | Purple |
| 12 | Lakehead Dock Slip / Elevator M Slip | Yellow |
| 13 | Barkers Island and Vicinity | Red-Gray |
| 14 | Pickle Pond | Red-Gray |
| 15 | Connors Point Waterfront | Yellow |
| 16 | Superior Light & Power MGP Site / Coal Slip | Red |
| 17 | Cutler-Magner Limestone Slip | Yellow |
| 34 | Koppers/Crawford Creek | Red |
| 47 | St. Louis Bay Flats | Yellow |
| 48 | Howards Bay West | Red-Gray |
| 48.1 | Howards Bay West NC | Red-Gray |
| 49 | Howards Bay Middle | Red |
| 49.1 | Howards Bay Middle NC | Red |
| 50 | Howards Bay East | Red |
| 50.1 | Howards Bay East NC | Red |
| 51 | Cummings Avenue Slip | Red-Gray |
| 52 | Hughitt Slip | Red-Gray |
| 53 | Tower Bay Slip | Red-Gray |
| 54 | Peavey Grain Globe Elevator Slip | Yellow |
| 55 | General Mills S and X Superior Terminal Slip | Red-Gray |
| 56 | Hallet 8 / C. Reiss Berwin Slip / BP Amoco / Midwest Energy | Yellow |
| 57 | Estuary Flats | Green |
| 64.2 | St. Louis Bay South | Yellow |
| 64.3 | SLRIDT Wisconsin | Purple |
| 72.2 | Clough Island | Yellow |
| 72.3 | Tallas Island Flats | Yellow |
| 72.4 | Alder Island | Red-Gray |
| 73 | Pokegama Bay | Green |
| 79 | Little Pokegama River/Bay | Yellow |

| SAAID | SAA Name | Color Designation |
|---|---|---|
| 86 | St. Louis River Upstream of Oliver Bridge | Green |
| 87 | Red River Bay | Green |

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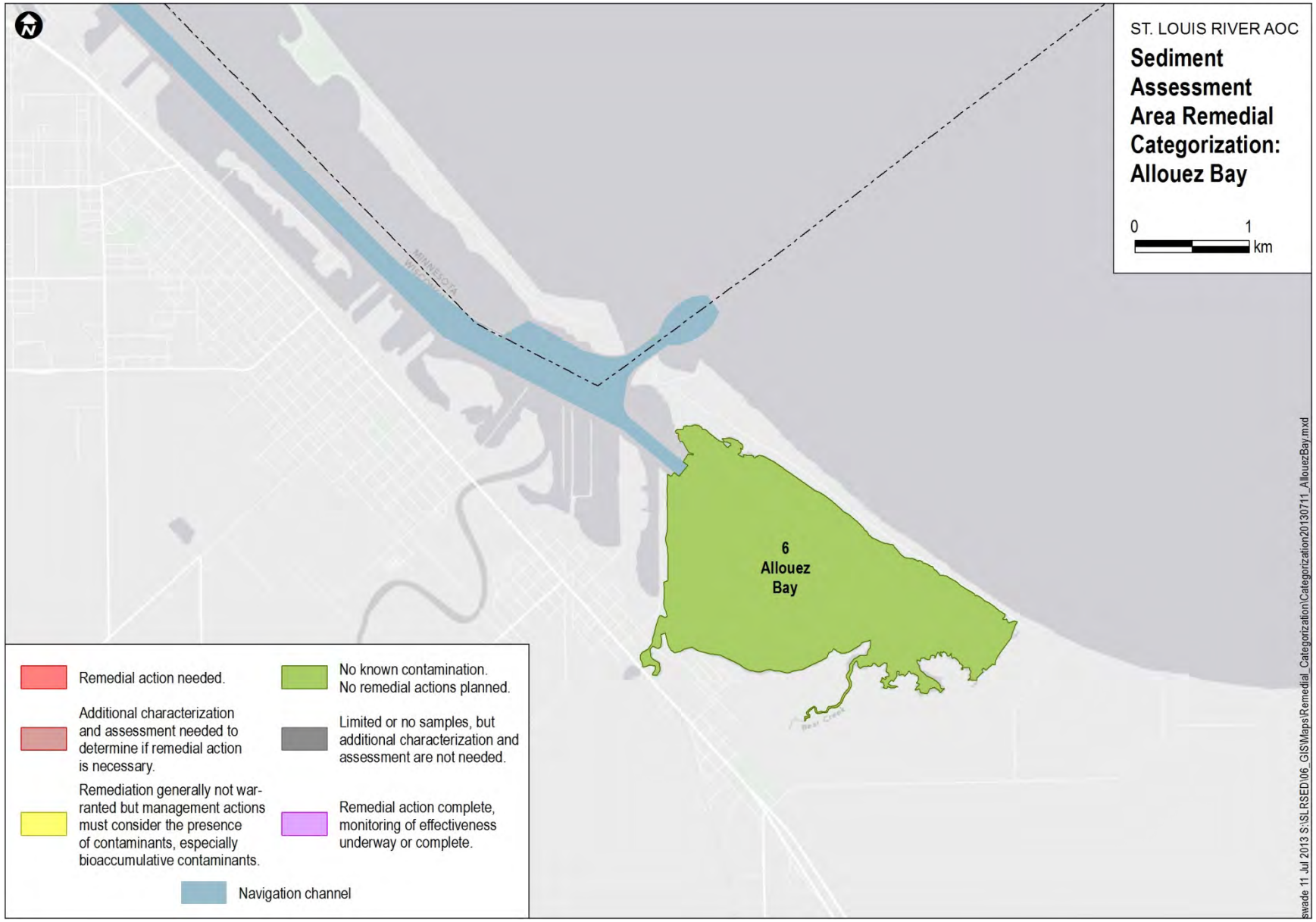


**Figure 1. Remedial categories in Allouez Bay**

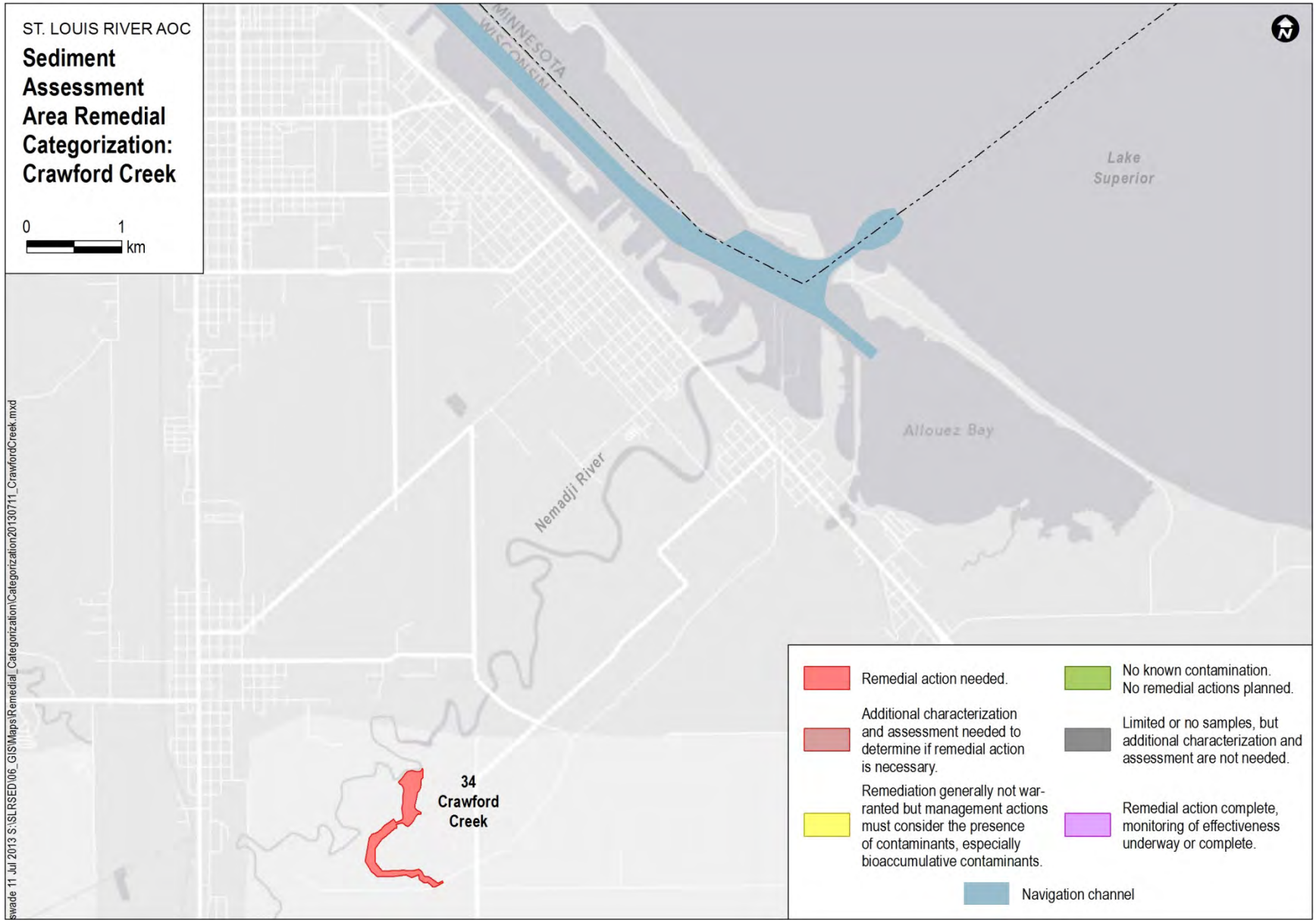


**Figure 2. Remedial categories in Koppers/Crawford Creek**

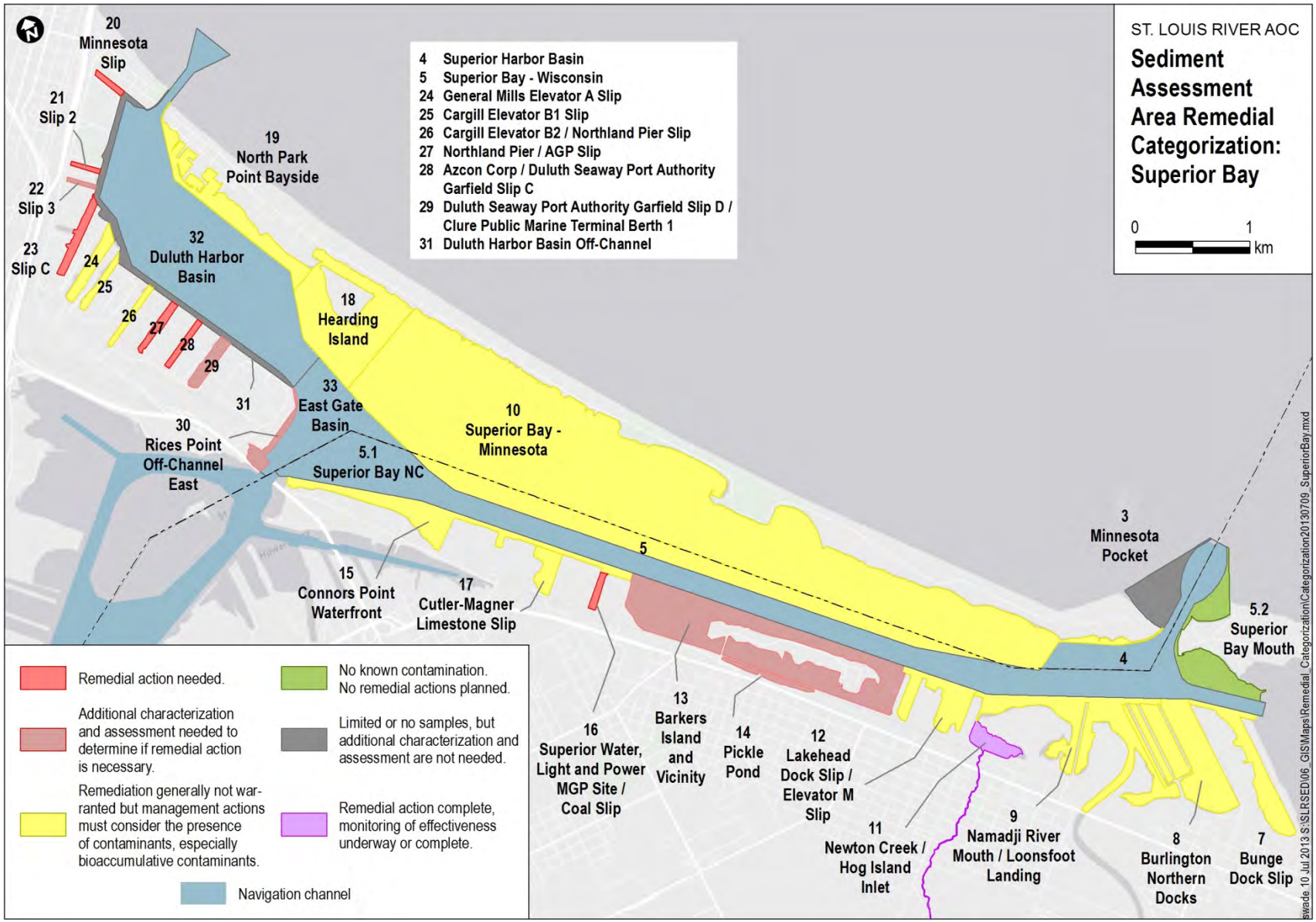


**Figure 3. Remedial categories in Superior Bay**

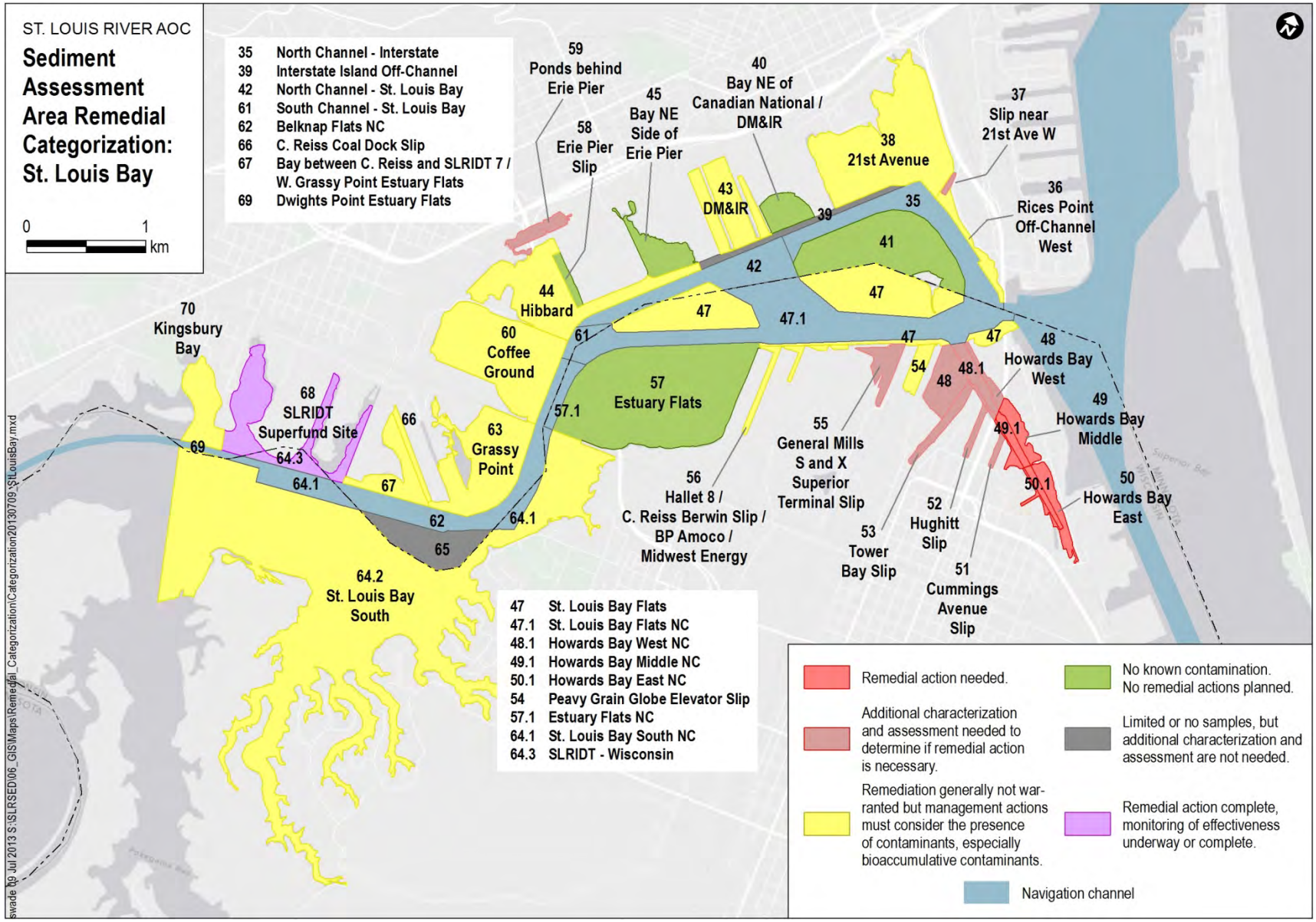


**Figure 4. Remedial categories in St. Louis Bay**

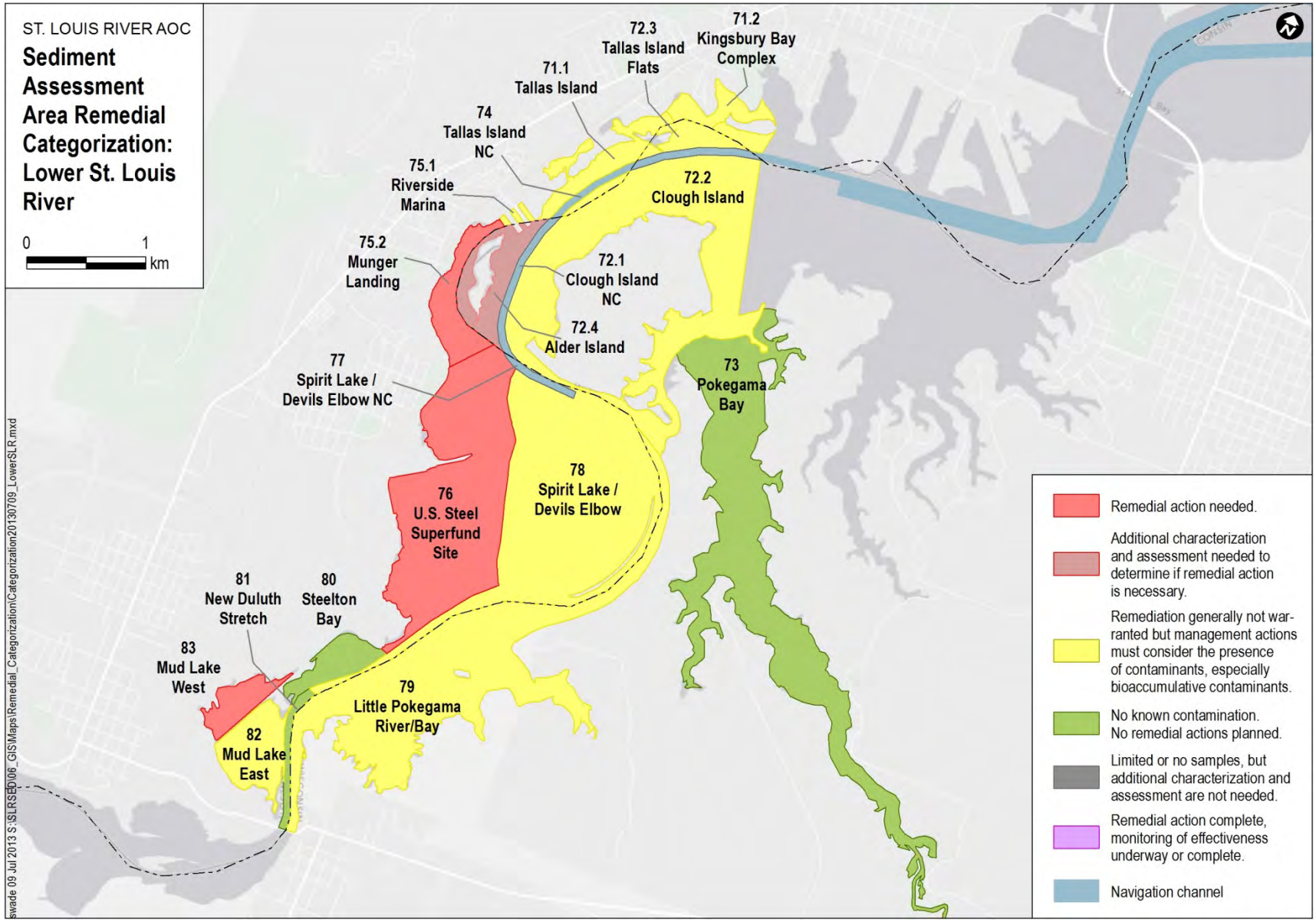


**Figure 5. Remedial categories in the Lower St. Louis River**

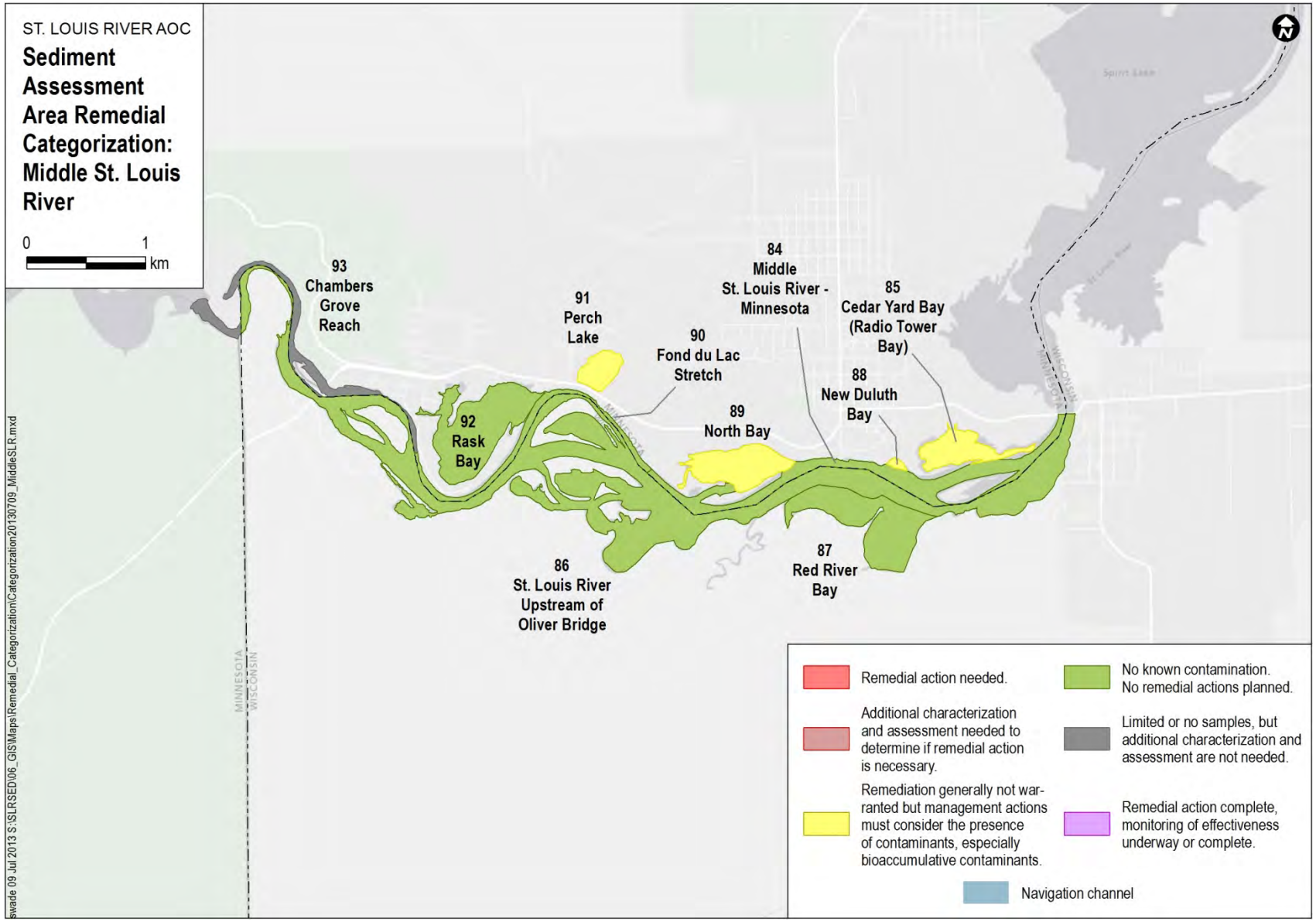


**Figure 6. Remedial categories in the Middle St. Louis River**

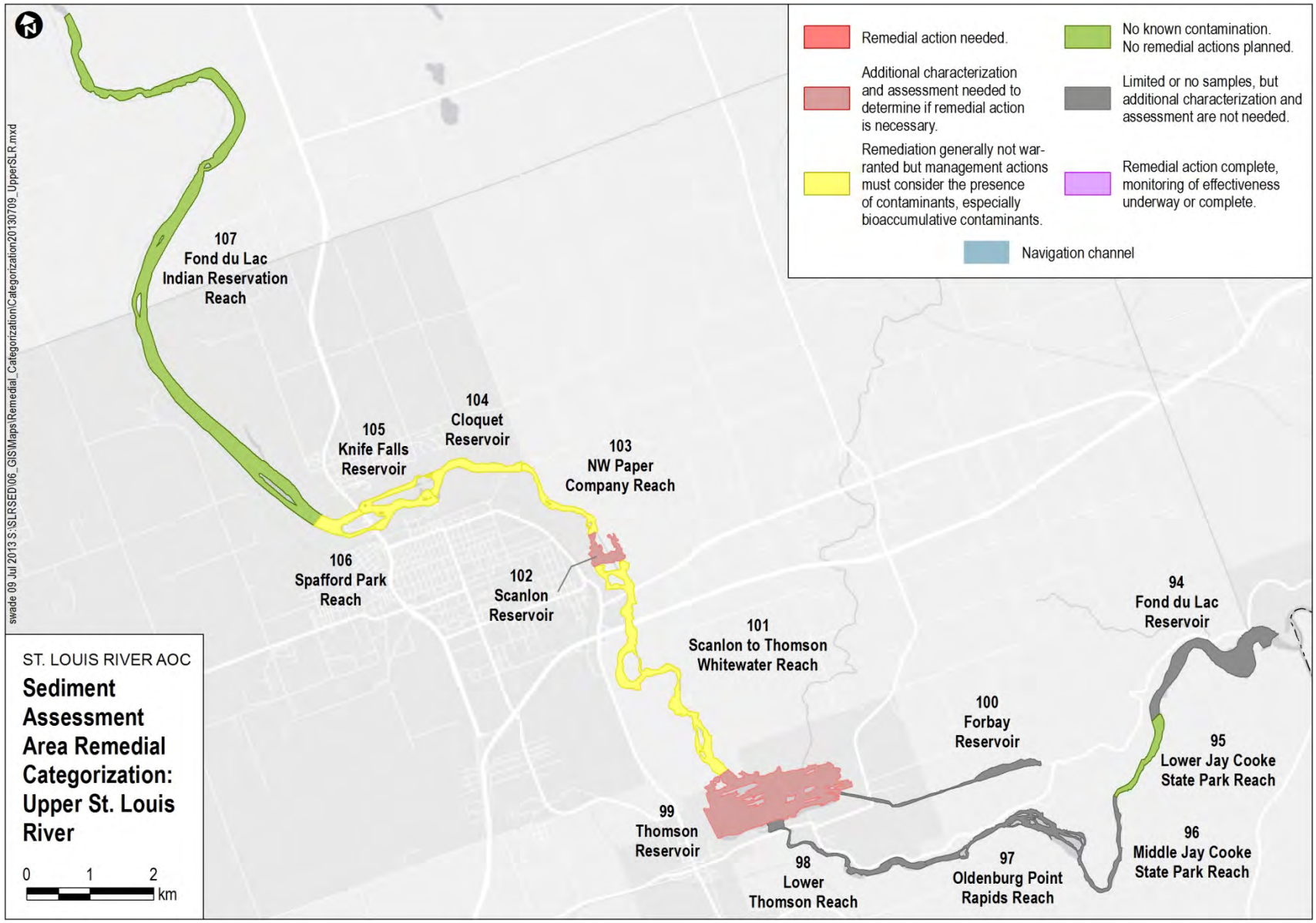


**Figure 7. Remedial categories in the Upper St. Louis River**

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# 5 References

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# Appendices

# Appendix A
# Sediment Assessment Area Dashboards

Note: Minnesota and Wisconsin chose different color schemes for the Mean PEC-Q diagrams.

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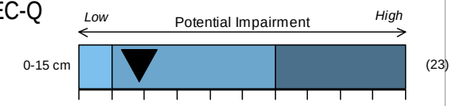
# Sediment Assessment Area Chemistry Characterization Guidance

## Sediment Assessment Area (SAA): ***[# and common name]***

*Geographic zone:*
*Date Generated:*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern. They are intended to assist in decision -making related to restoration initiatives. However, they do not provide a final remedial category determination. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas.

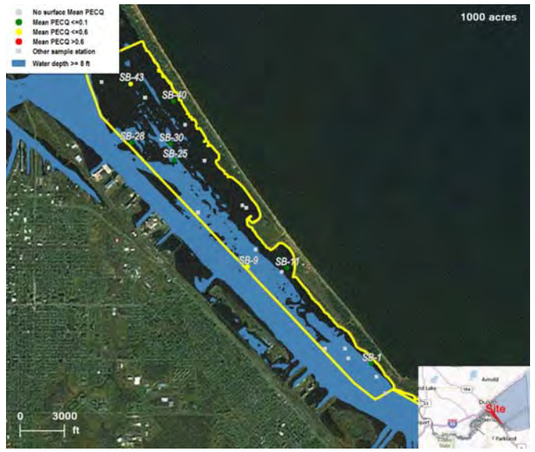
## Mean PEC-Q




The Mean PEC-Q is an integrated measurement of mixtures of sediment contaminants (metals, Total PAH, and Total PCB). It is an average of sediment chemical concentrations divided by their corresponding Probable Effects Concentrations (PECs) or Level II Sediment Quality Targets (SQTs). A Mean PEC-Q value is calculated for each sample. The graphic shows the mean of the Mean PEC-Q values for surface samples (0-15 cm) and subsurface samples (>15 cm). The number of samples is listed on the right side of the graphic. Minnesota dashboards use a blue color scale, while Wisconsin dashboards use a red, yellow, and green scale.

## Map of Assessment Area Cores

The map shows the locations of the available samples in the assessment area. Samples used to create the summary graphics are shown as purple dots and labeled. Other samples are shown as gray dots. Areas with a water depth greater than 8 ft are shown in blue.



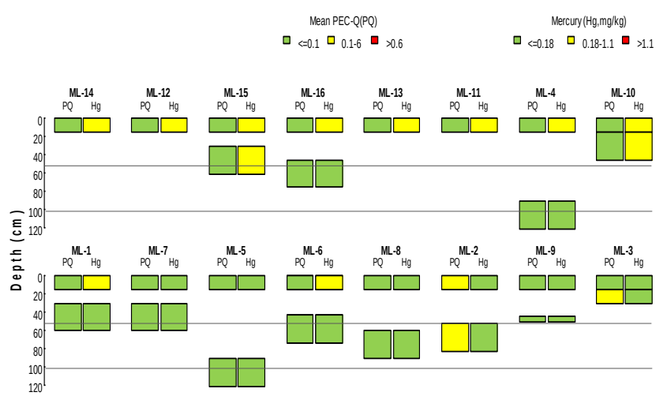

## Studies with Samples in Sediment Assessment Area:

This section lists the available studies for the sediment assessment areas. The studies are divided into sediment chemistry studies used in the assessment, additional available sediment chemistry studies, and available biological studies.

## Core Profiles

The vertical profiles show color coded levels of Mean PEC-Q values and Mercury concentrations from individual samples. Green indicates that the values are less than the Threshold Effects Concentration (TEC) or Level I SQT, yellow shows that the values are greater than the TEC but less than the PEC or Level II SQT, and red shows levels greater than the PEC. Stations are ordered from west to east.

Mercury concentrations are shown because they are not included in the calculation of the Mean PEC-Q. Due to space constraints, only stations with more than one sample are shown for assessment areas with greater than XX stations.




# Sediment Assessment Area Chemistry Characterization Guidance

## Data Summary

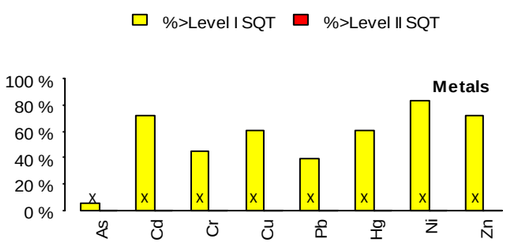
This section presents a table with a count of stations, samples, and results for several categories of sediment chemistry parameters: metals (without mercury), mercury, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs), pesticides, other chemicals, total organic carbon, and grain size distribution. The other chemicals category includes parameters such as diesel range organics and semi-volatiles (not including PAHs). The table shows the totals used in the assessment summary and, in parentheses, the totals available for the assessment area.

| Parameter group | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | XX(XX) | XX(XX) | XX(XX) |
| Mercury | XX(XX) | XX(XX) | XX(XX) |
| PAHs | XX(XX) | XX(XX) | XX(XX) |
| PCBs | XX(XX) | XX(XX) | XX(XX) |
| PCDD/Fs | XX(XX) | XX(XX) | XX(XX) |
| Pesticides | XX(XX) | XX(XX) | XX(XX) |
| Other chemicals | XX(XX) | XX(XX) | XX(XX) |
| TOC | XX(XX) | XX(XX) | XX(XX) |
| Grain size distribution | XX(XX) | XX(XX) | XX(XX) |

## Results Exceeding Thresholds (0-15 cm samples)

The bar plots show the percentages of surface samples exceeding sediment threshold concentrations for a number of parameters. Surface samples are limited to those that start at the surface and where the majority of the sample is found at a depth less than 15 cm. One bar plot is generated for metals and another for organic contaminants.

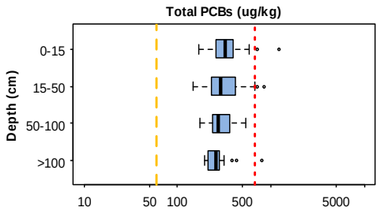
For assessment areas in Minnesota, the percentages exceeding the Level I and Level II SQTs are shown. For assessment areas in Wisconsin, the percentages exceeding the TEC, the midpoint effects concentration (MEC), and the PEC are shown. For each parameter, the number of surface samples used to make the calculation is shown at the bottom of each bar.




## Distributions of Constituent Concentrations

The distributions of Total PAHs, Total PCBs, Mercury, and PCDD/F toxic equivalents at various depths are shown with box-and-whisker plots. Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range (25th to 75th percentiles). Individual samples outside the whiskers are shown as open circles.

All samples are assigned to one of the following depth categories 0-15 cm, 15-50 cm, 50-100 cm, and >100 cm. Samples that span more than one depth interval are assigned to the interval where the highest fraction of the sample occurs. Minnesota plots use a logarithmic scale and Wisconsin plots use a linear scale.




## Sediment Assessment Summary Protocols for All Figures

- In general, recent studies were used to generate the summaries for assessment areas in Minnesota, based on selection by MPCA personnel. All available data was used to generate the summaries for assessment areas in Wisconsin.
- Level I and Level II SQTs were taken from *Guidance for the Use and Application of Sediment Quality Targets for the Protection of Sediment-dwelling Organisms In Minnesota* (Crane and Hennes, 2007).
- TEC, MEC, and PEC values were taken from *Consensus-Based Sediment Quality Guidelines Recommendations for Use & Application Interim Guidance* (WDNR, 2003).
- Total PAH values are calculated with the 13 priority PAHs.
- Metals values are preferentially based on total metal measurements. For samples that do not have a total measurement, the simultaneously extracted metal value was substituted.
- Total PCBs are preferentially calculated as congener sums. For samples without a PCB congener measurement, the sum of Aroclors was substituted.
- Dioxin TEQ values are calculated using Fish Ecological Risk toxic equivalency factors (TEFs) based on 1998 World Health Organization.
- Values below the detection limit are treated as follows:
  - Dioxin TEQ values are calculated using a Kaplan-Meier estimator
  - PAH values are estimated based on regressions with other PAH compounds
  - PCB sums are calculated assuming non-detects are equal to zero
  - Metal concentrations are replaced with :
    - Half the detection limit, if greater than 40% of measurements from the study are below detection limits
    - The detection limit ,if less than 40% of measurements from the study are below detection limits

# Sediment Assessment Area Chemistry Characterization

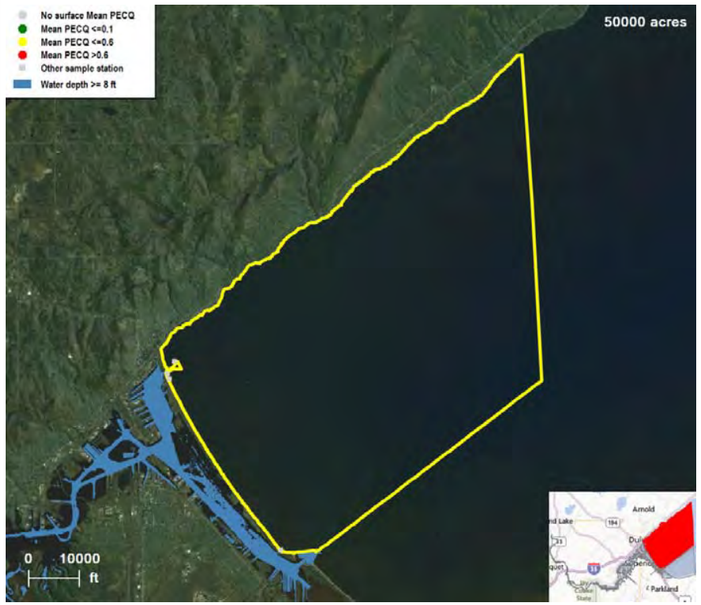
## Assessment Area # 1(Lake Superior - Minnesota)

*Geographic zone: Lake Superior*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*Nemadji Shoal, 2001 (1 stations);Duluth-Superior Harbor Study, 1995 (3).*

*Macro-invertebrate studies:*
*Nemadji Shoal, 2001;Duluth-Superior Harbor Study, 1995.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile


# Sediment Assessment Area Chemistry Characterization


## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(36) |
| Mercury | 0(0) | 0(0) | 0(4) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(28) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(54) |
| Other parameters | 0(0) | 0(0) | 0(27) |
| TOC | 0(0) | 0(0) | 0(4) |
| Grain size | 0(0) | 0(0) | 0(33) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

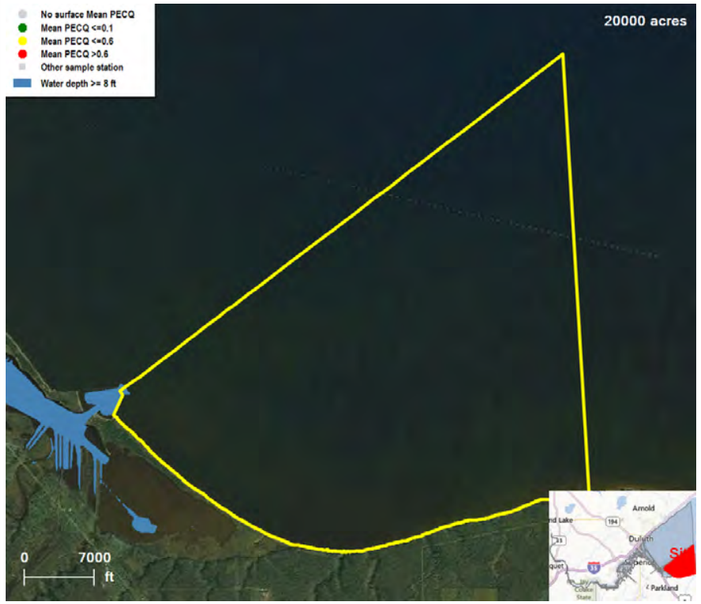
## Assessment Area # 2(Lake Superior - Wisconsin)

*Geographic zone: Lake Superior*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

TEC MEC PEC

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 3(Minnesota Pocket)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation


## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 4(Superior Harbor Basin)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation


## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*R-EMAP Study, 1995 (3 stations);R-EMAP Study, 1996 (1);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;USACE DACW35-93-D-0005 DELIVERY ORDER 29.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(31) |
| Mercury | 0(0) | 0(0) | 0(5) |
| PAHs | 0(0) | 0(0) | 0(53) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(33) |
| TOC | 0(0) | 0(0) | 0(5) |
| Grain size | 0(0) | 0(0) | 0(36) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

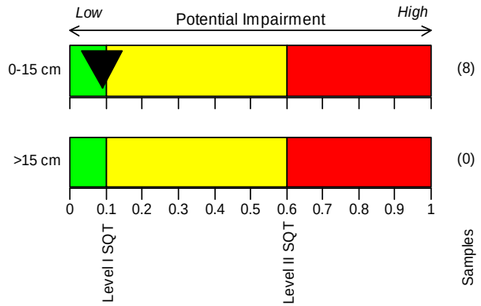
# Sediment Assessment Area Chemistry Characterization

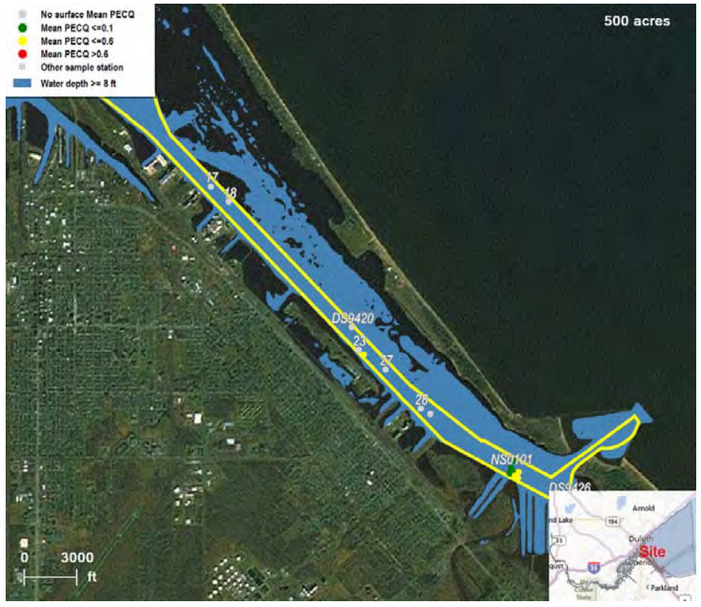
## Assessment Area # 5.1(Superior Bay NC)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

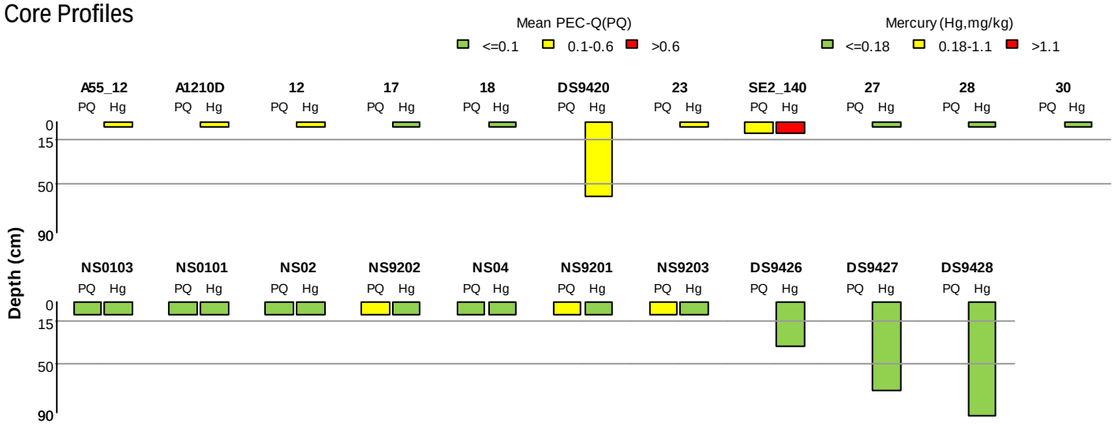
*Chemical studies used in the characterization: R-EMAP Study, 1995 (7 stations);R-EMAP Study, 1996 (2);Nemadji Shoal, 2001 (4);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (4);USACE DACW35-91-D-0001 DELIVERY ORDER 40 (3);Wisconsin Sampling, 2007 (1).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;R-EMAP Study, 1996;Nemadji Shoal, 2001;USACE DACW35-93-D-0005 DELIVERY ORDER 29;USACE DACW35-91-D-0001 DELIVERY ORDER 40;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



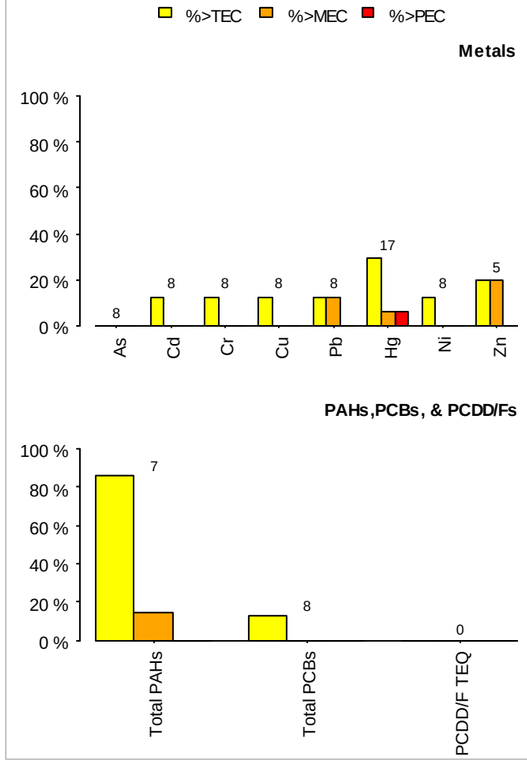

# Sediment Assessment Area Chemistry Characterization

## Data Summary

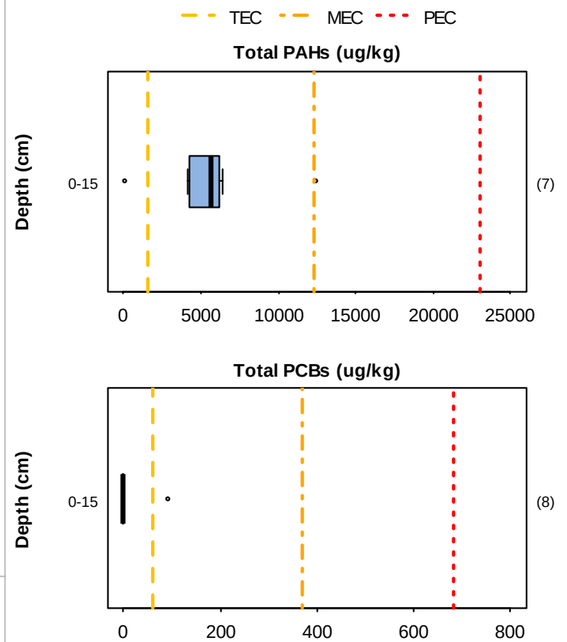
**Available data in studies used for characterization (All available data)**

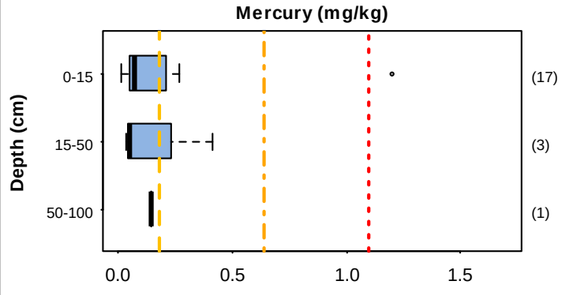
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 21(21) | 21(21) | 176(176) |
| Mercury | 21(21) | 21(21) | 21(21) |
| PAHs | 8(8) | 8(8) | 160(160) |
| PCBs | 8(8) | 8(8) | 60(60) |
| PCDD/Fs | 1(1) | 1(1) | 1(1) |
| Pesticides | 4(4) | 4(4) | 58(58) |
| Other parameters | 21(21) | 21(21) | 358(358) |
| TOC | 20(20) | 20(20) | 20(20) |
| Grain size | 21(21) | 21(21) | 146(146) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 5.2(Superior Bay Mouth)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation


## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

TEC MEC PEC

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

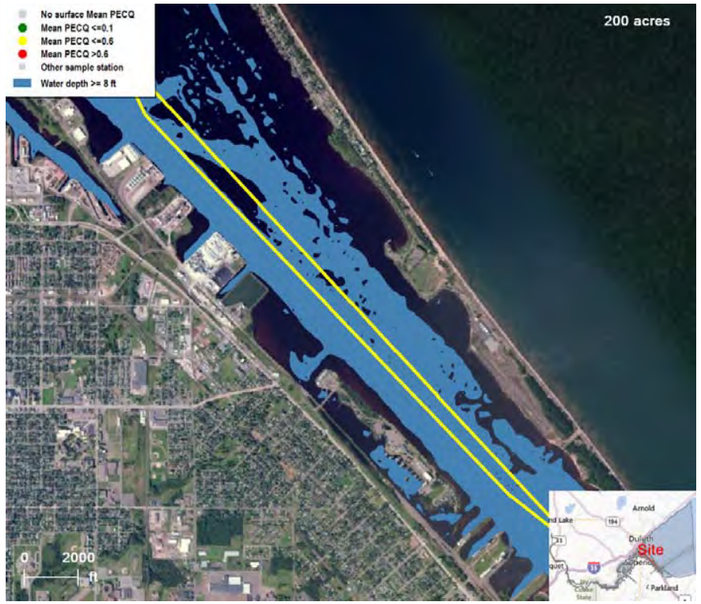
## Assessment Area # 5(Superior Bay - Wisconsin)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

TEC MEC PEC

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

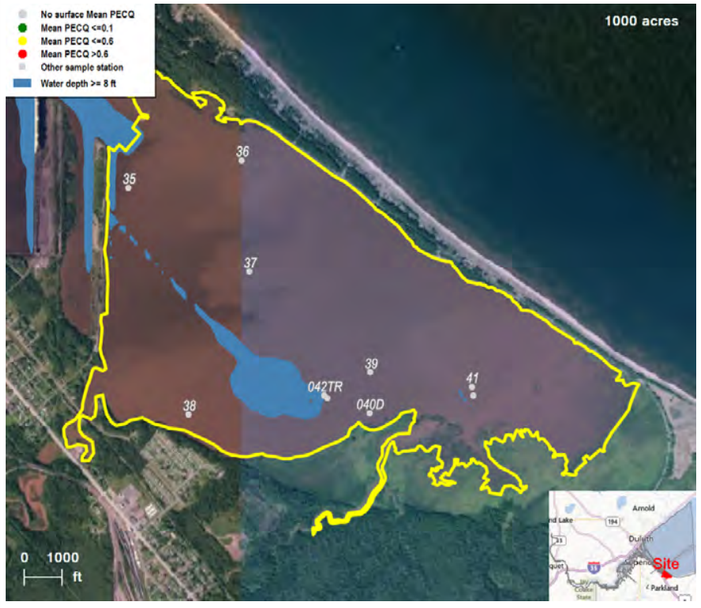
## Assessment Area # 6(Allouez Bay)

*Geographic zone: Allouez Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

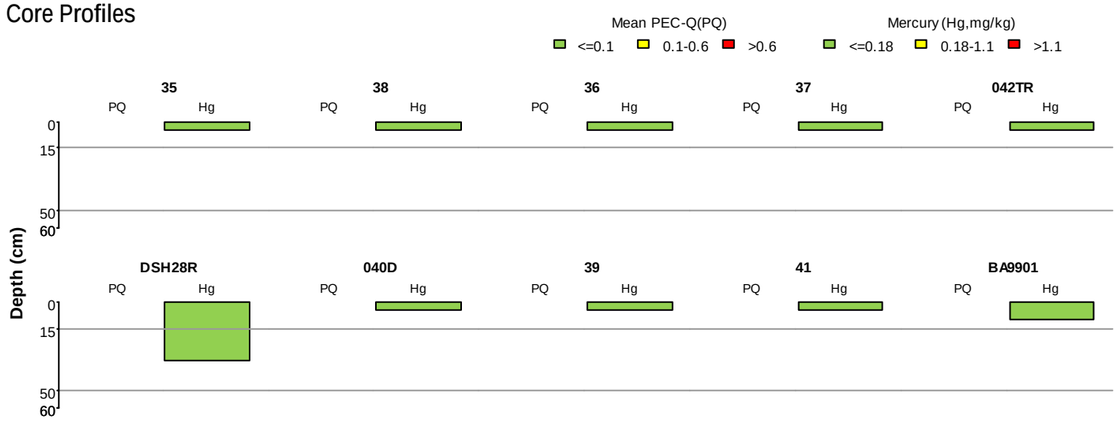
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (8 stations);Bioaccumulation Study, 1999 (1);Duluth-Superior Harbor Study, 1993 (1).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Bioaccumulation Study, 1999;Duluth-Superior Harbor Study, 1993.*

*Fish tissue studies:*
*Bioaccumulation Study, 1999.*

## Core Profiles



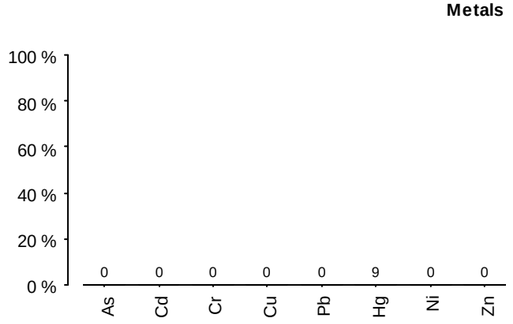

# Sediment Assessment Area Chemistry Characterization

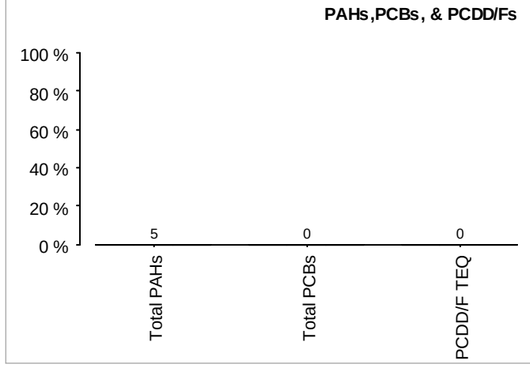
## Data Summary

**Available data in studies used for characterization (All available data)**

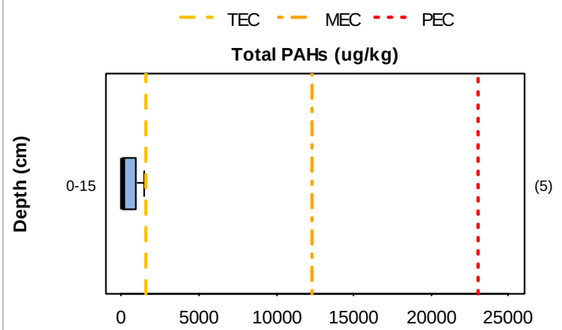
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 8(8) | 8(8) | 40(40) |
| Mercury | 10(10) | 10(10) | 10(10) |
| PAHs | 5(5) | 5(5) | 86(86) |
| PCBs | 1(1) | 1(1) | 21(21) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 10(10) | 10(10) | 56(56) |
| TOC | 10(10) | 10(10) | 10(10) |
| Grain size | 8(8) | 8(8) | 56(56) |

## Results Exceeding Thresholds (0-15 cm samples)

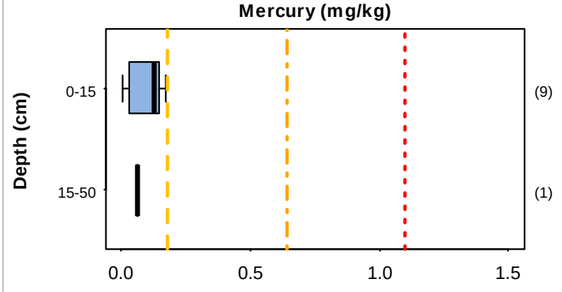



## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

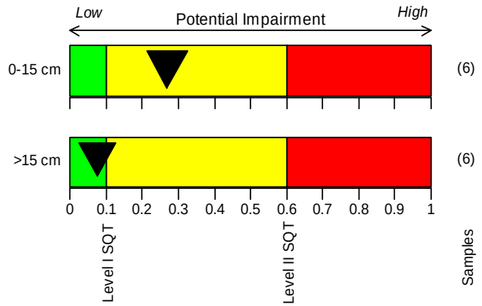
# Sediment Assessment Area Chemistry Characterization

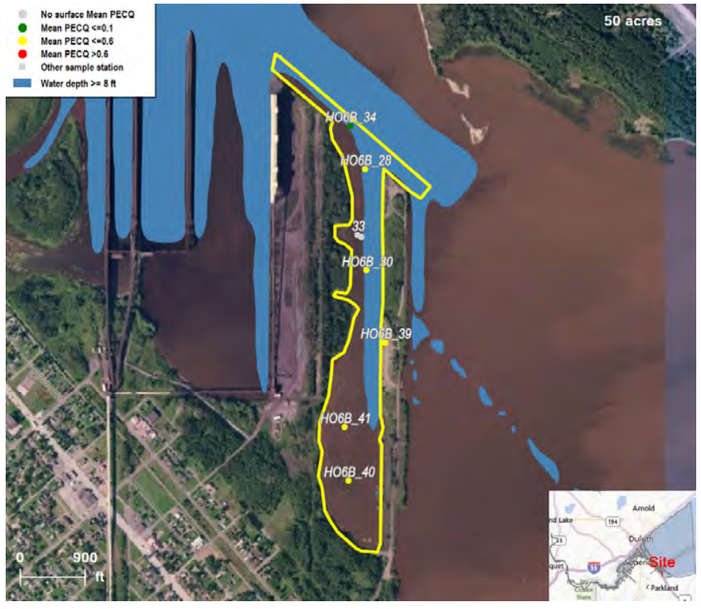
## Assessment Area # 7(Bunge Dock Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

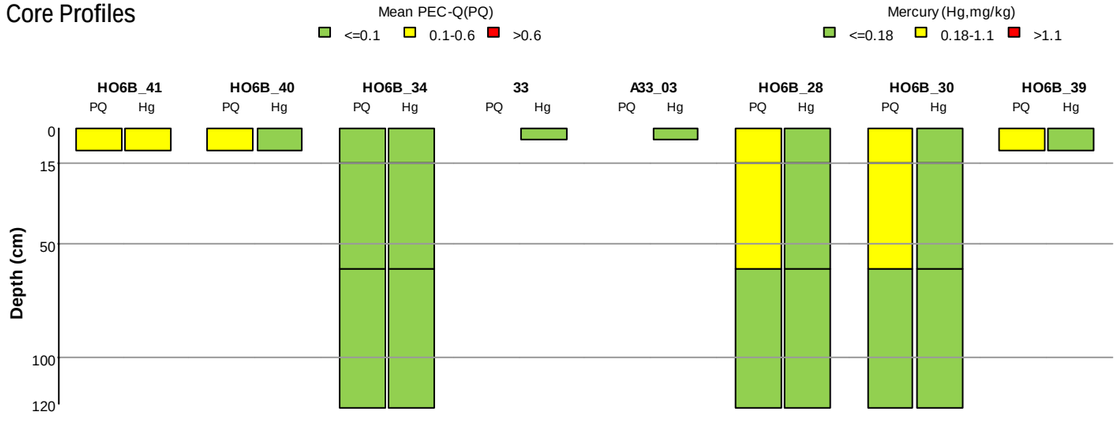
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (1 stations);R-EMAP Study, 1996 (1);Wisconsin Sampling, 2007 (7).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



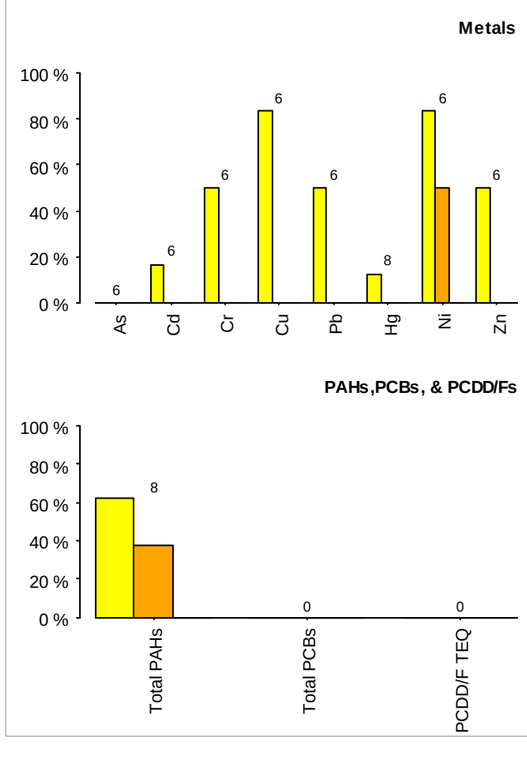

# Sediment Assessment Area Chemistry Characterization

## Data Summary

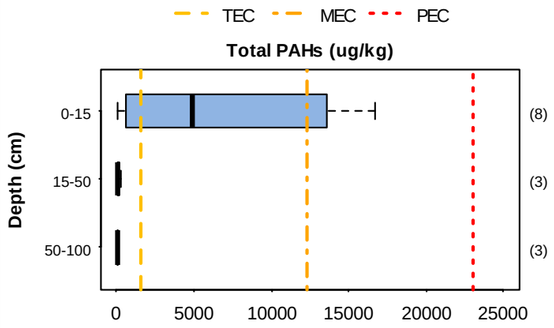
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 8(8) | 14(14) | 139(139) |
| Mercury | 8(8) | 14(14) | 14(14) |
| PAHs | 8(8) | 14(14) | 330(330) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 6(6) | 12(12) | 12(12) |
| Other parameters | 8(8) | 14(14) | 149(149) |
| TOC | 8(8) | 14(14) | 14(14) |
| Grain size | 9(9) | 15(15) | 40(40) |

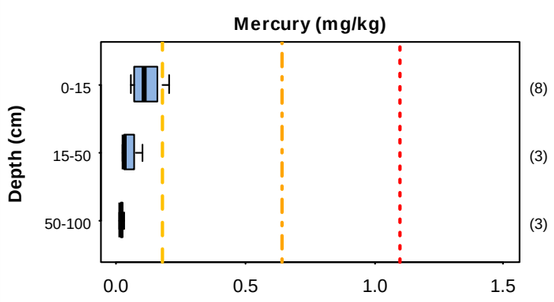
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

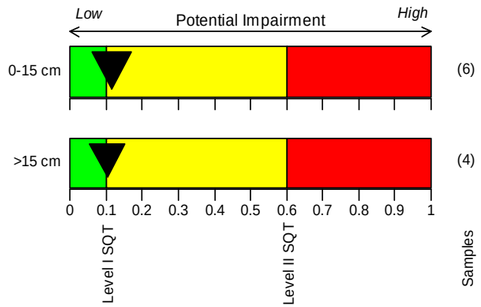
# Sediment Assessment Area Chemistry Characterization

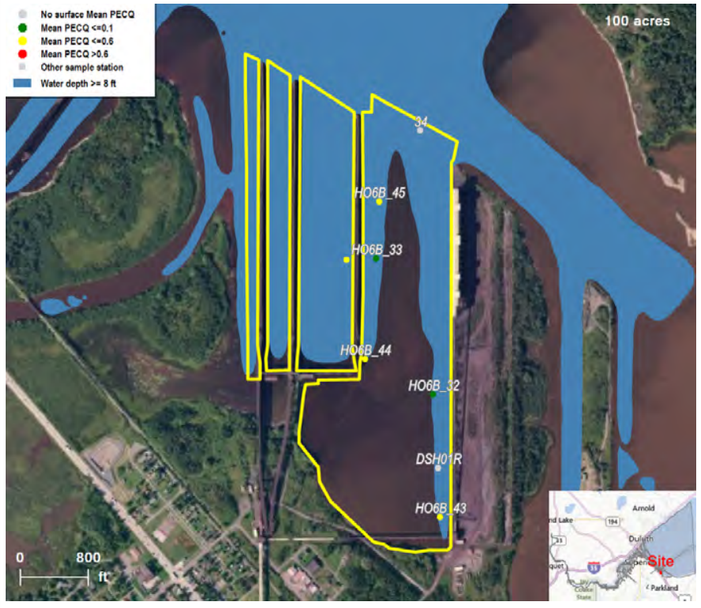
## Assessment Area # 8(Burlington Northern Docks)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

### Studies with Samples in Sediment Assessment Area:

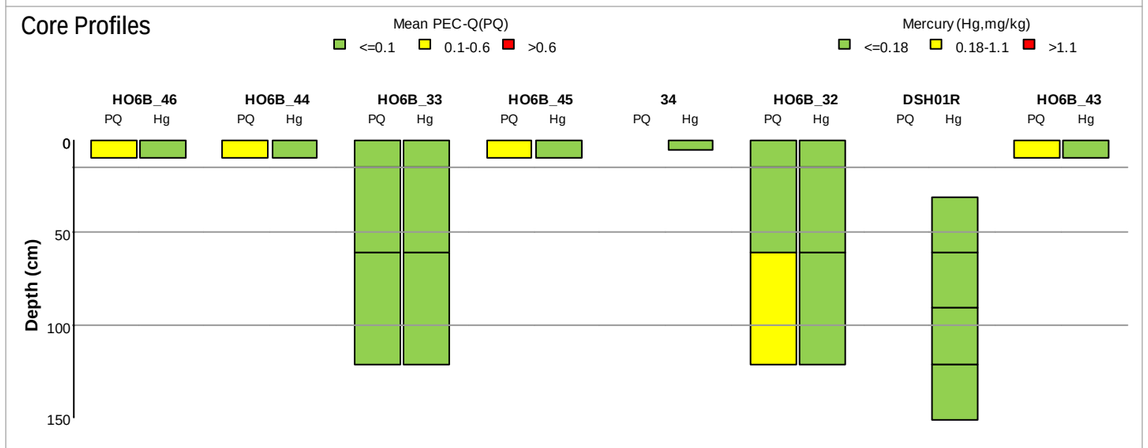
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (1 stations);Duluth-Superior Harbor Study, 1993 (1);Wisconsin Sampling, 2007 (6).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Duluth-Superior Harbor Study, 1993;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



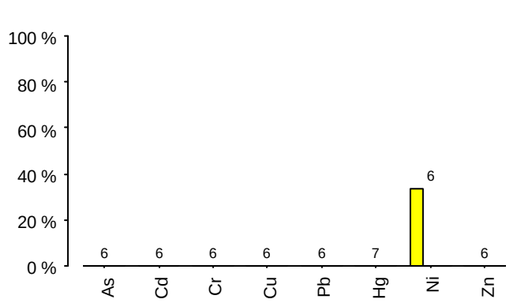

# Sediment Assessment Area Chemistry Characterization

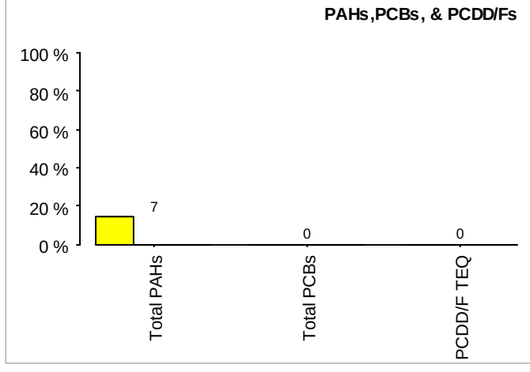
## Data Summary

**Available data in studies used for characterization (All available data)**

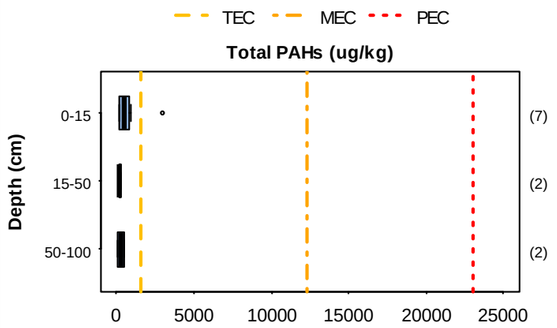
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 7(7) | 11(11) | 123(123) |
| Mercury | 8(8) | 15(15) | 15(15) |
| PAHs | 7(7) | 11(11) | 289(289) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 6(6) | 10(10) | 10(10) |
| Other parameters | 8(8) | 15(15) | 130(130) |
| TOC | 8(8) | 15(15) | 15(15) |
| Grain size | 7(7) | 11(11) | 27(27) |

## Results Exceeding Thresholds (0-15 cm samples)

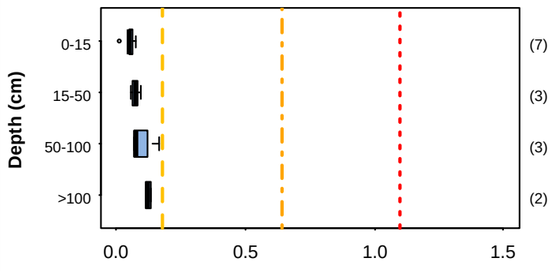



## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

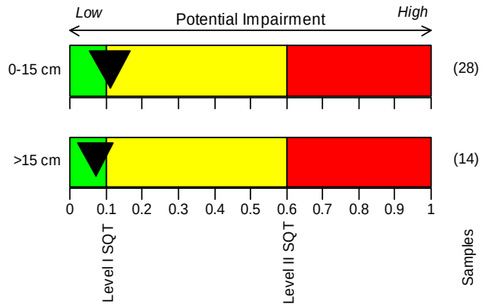
# Sediment Assessment Area Chemistry Characterization

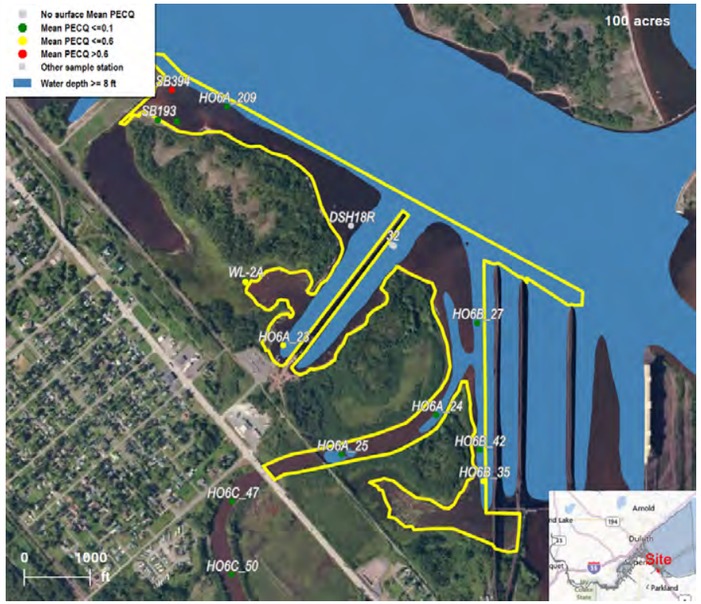
## Assessment Area # 9(Nemadji River Mouth / L. Landing)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

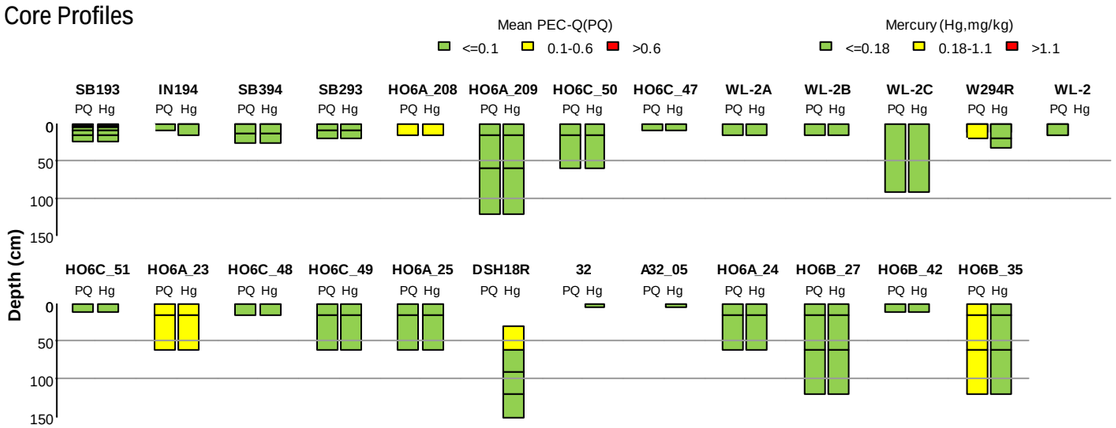
*Chemical studies used in the characterization: R-EMAP Study, 1995 (1 stations);R-EMAP Study, 1996 (1);Duluth-Superior Harbor Study, 1993 (1);Hog Island Inlet Study, 2002 (3);Newton Creek Study, 1993-94 (6);Hog Island Post Remediation, 2006 (1);Wisconsin Sampling, 2007 (20).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;R-EMAP Study, 1996;Duluth-Superior Harbor Study, 1993;Hog Island Inlet Study, 2002;Newton Creek Study, 1993-94;Hog Island Post Remediation, 2006;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



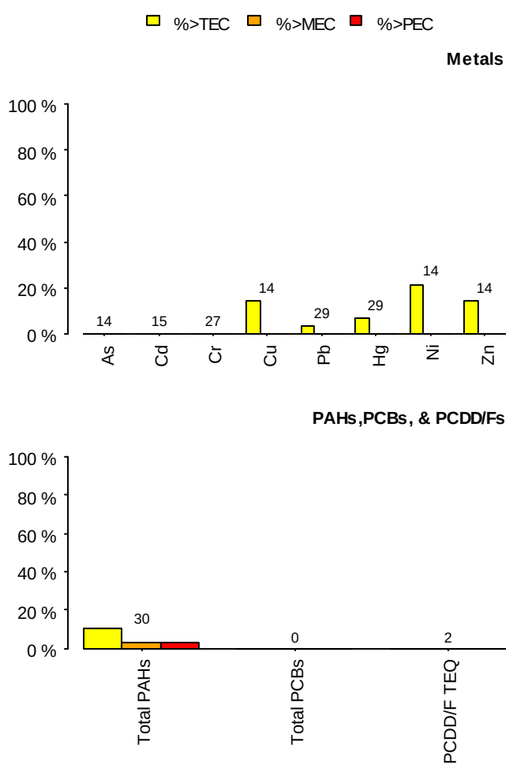

# Sediment Assessment Area Chemistry Characterization

## Data Summary

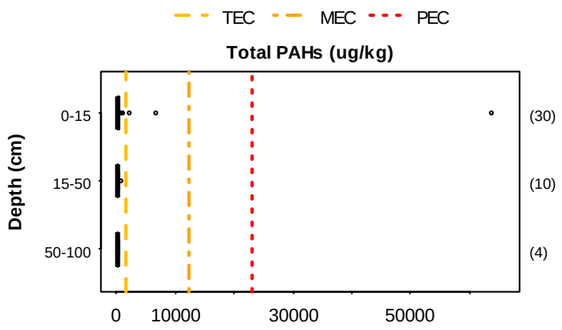
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 24(24) | 46(46) | 304(304) |
| Mercury | 24(24) | 48(48) | 48(48) |
| PAHs | 24(24) | 44(44) | 885(885) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 6(6) | 6(6) | 102(102) |
| Pesticides | 13(13) | 24(24) | 24(24) |
| Other parameters | 30(30) | 56(56) | 667(667) |
| TOC | 29(29) | 50(50) | 50(50) |
| Grain size | 27(27) | 47(47) | 95(95) |

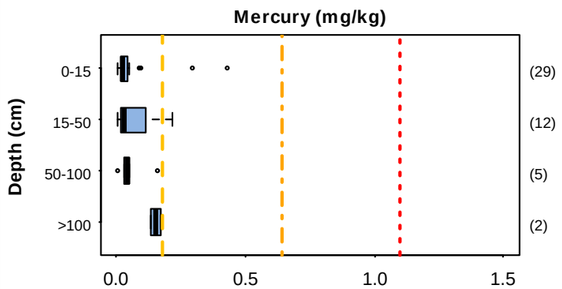
## Results Exceeding Thresholds (0-15 cm samples)

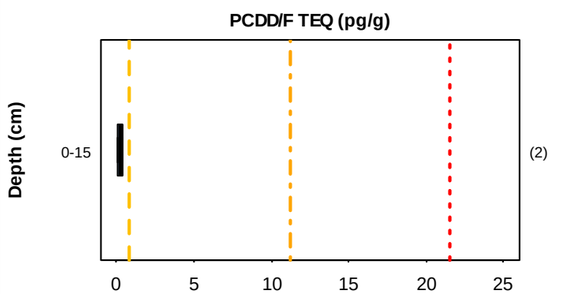



## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

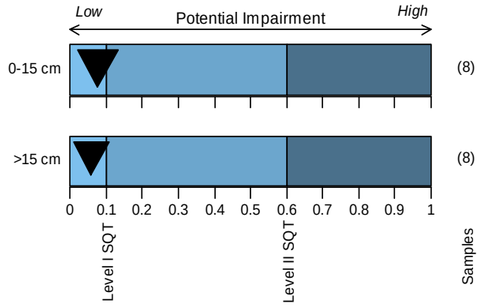
# Sediment Assessment Area Chemistry Characterization

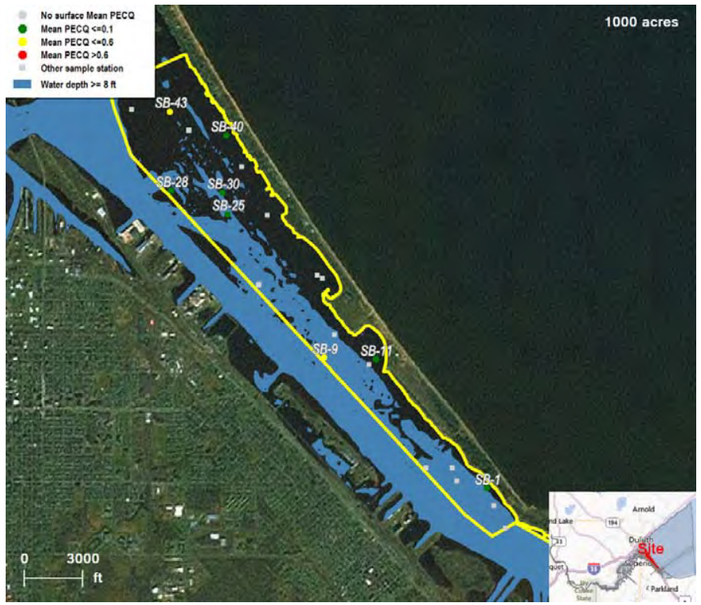
## Assessment Area # 10(Superior Bay - Minnesota)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

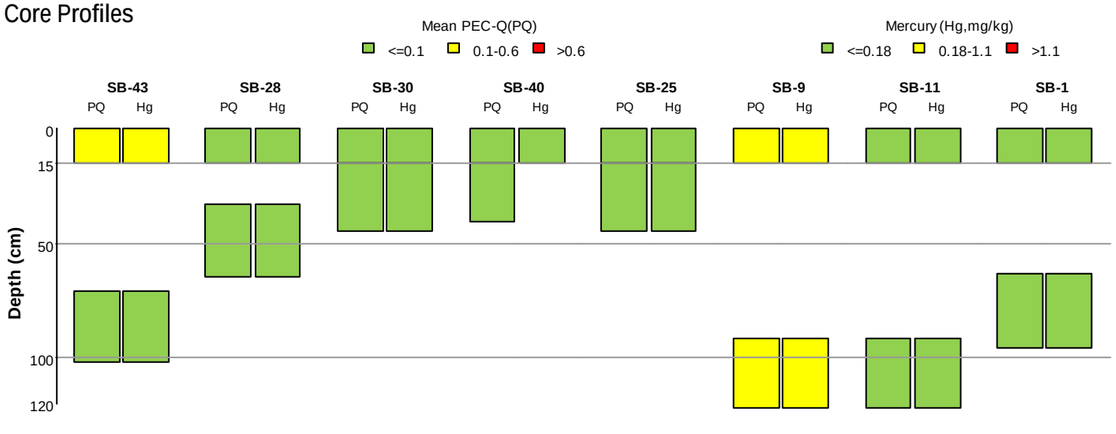
*Chemical studies used in the characterization: Superior Bay - 21st Ave., 2008&10 (8 stations).*

*Other chemical studies: R-EMAP Study, 1995 (9 stations);R-EMAP Study, 1996 (2);Duluth-Superior Harbor Study, 1993 (1);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (4).*

*Macro-invertebrate studies: R-EMAP Study, 1995;R-EMAP Study, 1996;Duluth-Superior Harbor Study, 1993;USACE DACW35-93-D-0005 DELIVERY ORDER 29;Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies: Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



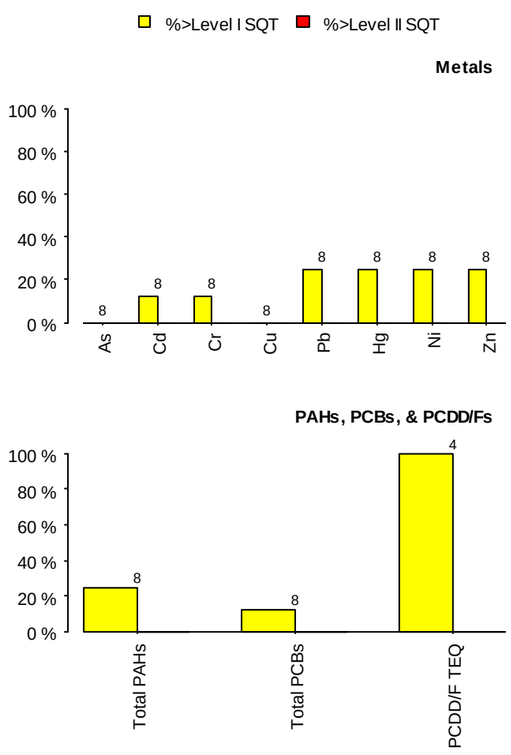

# Sediment Assessment Area Chemistry Characterization

## Data Summary

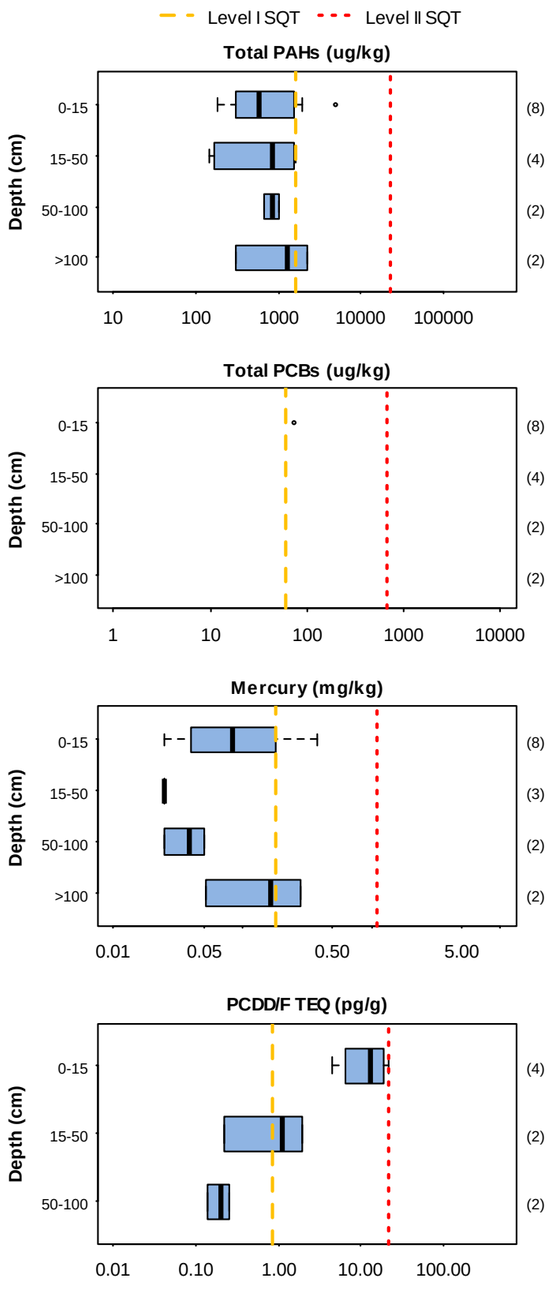
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 8(23) | 16(31) | 160(259) |
| Mercury | 8(24) | 16(34) | 16(34) |
| PAHs | 8(14) | 16(22) | 288(390) |
| PCBs | 8(8) | 16(16) | 112(112) |
| PCDD/Fs | 4(4) | 8(8) | 200(200) |
| Pesticides | 4(4) | 8(8) | 208(208) |
| Other parameters | 8(24) | 16(35) | 641(720) |
| TOC | 8(24) | 16(35) | 16(35) |
| Grain size | 8(23) | 16(31) | 16(125) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

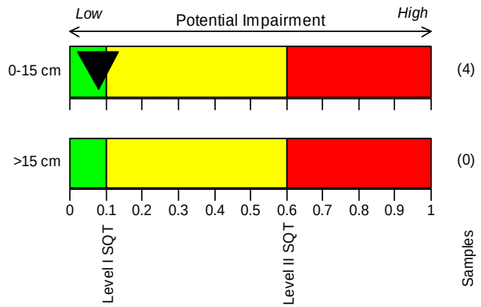
# Sediment Assessment Area Chemistry Characterization

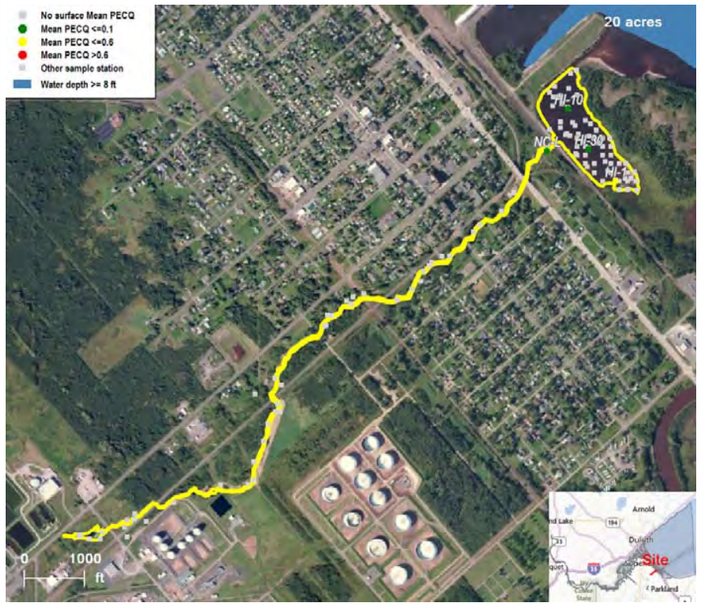
## Assessment Area # 11(Newton Creek / Hog Island Inlet)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

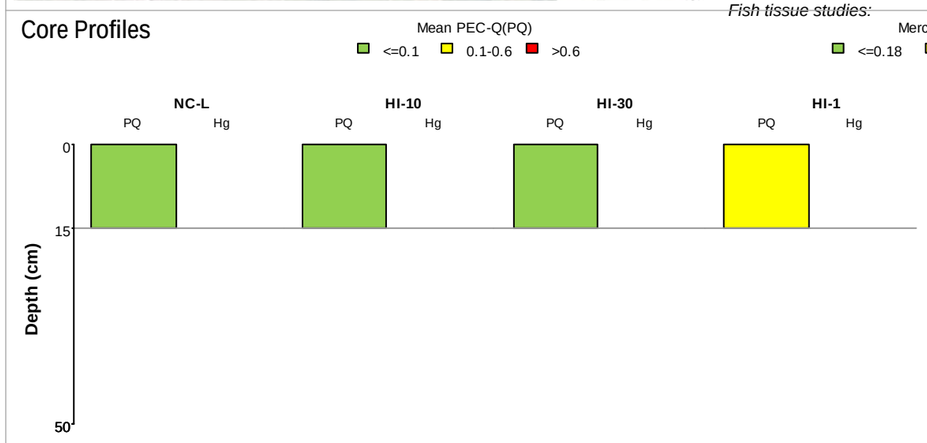
*Chemical studies used in the characterization:*
*Hog Island Post Remediation, 2006 (9 stations).*

*Other chemical studies:*
*R-EMAP Study, 1995 (2 stations);R-EMAP Study, 1996 (2);Hog Island Inlet Study, 2002 (17);Newton Creek Study, 2002 (14);Newton Creek Study, 1993-94 (68);Hog Island Inlet/Newton Creek 2004 (29);Newton Creek Segments B and C 2000 (12);Wisconsin Sampling, 2007 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;Hog Island Inlet Study, 2002;Newton Creek Study, 2002;Newton Creek Study, 1993-94;Hog Island Inlet/Newton Creek 2004;Benthic Data Newton Creek, Oct 2003;Benthic Data Newton Creek, Oct 2002;Benthic Data Newton Creek, Jul 2002;Newton Creek Segments B and C 2000;Hog Island Post Remediation, 2006;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



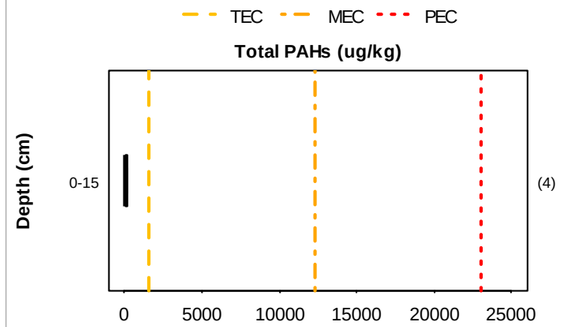

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

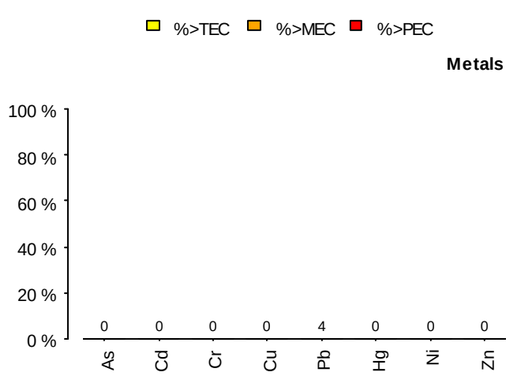
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 9(123) | 14(216) | 14(760) |
| Mercury | 0(92) | 0(153) | 0(153) |
| PAHs | 9(114) | 14(197) | 252(3649) |
| PCBs | 0(2) | 0(2) | 0(14) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(5) | 0(5) | 0(5) |
| Other parameters | 9(153) | 14(290) | 140(3227) |
| TOC | 9(86) | 14(118) | 14(118) |
| Grain size | 0(84) | 0(165) | 0(230) |

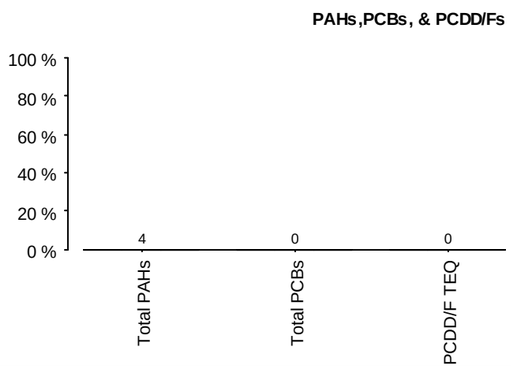
## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples

## Results Exceeding Thresholds (0-15 cm samples)




No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

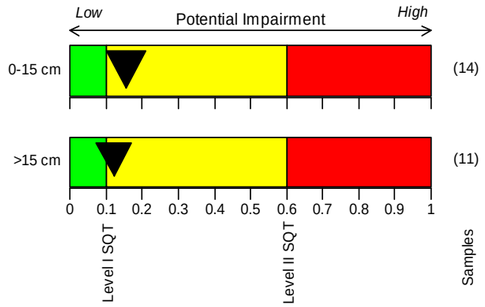
# Sediment Assessment Area Chemistry Characterization

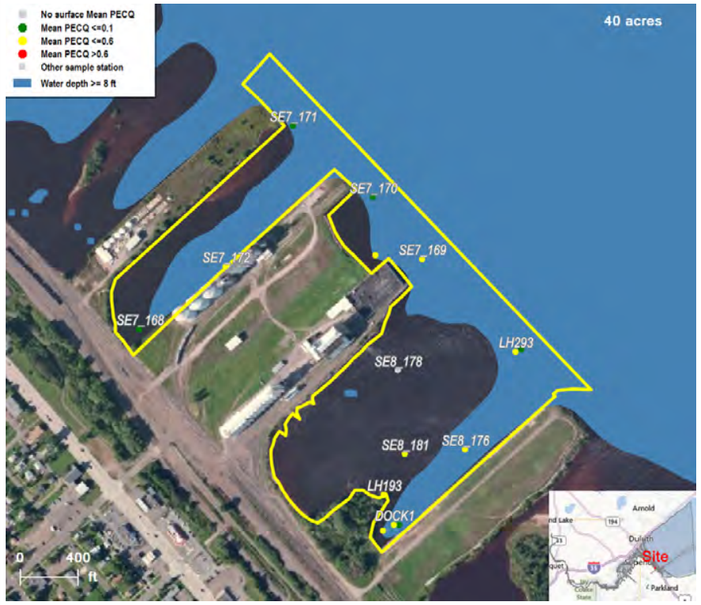
## Assessment Area # 12(Lakehead Dock Slip / Elevator M Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

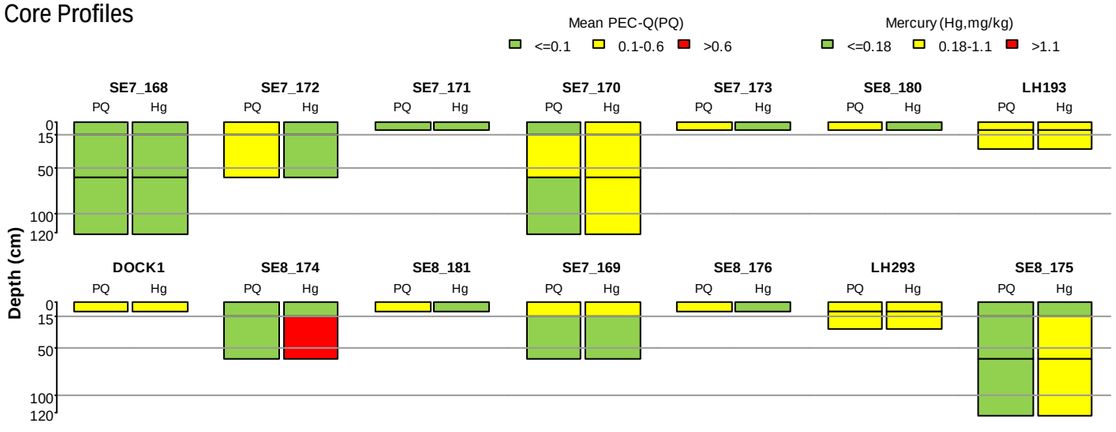
*Chemical studies used in the characterization:*
*Lakehead Dock, 1995 (1 stations);Newton Creek Study, 1993-94 (2);Wisconsin Sampling, 2007 (13).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lakehead Dock, 1995;Newton Creek Study, 1993-94;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



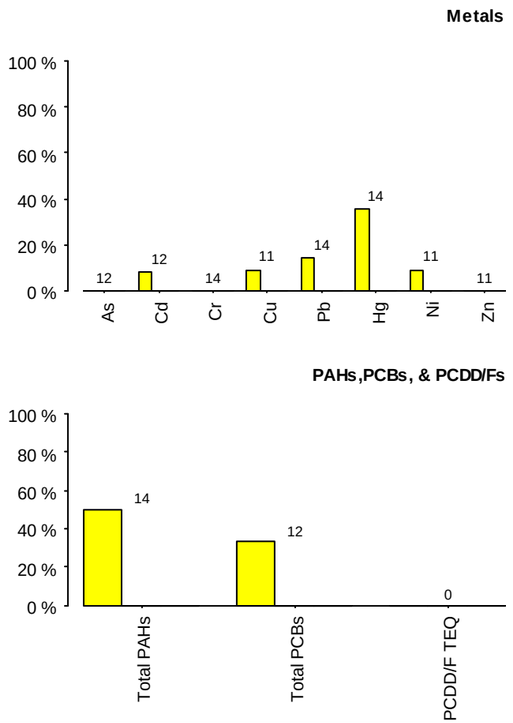

# Sediment Assessment Area Chemistry Characterization

## Data Summary

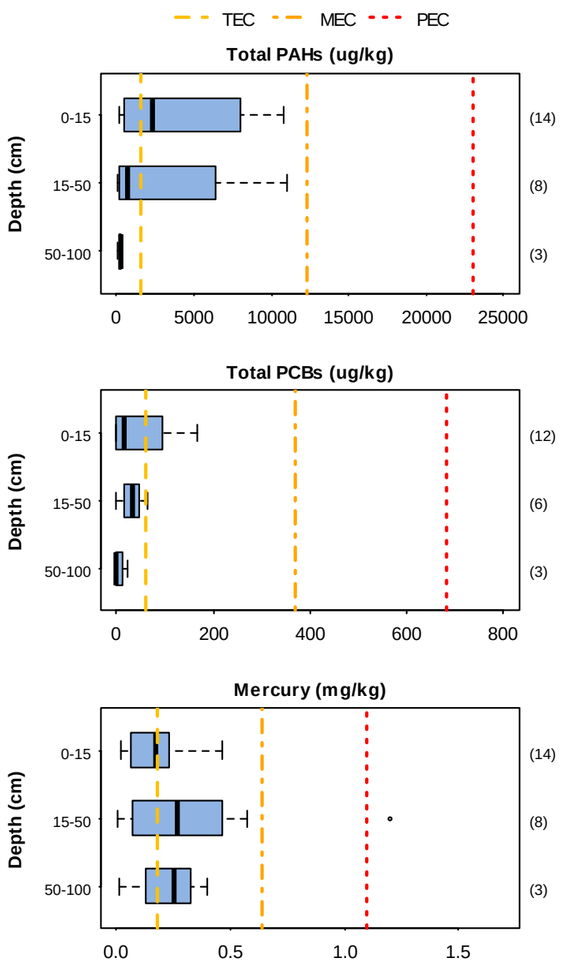
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 14(14) | 25(25) | 213(213) |
| Mercury | 14(14) | 25(25) | 25(25) |
| PAHs | 14(14) | 25(25) | 575(575) |
| PCBs | 12(12) | 21(21) | 231(231) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 12(12) | 21(21) | 32(32) |
| Other parameters | 15(15) | 26(26) | 322(322) |
| TOC | 14(14) | 25(25) | 25(25) |
| Grain size | 14(14) | 23(23) | 45(45) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

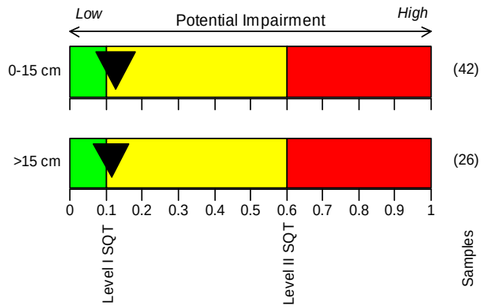
# Sediment Assessment Area Chemistry Characterization

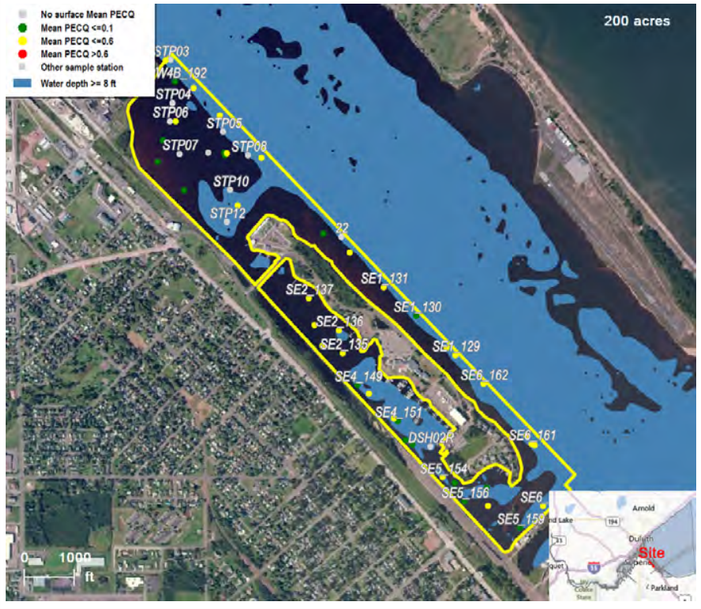
## Assessment Area # 13(Barkers Island and Vicinity)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

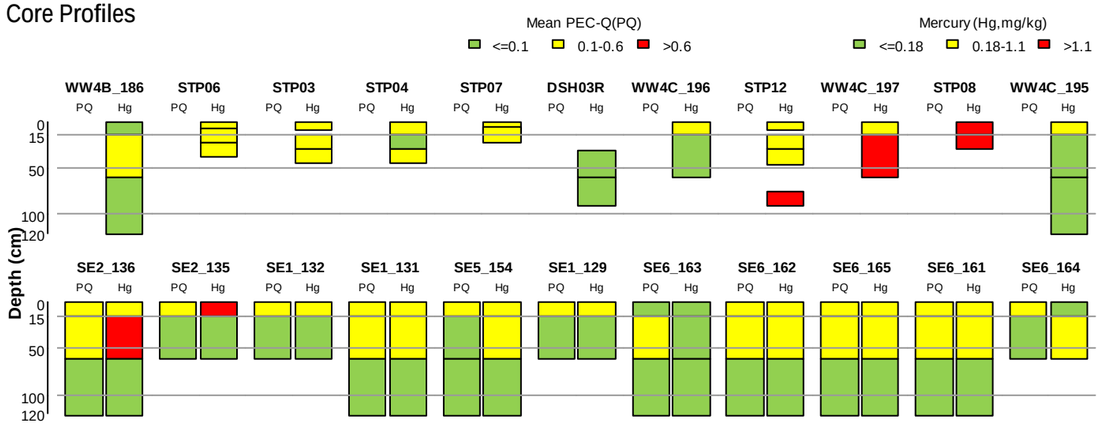
*Chemical studies used in the characterization: R-EMAP Study, 1995 (1 stations);Hotspot Study, 1994 (8);Duluth-Superior Harbor Study, 1993 (1);IT Interlake, 1994 (1);Wisconsin Sampling, 2007 (42).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;Hotspot Study, 1994;Duluth-Superior Harbor Study, 1993;IT Interlake, 1994;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



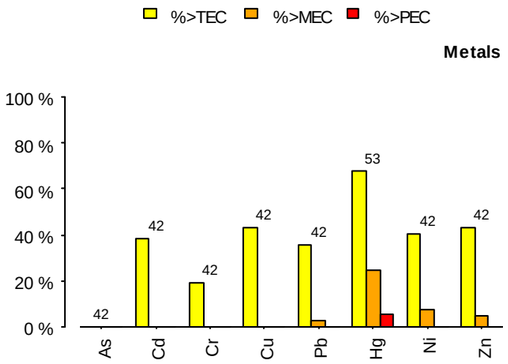

# Sediment Assessment Area Chemistry Characterization

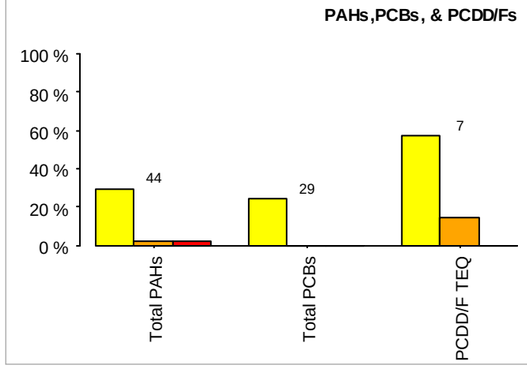
## Data Summary

**Available data in studies used for characterization (All available data)**

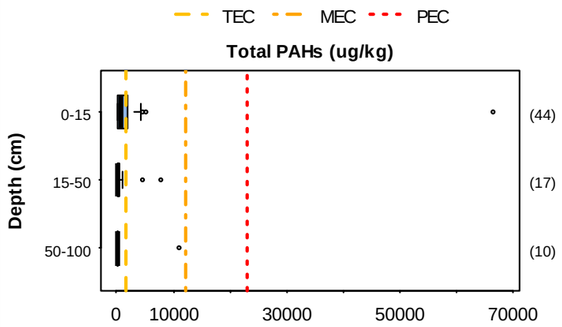
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 43(43) | 69(69) | 694(694) |
| Mercury | 52(52) | 90(90) | 90(90) |
| PAHs | 44(44) | 73(73) | 1906(1906) |
| PCBs | 37(37) | 66(66) | 1895(1895) |
| PCDD/Fs | 7(7) | 9(9) | 153(153) |
| Pesticides | 42(42) | 66(66) | 95(95) |
| Other parameters | 53(53) | 91(91) | 1135(1135) |
| TOC | 52(52) | 88(88) | 88(88) |
| Grain size | 51(51) | 86(86) | 310(310) |

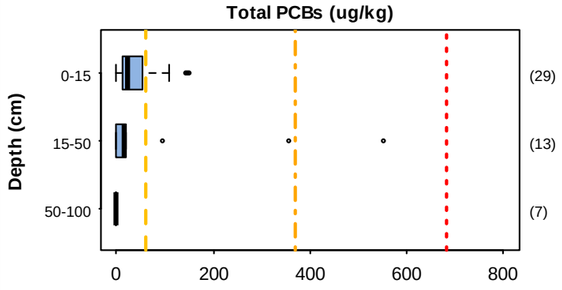
## Results Exceeding Thresholds (0-15 cm samples)

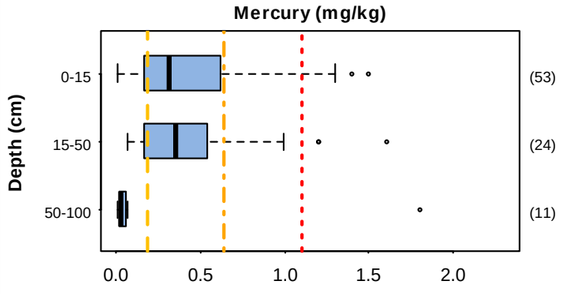


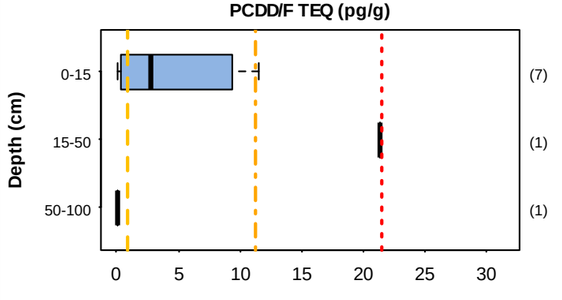




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

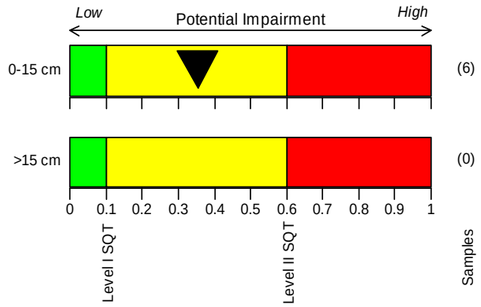
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 14(Pickle Pond)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

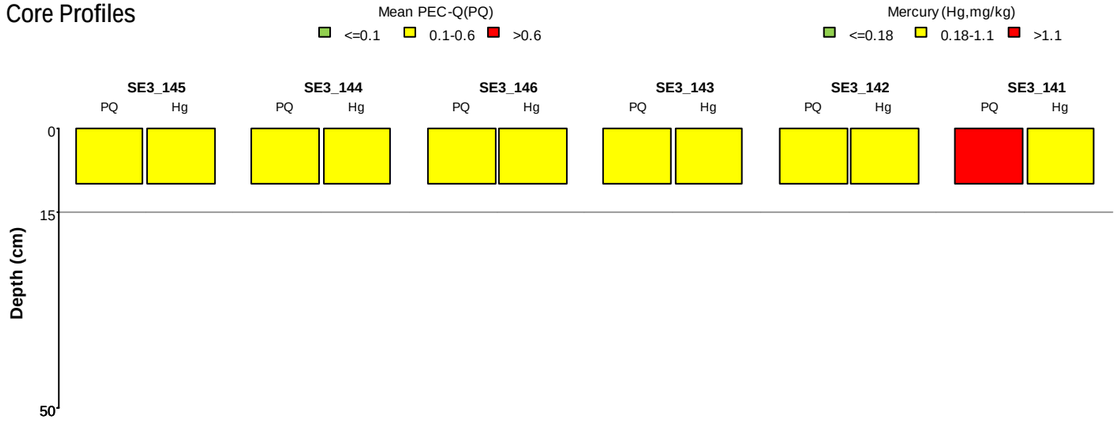
*Chemical studies used in the characterization:*
*Wisconsin Sampling, 2007 (6 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



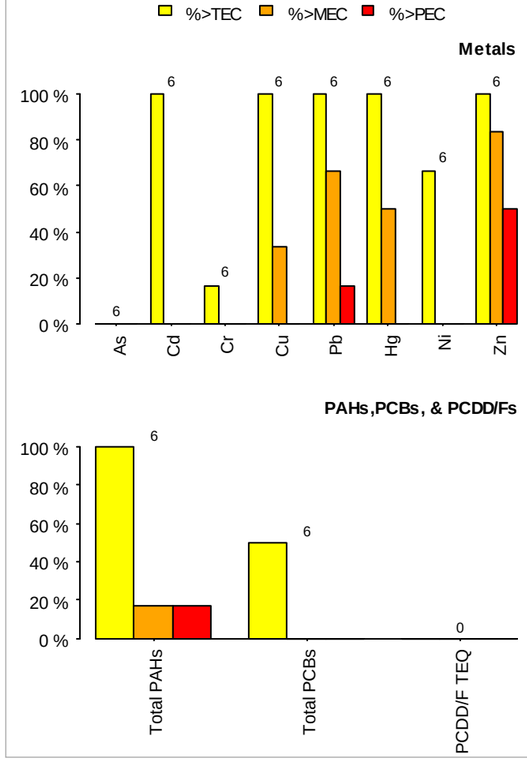

# Sediment Assessment Area Chemistry Characterization

## Data Summary

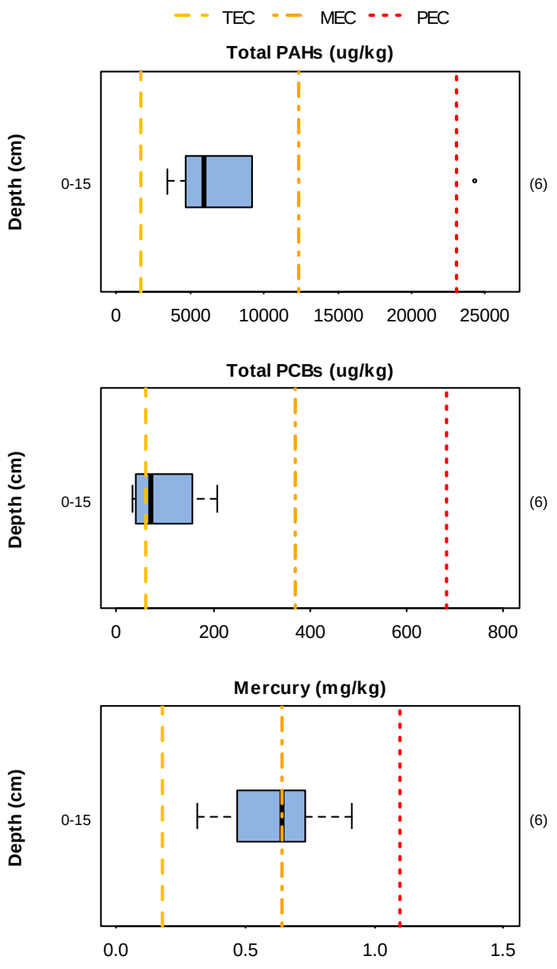
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 6(6) | 54(54) |
| Mercury | 6(6) | 6(6) | 6(6) |
| PAHs | 6(6) | 6(6) | 228(228) |
| PCBs | 6(6) | 6(6) | 66(66) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 6(6) | 6(6) | 12(12) |
| Other parameters | 6(6) | 6(6) | 90(90) |
| TOC | 6(6) | 6(6) | 6(6) |
| Grain size | 6(6) | 6(6) | 12(12) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

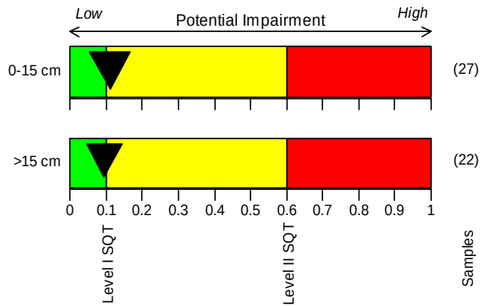
# Sediment Assessment Area Chemistry Characterization

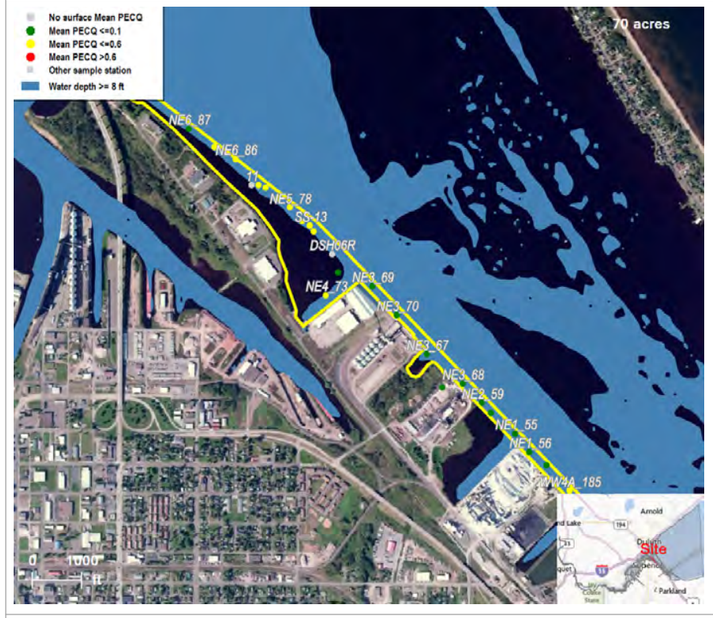
## Assessment Area # 15(Connors Point Waterfront)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

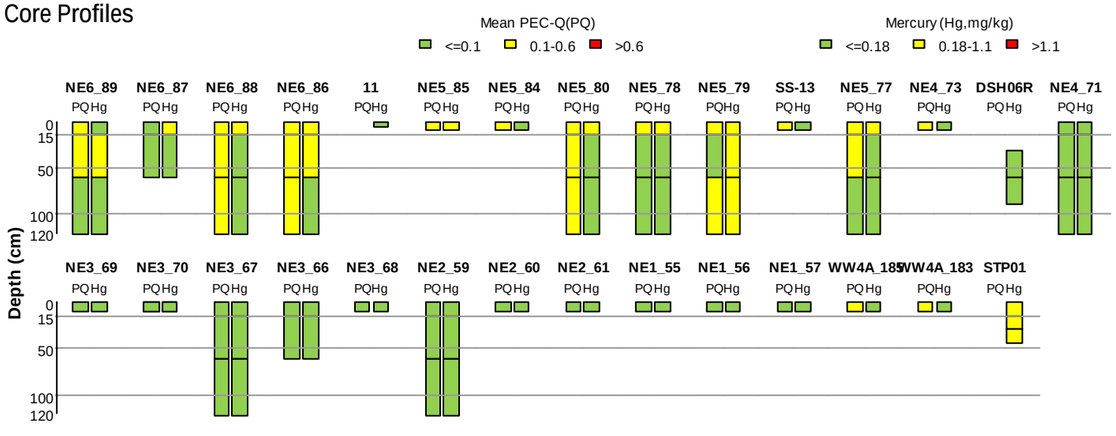
*Chemical studies used in the characterization: R-EMAP Study, 1995 (1 stations);Hotspot Study, 1994 (1);Duluth-Superior Harbor Study, 1993 (1);Fraser Shipyards/Howard's Pocket, 2002 (1);Wisconsin Sampling, 2007 (34).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;Hotspot Study, 1994;Duluth-Superior Harbor Study, 1993;Fraser Shipyards/Howard's Pocket, 2002;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



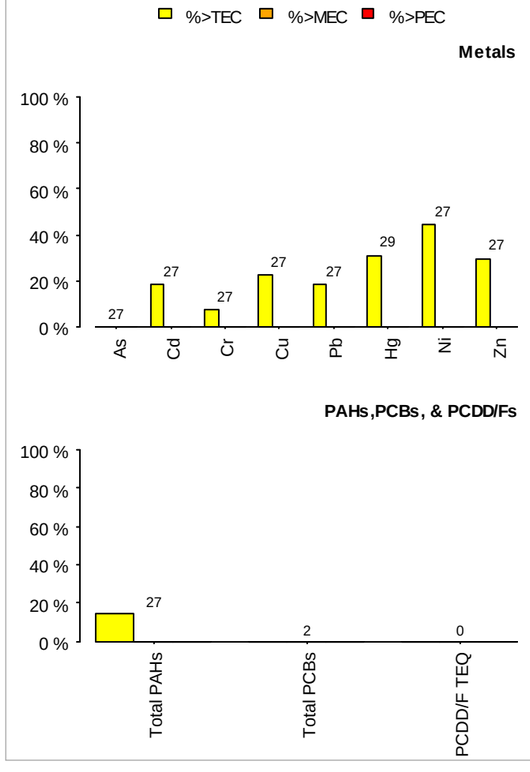

# Sediment Assessment Area Chemistry Characterization

## Data Summary

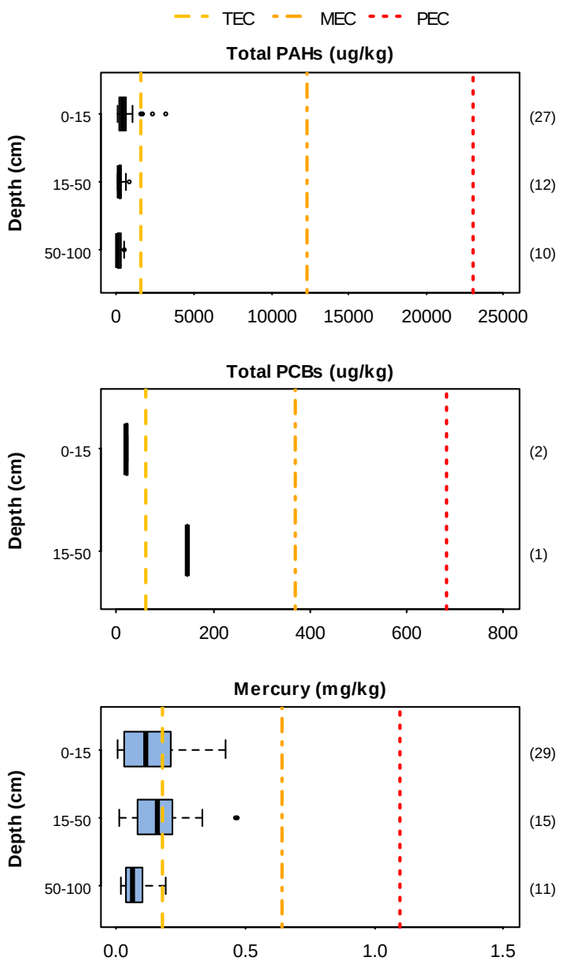
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 27(27) | 50(50) | 487(487) |
| Mercury | 29(29) | 55(55) | 55(55) |
| PAHs | 27(27) | 50(50) | 1202(1202) |
| PCBs | 3(3) | 5(5) | 251(251) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 25(25) | 47(47) | 69(69) |
| Other parameters | 29(29) | 55(55) | 617(617) |
| TOC | 27(27) | 52(52) | 52(52) |
| Grain size | 37(37) | 61(61) | 147(147) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

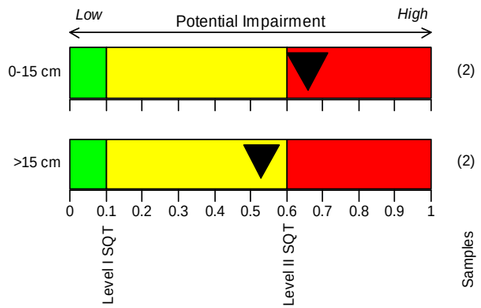
# Sediment Assessment Area Chemistry Characterization

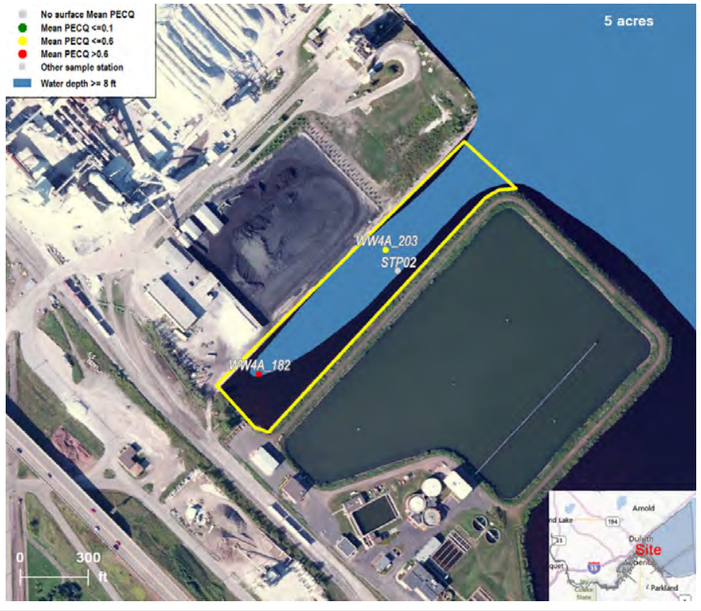
## Assessment Area # 16(Graymont / Cutler-Magner Coal Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

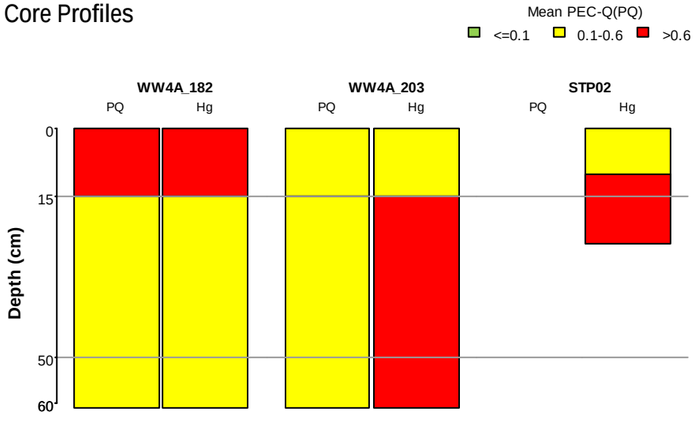
*Chemical studies used in the characterization:*
*Hotspot Study, 1994 (1 stations);Wisconsin Sampling, 2007 (2).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Hotspot Study, 1994;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



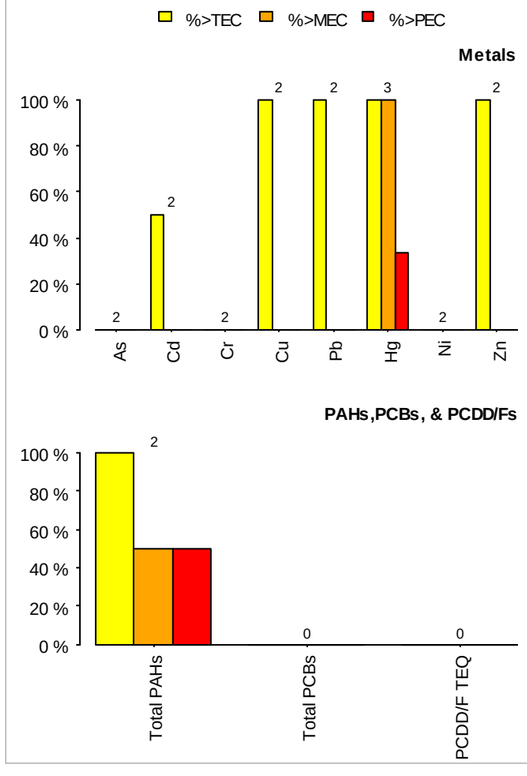

# Sediment Assessment Area Chemistry Characterization

## Data Summary

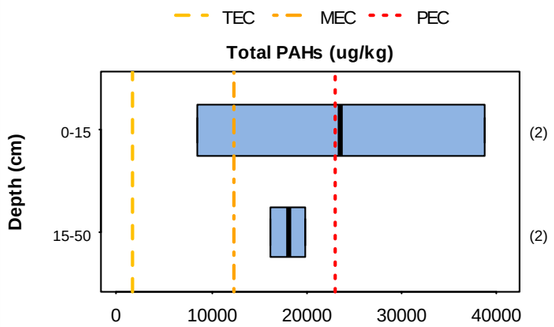
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 4(4) | 36(36) |
| Mercury | 3(3) | 6(6) | 6(6) |
| PAHs | 2(2) | 4(4) | 152(152) |
| PCBs | 1(1) | 2(2) | 149(149) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 2(2) | 4(4) | 4(4) |
| Other parameters | 3(3) | 6(6) | 58(58) |
| TOC | 3(3) | 6(6) | 6(6) |
| Grain size | 3(3) | 6(6) | 26(26) |

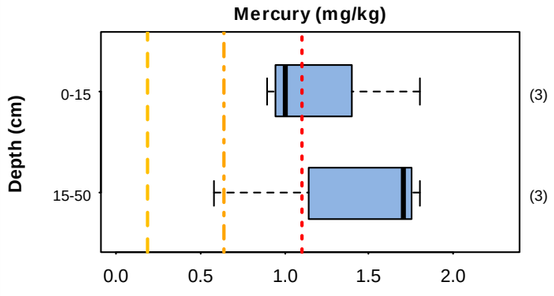
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

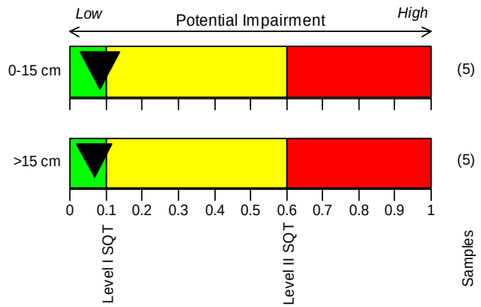
# Sediment Assessment Area Chemistry Characterization

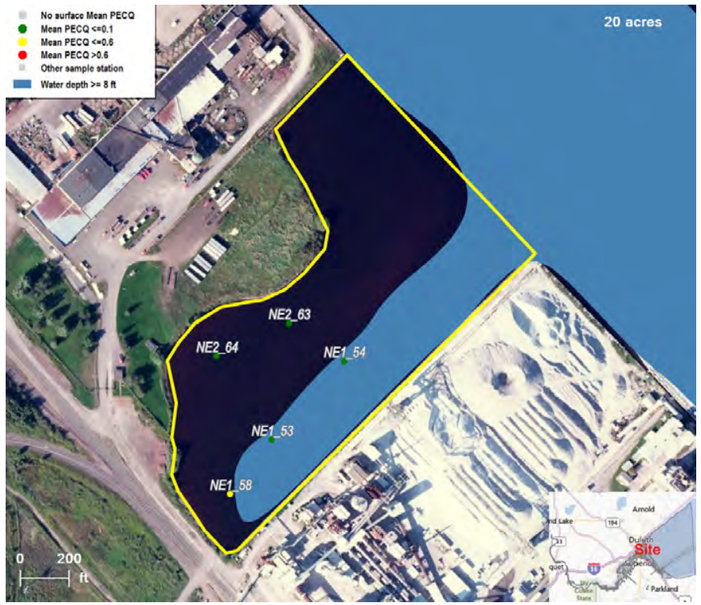
## Assessment Area # 17(Cutler-Magner Limestone Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

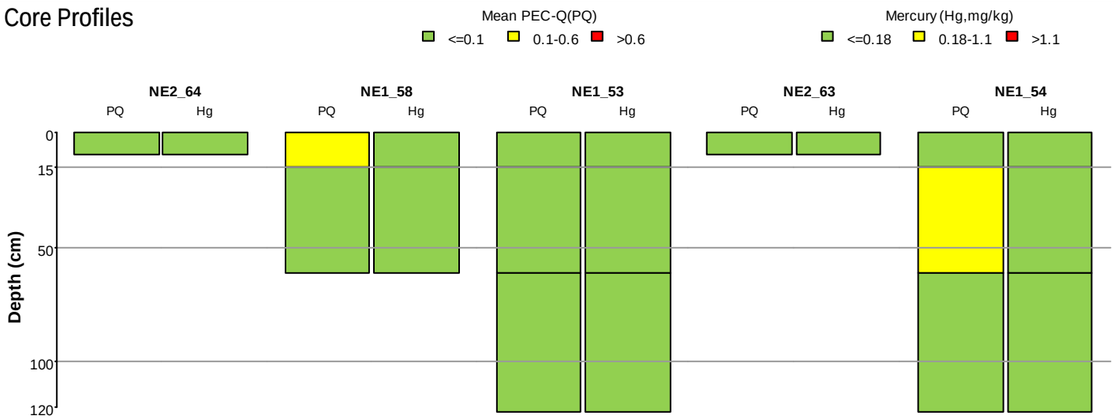
*Chemical studies used in the characterization:*
*Wisconsin Sampling, 2007 (7 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



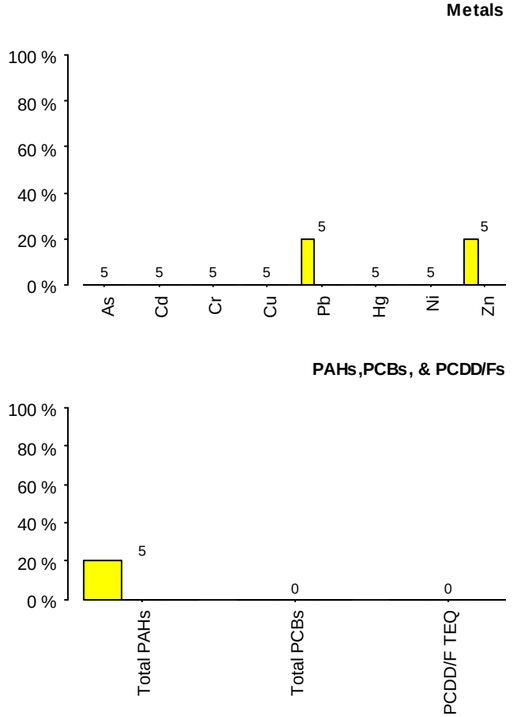

# Sediment Assessment Area Chemistry Characterization

## Data Summary

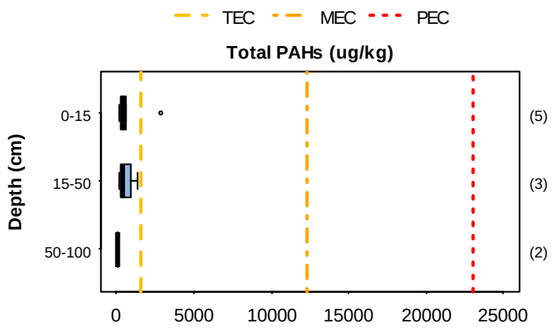
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 5(5) | 10(10) | 90(90) |
| Mercury | 5(5) | 10(10) | 10(10) |
| PAHs | 5(5) | 10(10) | 236(236) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 5(5) | 10(10) | 10(10) |
| Other parameters | 5(5) | 10(10) | 106(106) |
| TOC | 5(5) | 10(10) | 10(10) |
| Grain size | 7(7) | 12(12) | 24(24) |

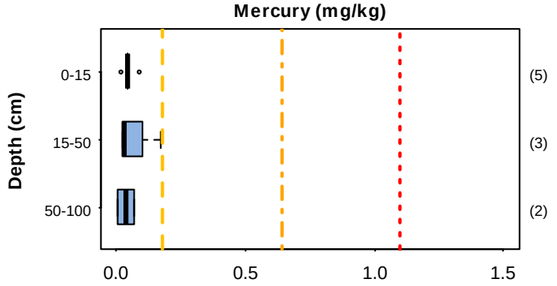
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

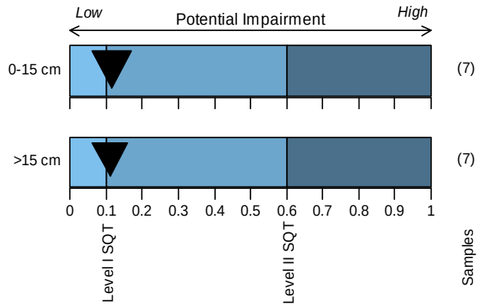
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 18(Hearding Island)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

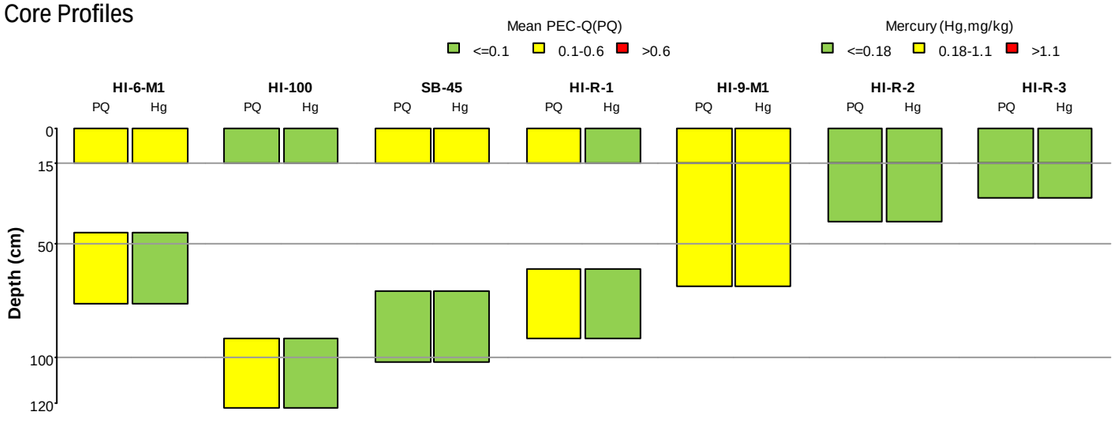
*Chemical studies used in the characterization: Superior Bay - 21st Ave., 2008&10 (7 stations).*

*Other chemical studies: R-EMAP Study, 1995 (1 stations);Duluth-Superior Harbor Study, 1993 (2);USACE DACW35-93-D-0005 DELIVERY ORDER 36 (16).*

*Macro-invertebrate studies: R-EMAP Study, 1995;Duluth-Superior Harbor Study, 1993;USACE DACW35-93-D-0005 DELIVERY ORDER 36;Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies: Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



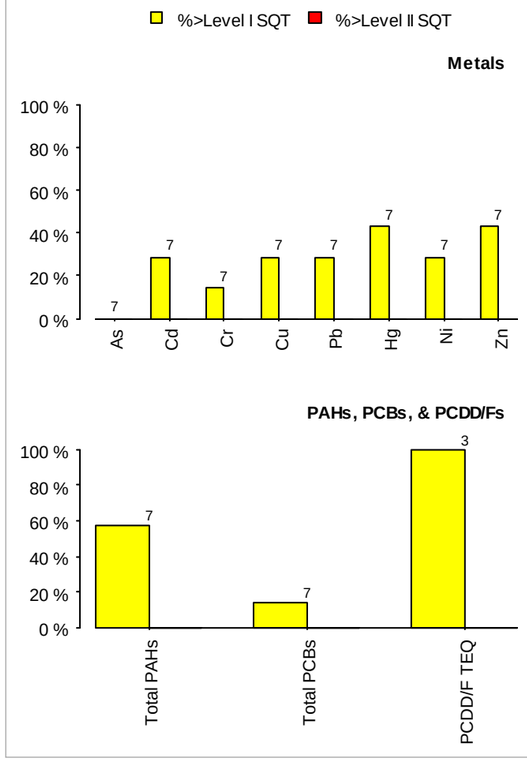

# Sediment Assessment Area Chemistry Characterization

## Data Summary

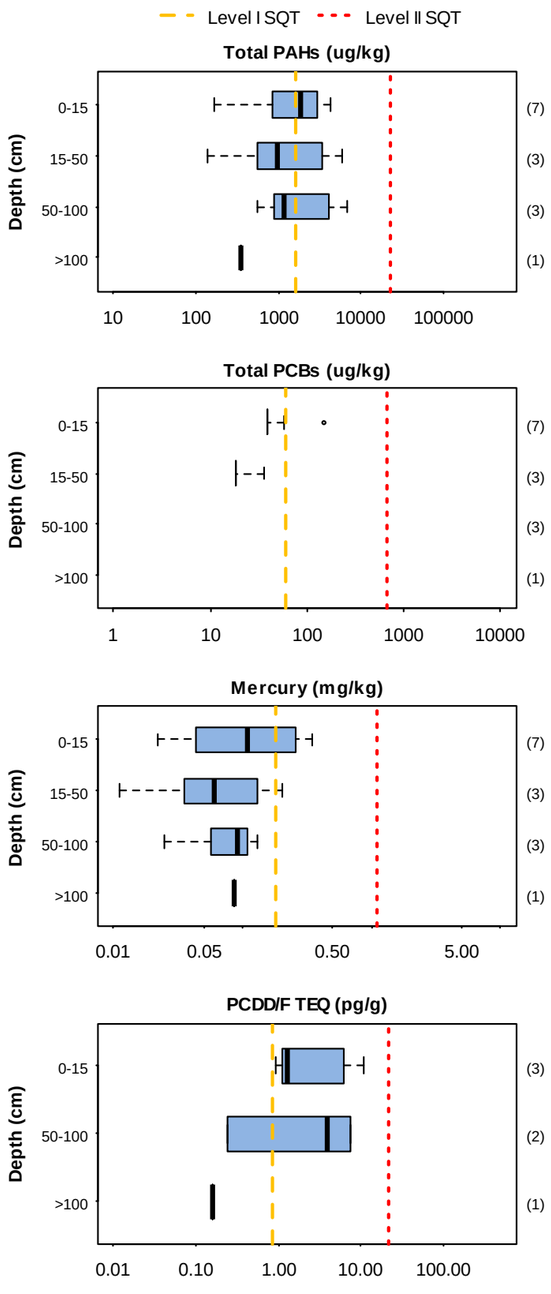
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 7(16) | 14(23) | 140(233) |
| Mercury | 7(18) | 14(27) | 14(27) |
| PAHs | 7(16) | 14(23) | 502(647) |
| PCBs | 7(15) | 14(22) | 98(154) |
| PCDD/Fs | 3(3) | 6(6) | 150(150) |
| Pesticides | 3(3) | 6(6) | 150(150) |
| Other parameters | 7(18) | 14(27) | 527(617) |
| TOC | 7(10) | 14(19) | 14(19) |
| Grain size | 7(17) | 14(24) | 24(103) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

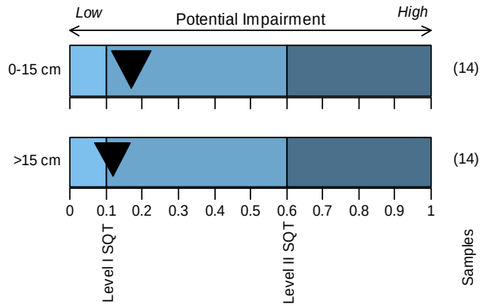
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 19(North Park Point Bayside)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

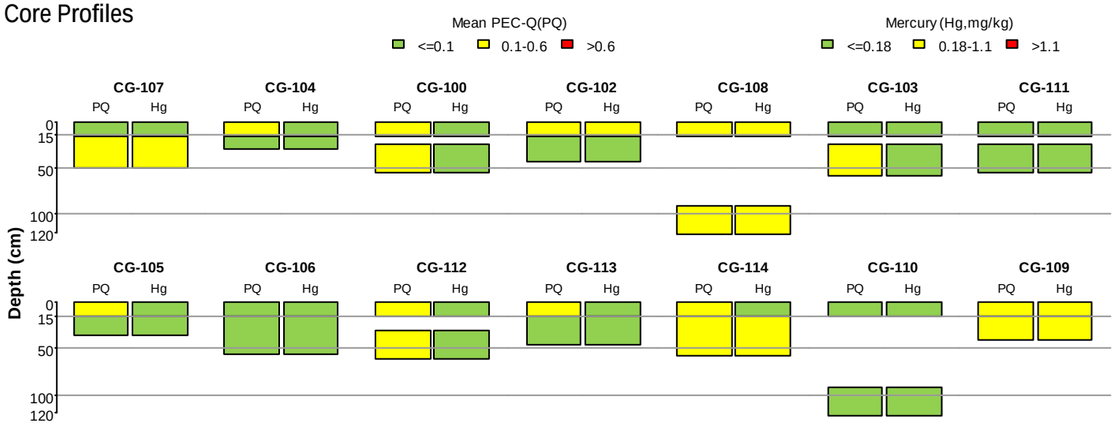
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (14 stations).*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations);R-EMAP Study, 1996 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;Duluth-Superior Harbor Study, 1993;Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



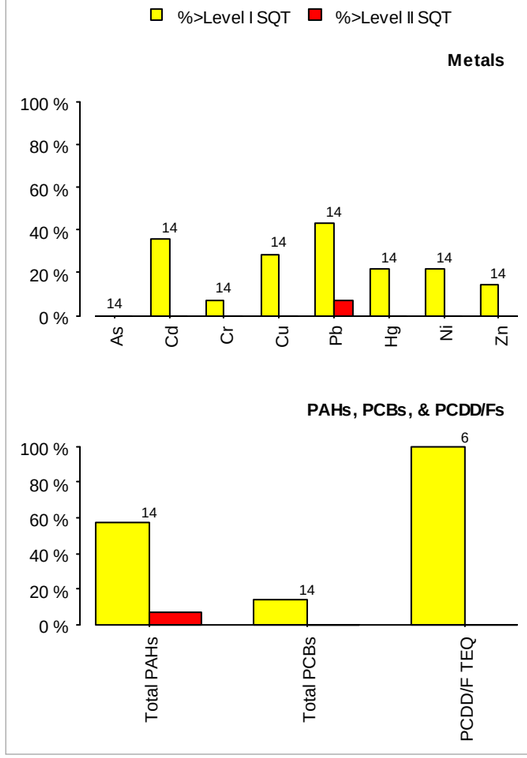

# Sediment Assessment Area Chemistry Characterization

## Data Summary

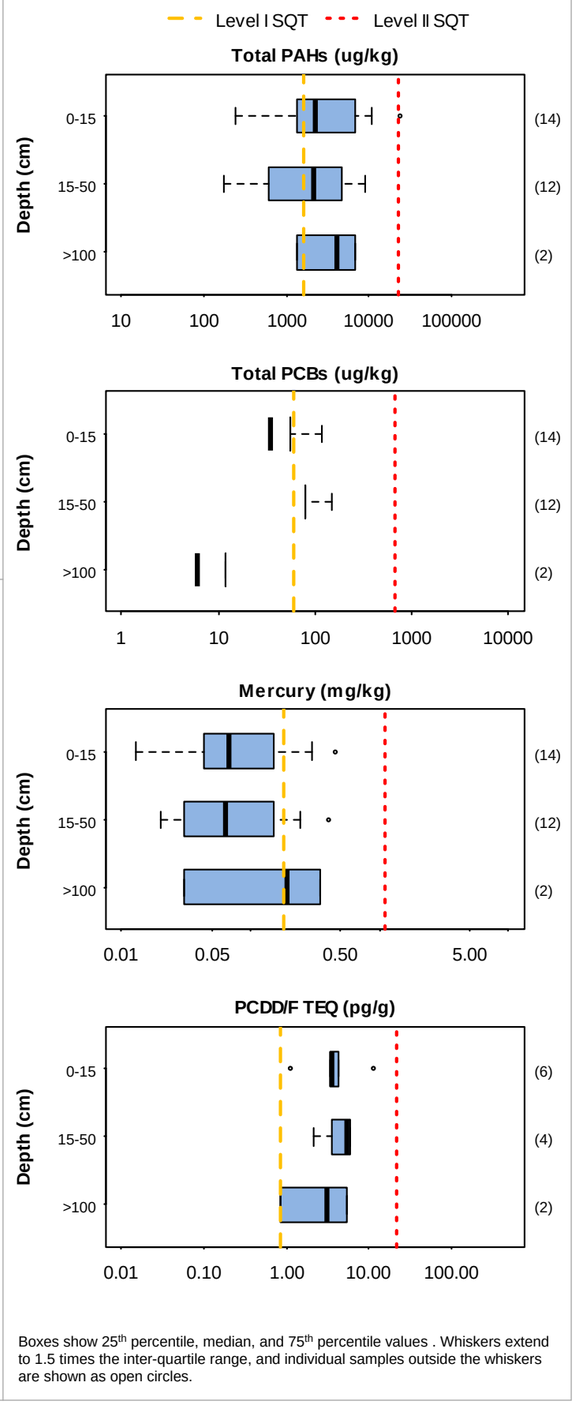
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 14(16) | 28(30) | 280(290) |
| Mercury | 14(16) | 28(30) | 28(30) |
| PAHs | 14(16) | 28(30) | 1088(1124) |
| PCBs | 14(14) | 28(28) | 196(196) |
| PCDD/Fs | 6(6) | 12(12) | 300(300) |
| Pesticides | 6(6) | 12(12) | 300(300) |
| Other parameters | 14(16) | 28(30) | 1064(1084) |
| TOC | 14(16) | 28(30) | 28(30) |
| Grain size | 14(16) | 28(30) | 56(70) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

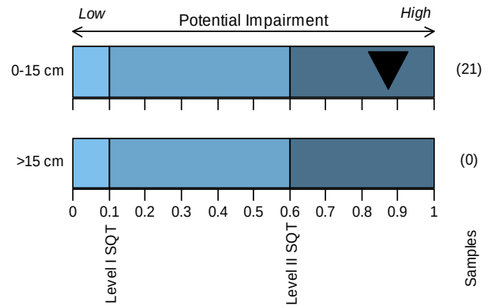
# Sediment Assessment Area Chemistry Characterization

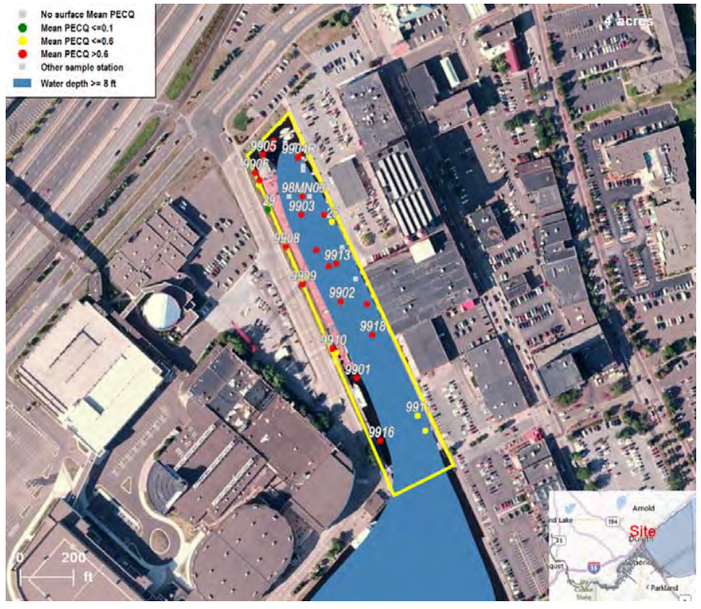
## Assessment Area # 20(Minnesota Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

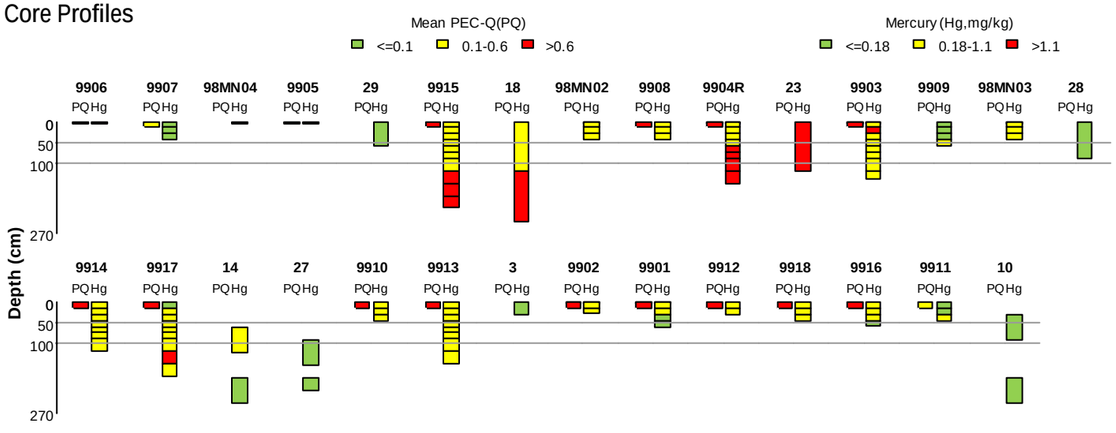
*Chemical studies used in the characterization: MN Slip Sed. Remediation Scoping, 1999 (18 stations);Minnesota Slip Samples, 1998 (3);Minnesota Slip MPCA 2004 (8).*

*Other chemical studies: R-EMAP Study, 1995 (1 stations);Hotspot Study, 1994 (5);R-EMAP Study, 1996 (1);Bioaccumulation Study, 1999 (2);Duluth-Superior Harbor Study, 1993 (1).*

*Macro-invertebrate studies: R-EMAP Study, 1995;Hotspot Study, 1994;R-EMAP Study, 1996;MN Slip Sed. Remediation Scoping, 1999;Minnesota Slip Samples, 1998;Bioaccumulation Study, 1999;Duluth-Superior Harbor Study, 1993;Minnesota Slip MPCA 2004.*

*Fish tissue studies: Bioaccumulation Study, 1999.*

## Core Profiles



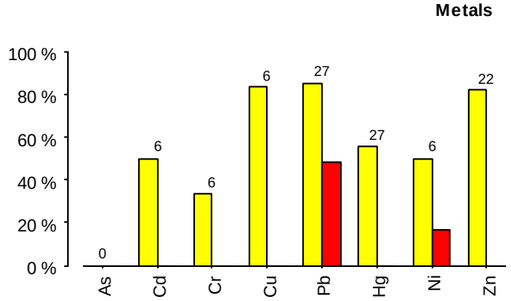

# Sediment Assessment Area Chemistry Characterization

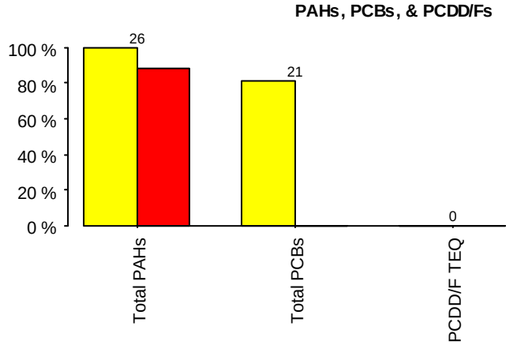
## Data Summary

**Available data in studies used for characterization (All available data)**

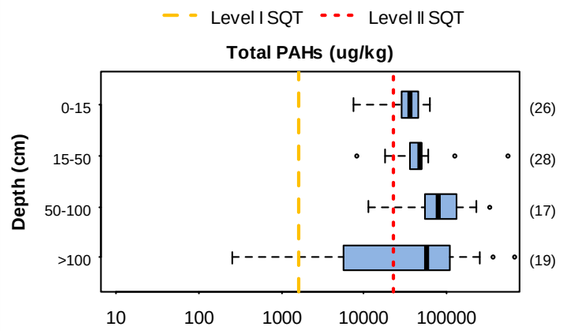
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 29(31) | 110(112) | 375(385) |
| Mercury | 29(39) | 110(138) | 110(138) |
| PAHs | 29(38) | 91(105) | 1638(1870) |
| PCBs | 17(24) | 21(43) | 1911(3372) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 29(39) | 110(138) | 920(1118) |
| TOC | 29(39) | 105(133) | 105(133) |
| Grain size | 21(28) | 71(93) | 691(885) |

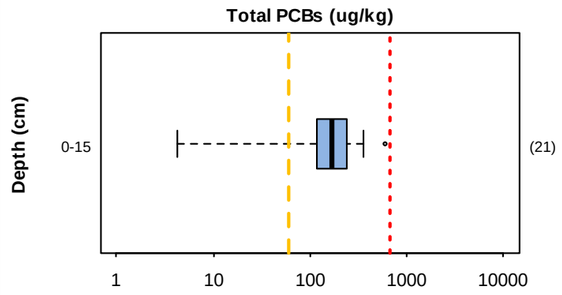
## Results Exceeding Thresholds (0-15 cm samples)

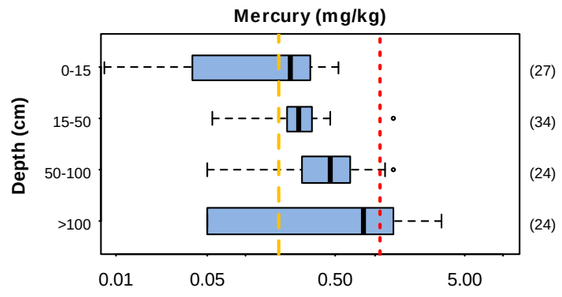



## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

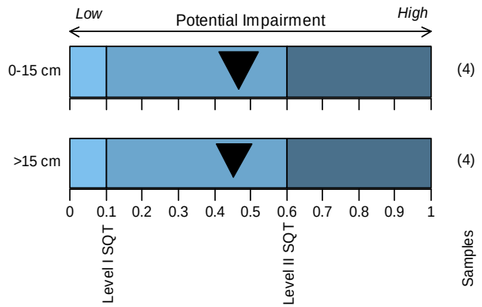
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 21(Slip 2)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

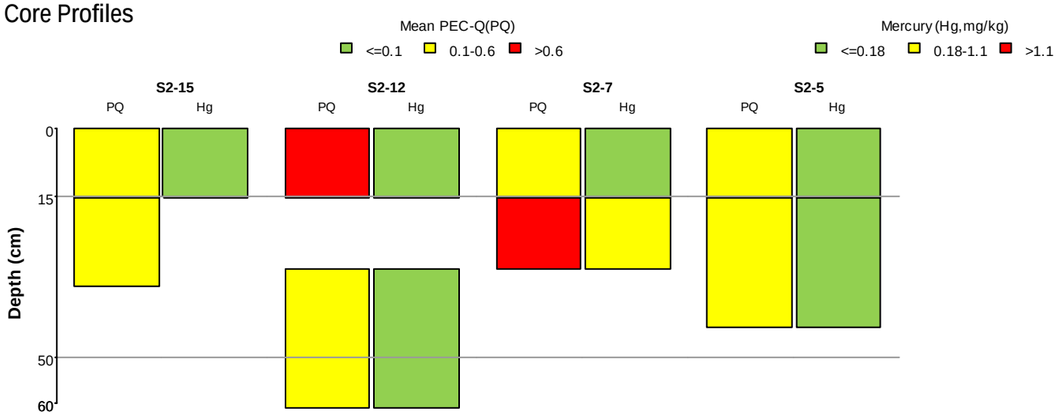
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (4 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



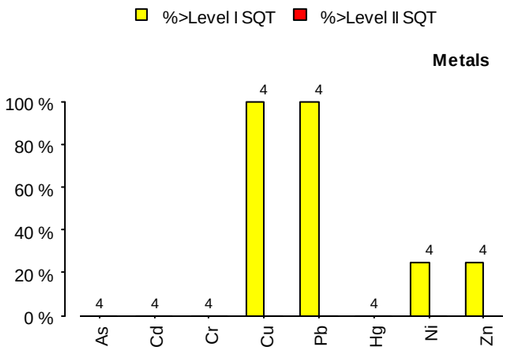

# Sediment Assessment Area Chemistry Characterization

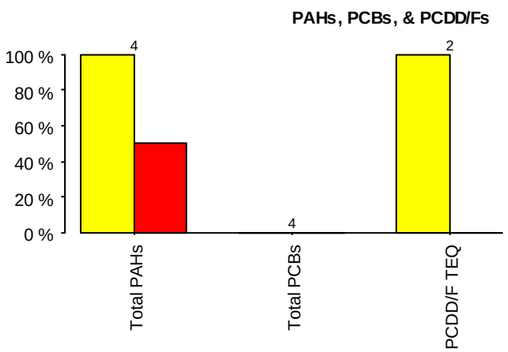
## Data Summary

**Available data in studies used for characterization (All available data)**

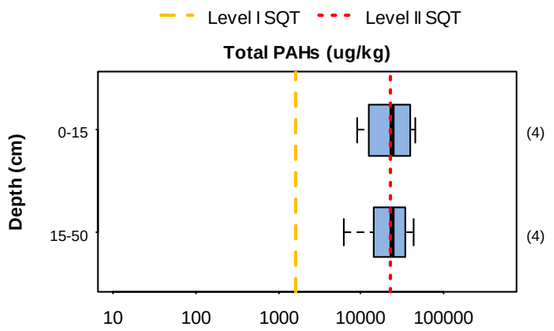
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(4) | 8(8) | 80(80) |
| Mercury | 4(4) | 8(8) | 8(8) |
| PAHs | 4(4) | 8(8) | 144(144) |
| PCBs | 4(4) | 8(8) | 56(56) |
| PCDD/Fs | 2(2) | 4(4) | 100(100) |
| Pesticides | 2(2) | 4(4) | 104(104) |
| Other parameters | 4(4) | 8(8) | 324(324) |
| TOC | 4(4) | 8(8) | 8(8) |
| Grain size | 4(4) | 8(8) | 8(8) |

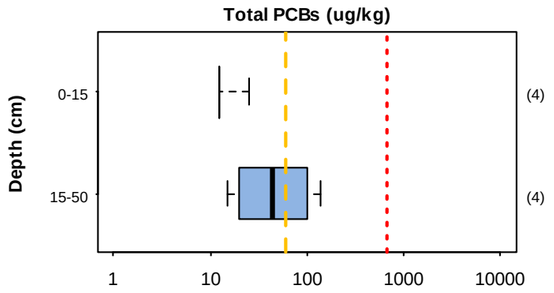
## Results Exceeding Thresholds (0-15 cm samples)

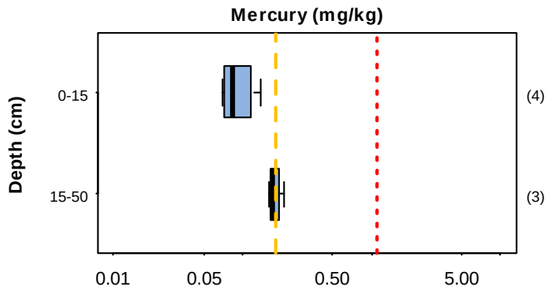


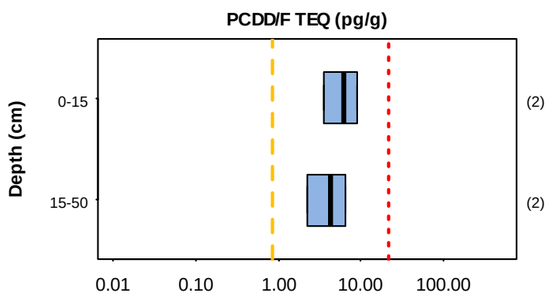




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

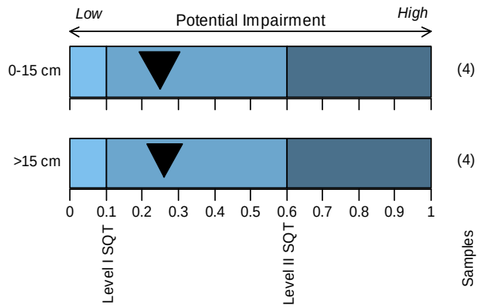
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 22(Slip 3)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

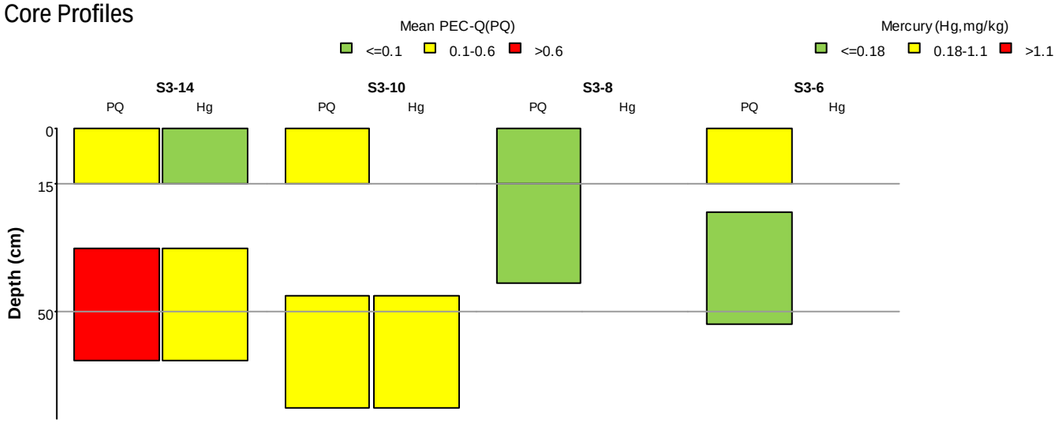
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (4 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



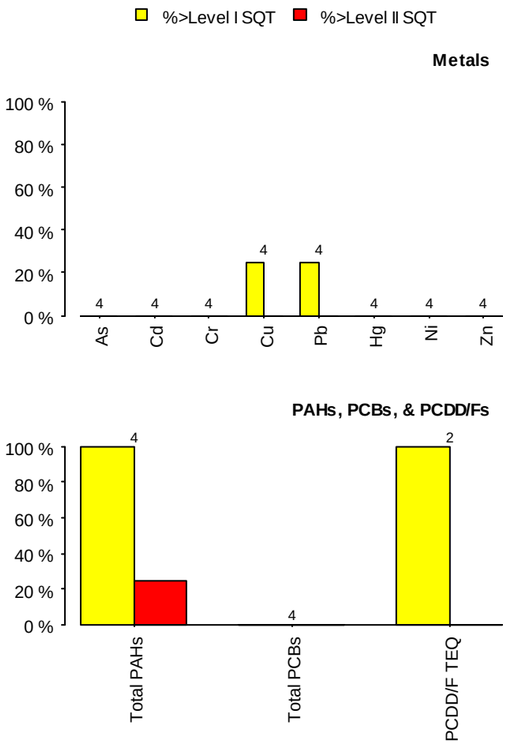

# Sediment Assessment Area Chemistry Characterization

## Data Summary

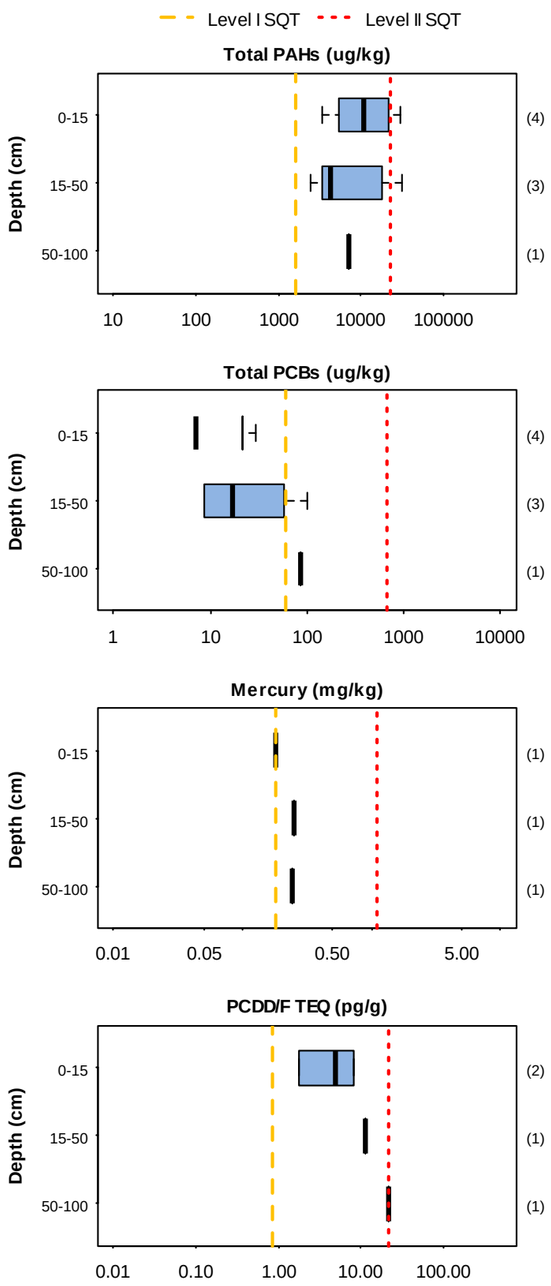
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(4) | 8(8) | 80(80) |
| Mercury | 4(4) | 8(8) | 8(8) |
| PAHs | 4(4) | 8(8) | 144(144) |
| PCBs | 4(4) | 8(8) | 56(56) |
| PCDD/Fs | 2(2) | 4(4) | 100(100) |
| Pesticides | 2(2) | 4(4) | 104(104) |
| Other parameters | 4(4) | 8(8) | 324(324) |
| TOC | 4(4) | 8(8) | 8(8) |
| Grain size | 4(4) | 8(8) | 8(8) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

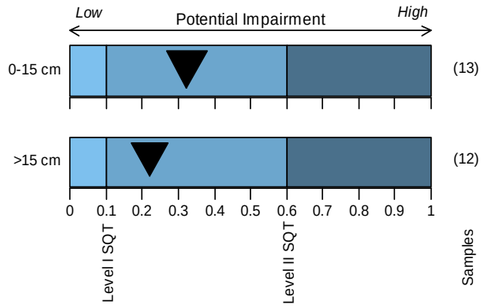
# Sediment Assessment Area Chemistry Characterization

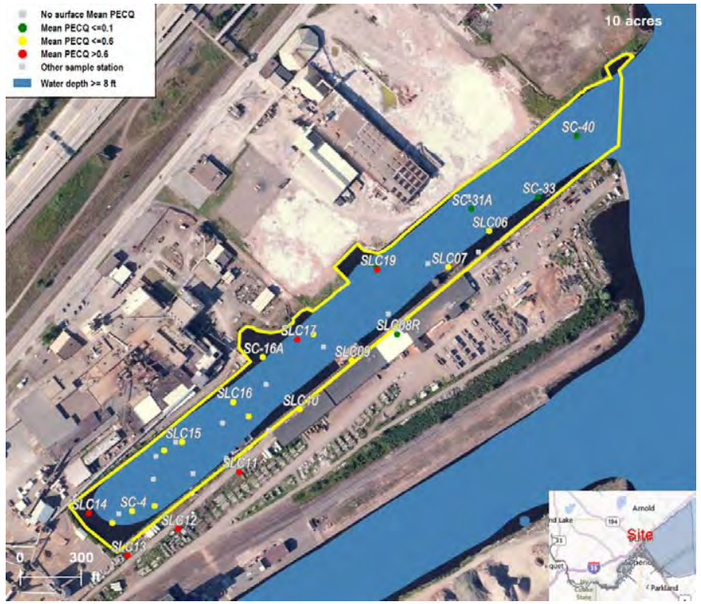
## Assessment Area # 23(Slip C)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

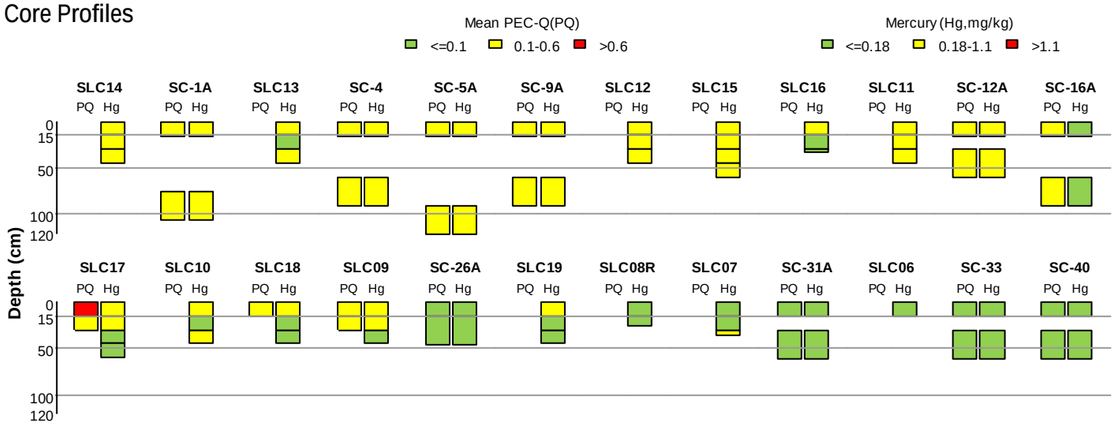
*Chemical studies used in the characterization: Assessment Study of Slip C, 1997 (14 stations);Superior Bay - 21st Ave., 2008&10 (10).*

*Other chemical studies: R-EMAP Study, 1995 (2 stations);Hotspot Study, 1994 (7);Bioaccumulation Study, 1999 (2);Duluth-Superior Harbor Study, 1993 (4).*

*Macro-invertebrate studies: R-EMAP Study, 1995;Hotspot Study, 1994;Assessment Study of Slip C, 1997;Bioaccumulation Study, 1999;Duluth-Superior Harbor Study, 1993;Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies: Bioaccumulation Study, 1999.*

## Core Profiles



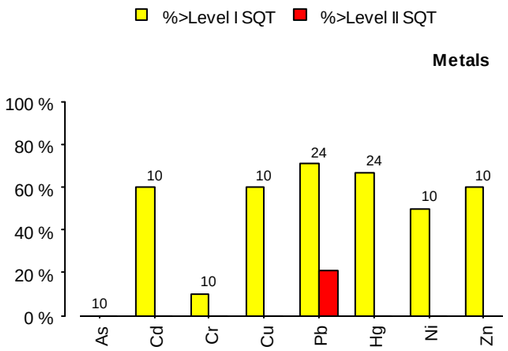

# Sediment Assessment Area Chemistry Characterization

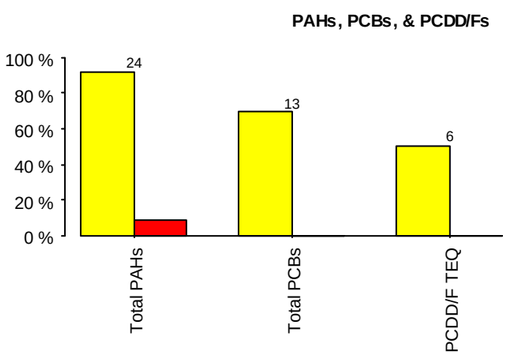
## Data Summary

**Available data in studies used for characterization (All available data)**

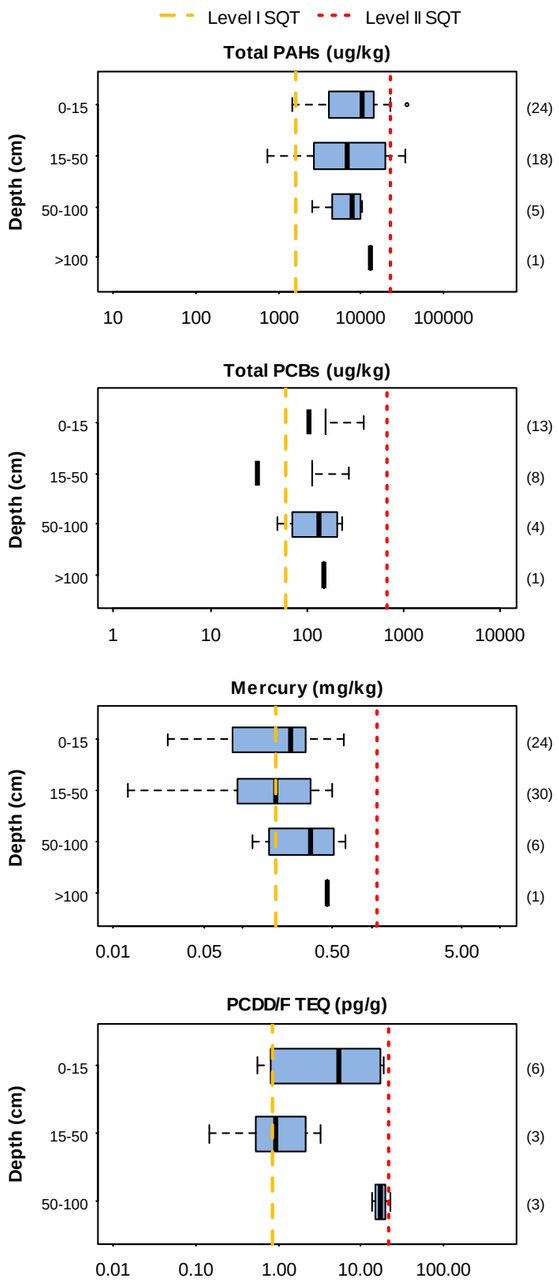
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 24(26) | 61(63) | 241(251) |
| Mercury | 24(39) | 61(104) | 61(104) |
| PAHs | 24(35) | 48(66) | 1288(1582) |
| PCBs | 13(22) | 26(56) | 674(2814) |
| PCDD/Fs | 6(6) | 12(12) | 300(300) |
| Pesticides | 6(6) | 12(12) | 300(300) |
| Other parameters | 24(39) | 61(104) | 1179(1451) |
| TOC | 24(39) | 49(92) | 49(92) |
| Grain size | 24(33) | 49(78) | 272(529) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

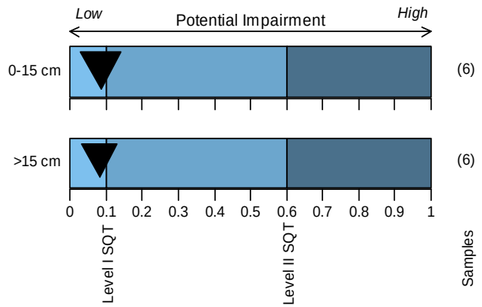
# Sediment Assessment Area Chemistry Characterization

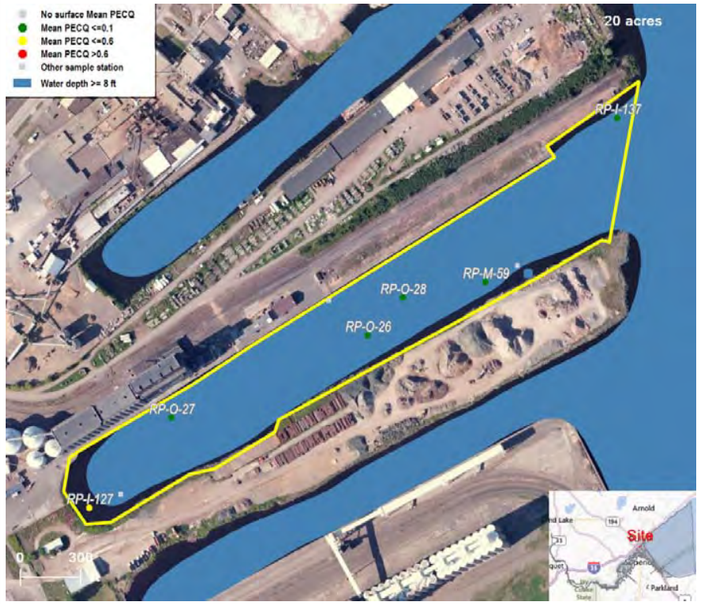
## Assessment Area # 24(General Mills Elevator A Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

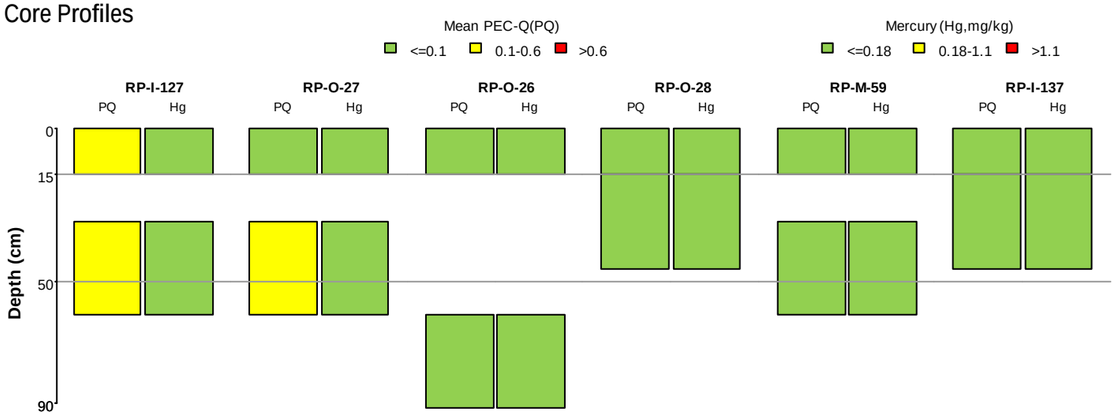
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (6 stations).*

*Other chemical studies:*
*Assessment Study of Slip C, 1997 (3 stations).*

*Macro-invertebrate studies:*
*Assessment Study of Slip C, 1997;Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



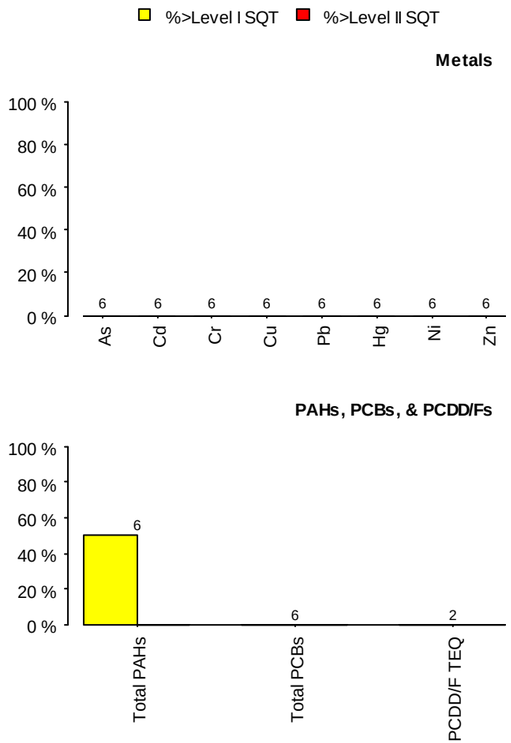

# Sediment Assessment Area Chemistry Characterization

## Data Summary

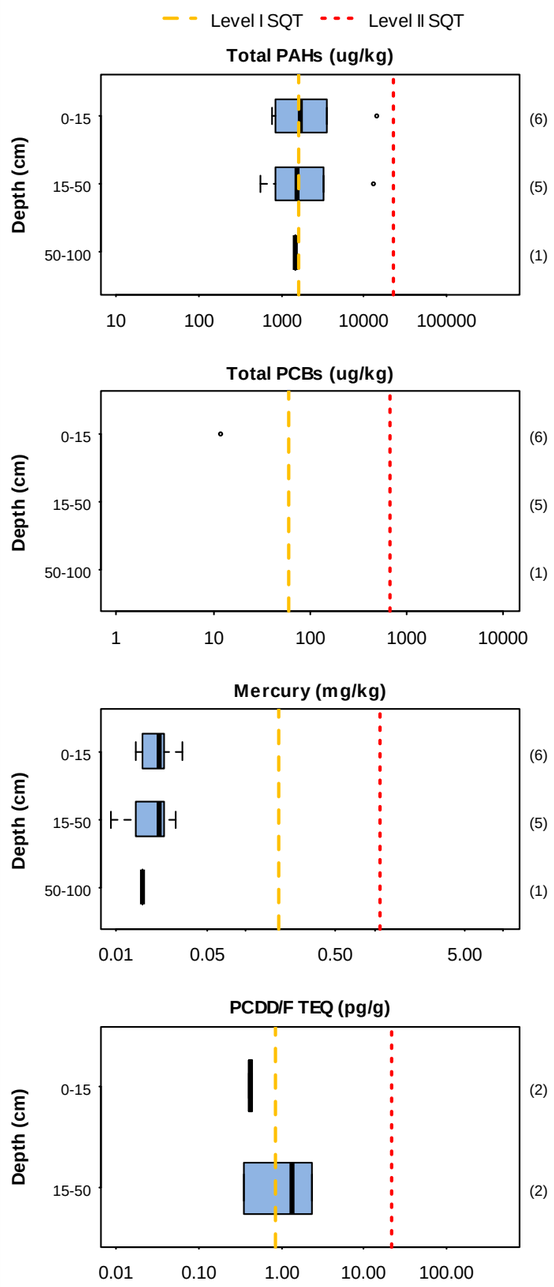
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(9) | 12(15) | 120(123) |
| Mercury | 6(9) | 12(15) | 12(15) |
| PAHs | 6(9) | 12(15) | 464(518) |
| PCBs | 6(6) | 12(12) | 84(84) |
| PCDD/Fs | 2(2) | 4(4) | 100(100) |
| Pesticides | 2(2) | 4(4) | 100(100) |
| Other parameters | 6(9) | 12(15) | 381(408) |
| TOC | 6(9) | 12(15) | 12(15) |
| Grain size | 6(9) | 12(15) | 24(48) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

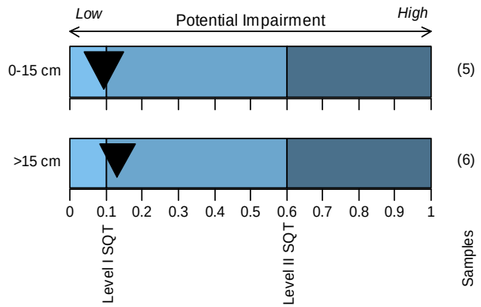
# Sediment Assessment Area Chemistry Characterization

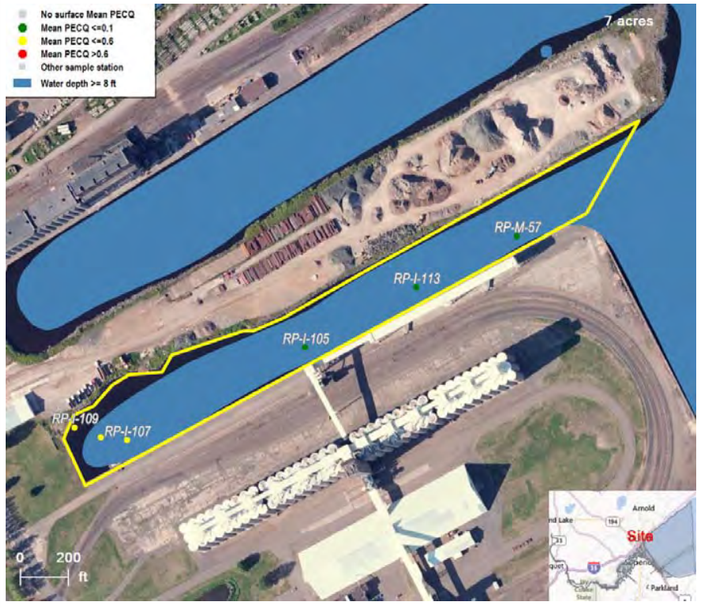
## Assessment Area # 25(Cargill Elevator B1 Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

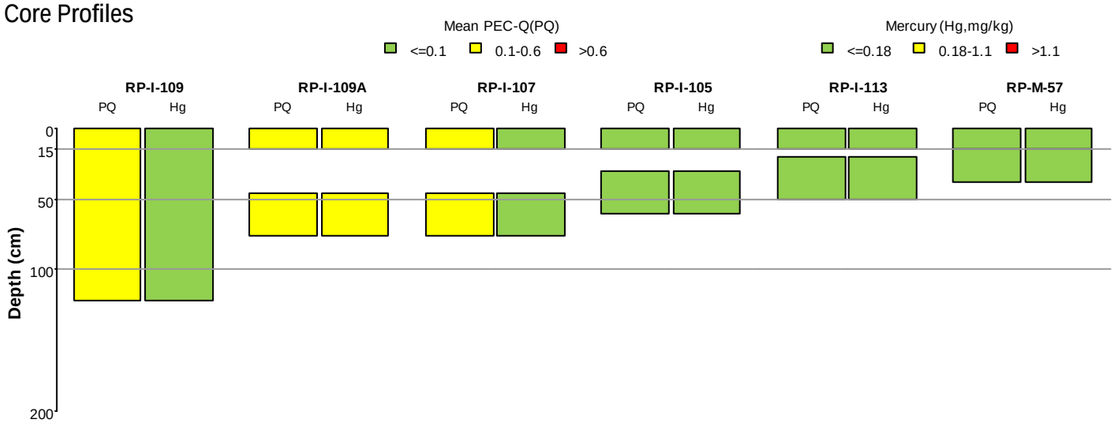
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (6 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



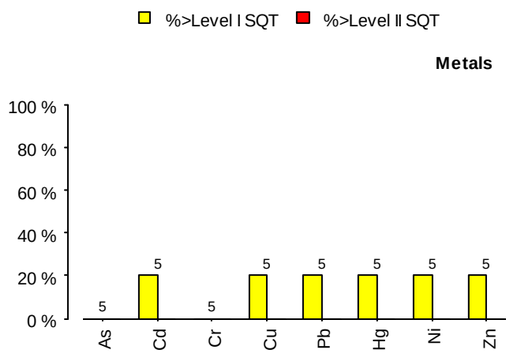

# Sediment Assessment Area Chemistry Characterization

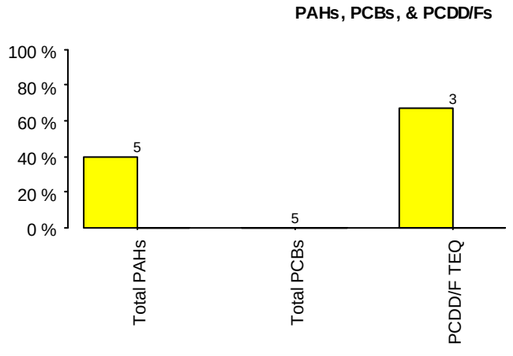
## Data Summary

**Available data in studies used for characterization (All available data)**

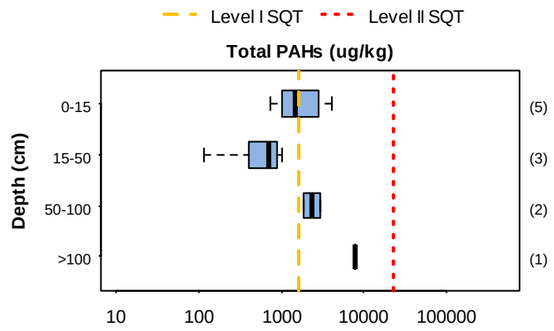
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 11(11) | 111(111) |
| Mercury | 6(6) | 11(11) | 11(11) |
| PAHs | 6(6) | 11(11) | 411(411) |
| PCBs | 6(6) | 11(11) | 77(77) |
| PCDD/Fs | 4(4) | 7(7) | 175(175) |
| Pesticides | 4(4) | 7(7) | 153(153) |
| Other parameters | 6(6) | 11(11) | 515(515) |
| TOC | 6(6) | 11(11) | 11(11) |
| Grain size | 6(6) | 11(11) | 21(21) |

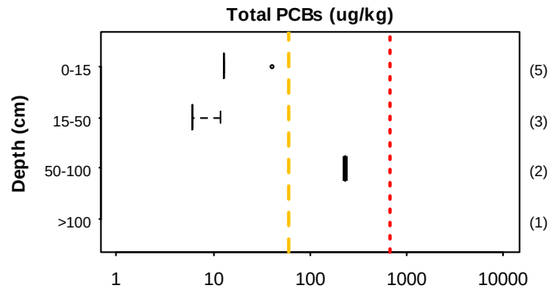
## Results Exceeding Thresholds (0-15 cm samples)

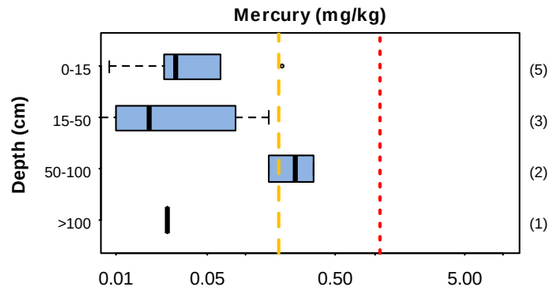


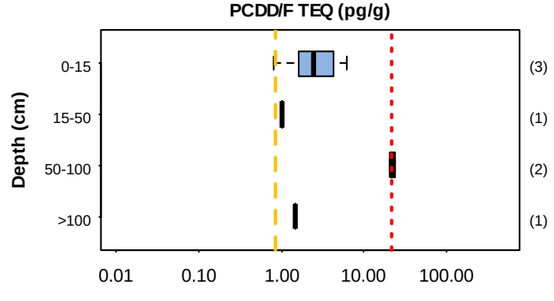




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

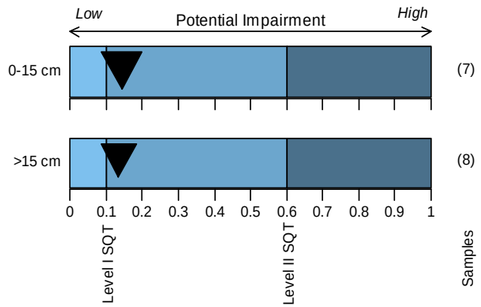
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 26(Cargill Elevator B2 / N. Pier Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

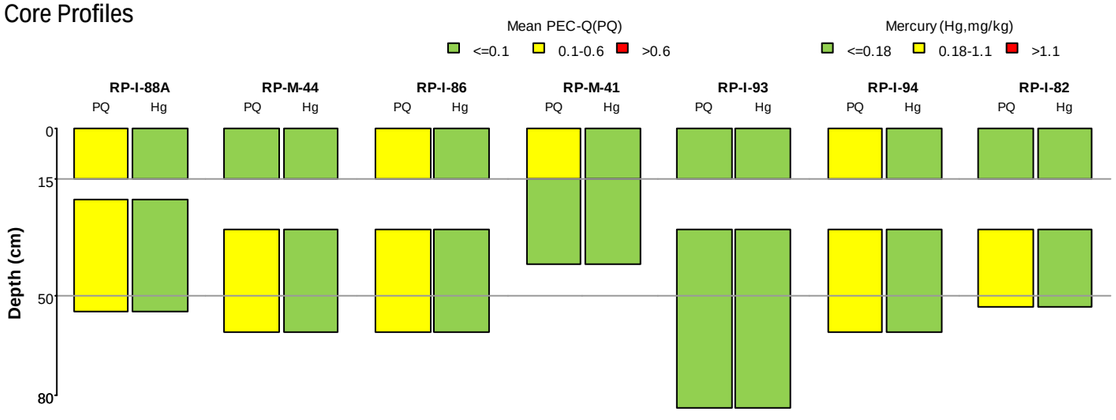
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (8 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



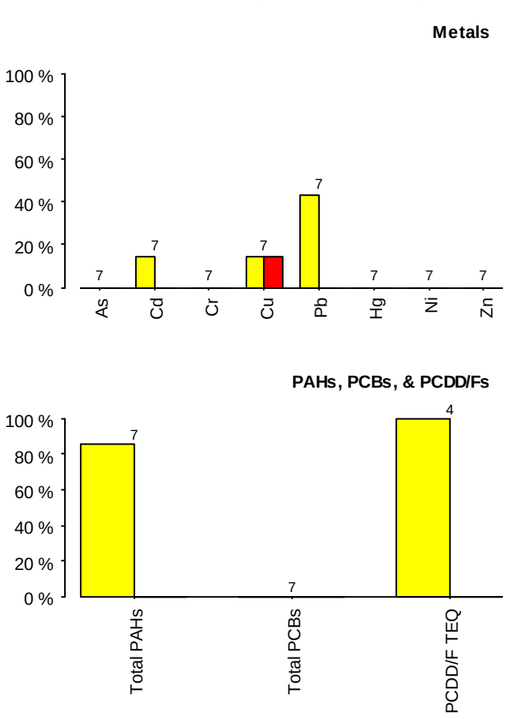

# Sediment Assessment Area Chemistry Characterization

## Data Summary

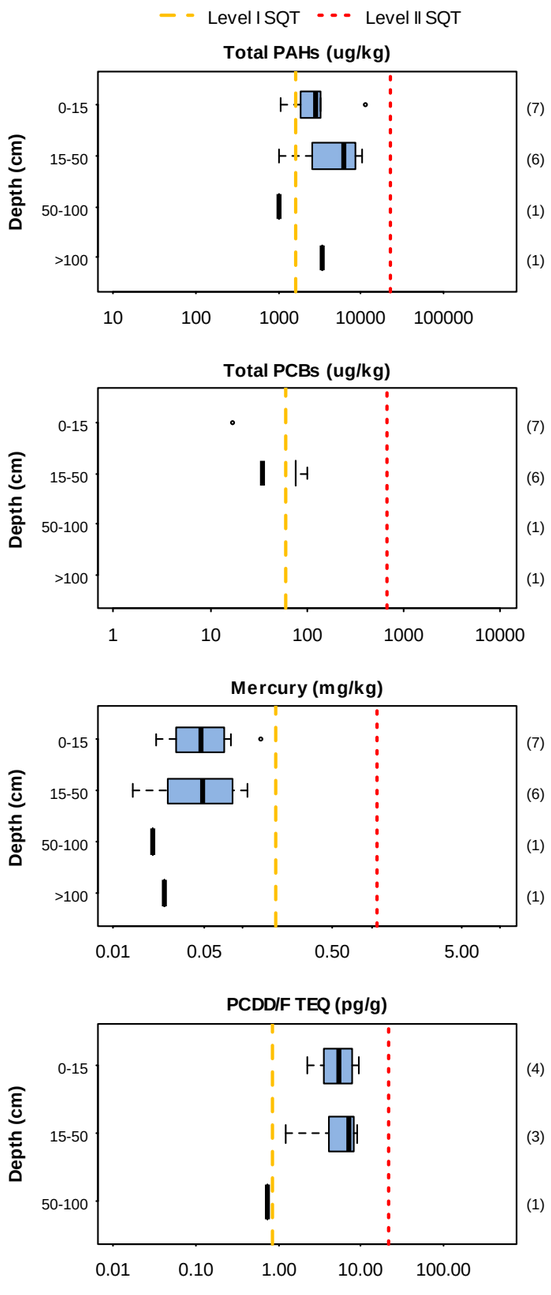
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 8(8) | 15(15) | 151(151) |
| Mercury | 8(8) | 15(15) | 15(15) |
| PAHs | 8(8) | 15(15) | 567(567) |
| PCBs | 8(8) | 15(15) | 105(105) |
| PCDD/Fs | 4(4) | 8(8) | 200(200) |
| Pesticides | 5(5) | 9(9) | 203(203) |
| Other parameters | 8(8) | 15(15) | 680(680) |
| TOC | 8(8) | 15(15) | 15(15) |
| Grain size | 7(7) | 14(14) | 27(27) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

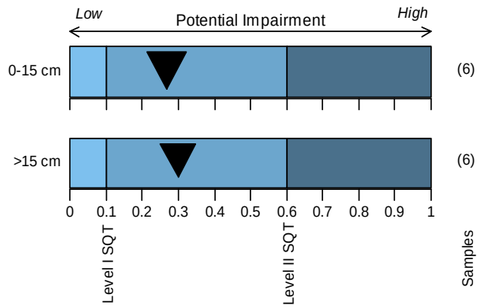
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 27(Northland Pier / AGP Slip)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

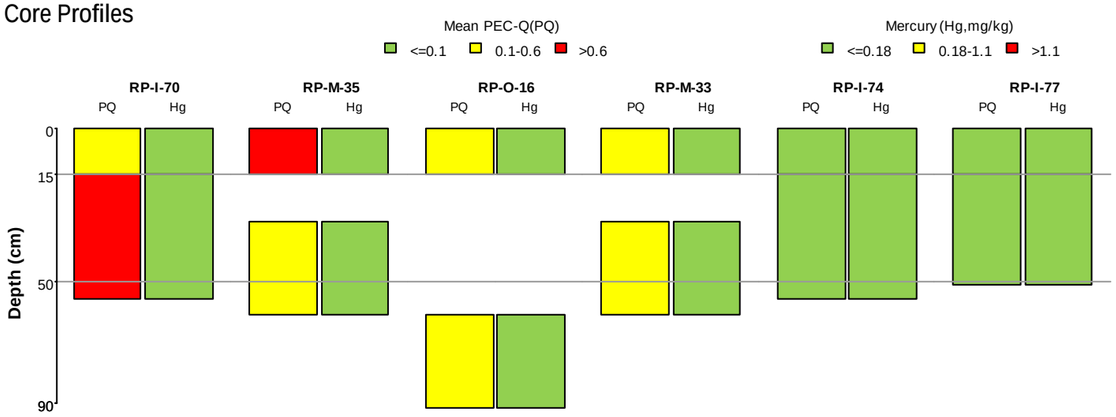
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (6 stations).*

*Other chemical studies:*
*Dakota Pier Samples, 1998 (3 stations).*

*Macro-invertebrate studies:*
*Dakota Pier Samples, 1998;Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



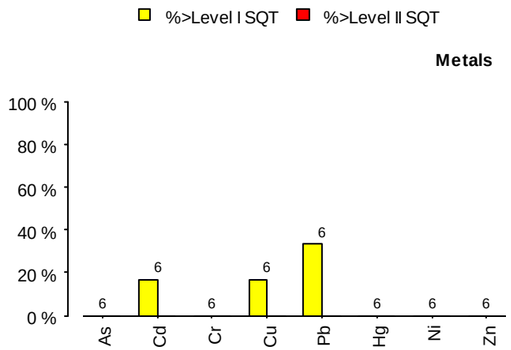

# Sediment Assessment Area Chemistry Characterization

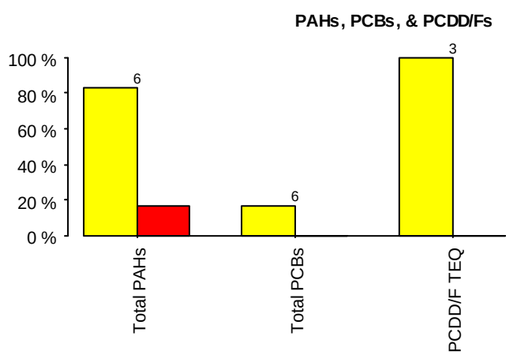
## Data Summary

**Available data in studies used for characterization (All available data)**

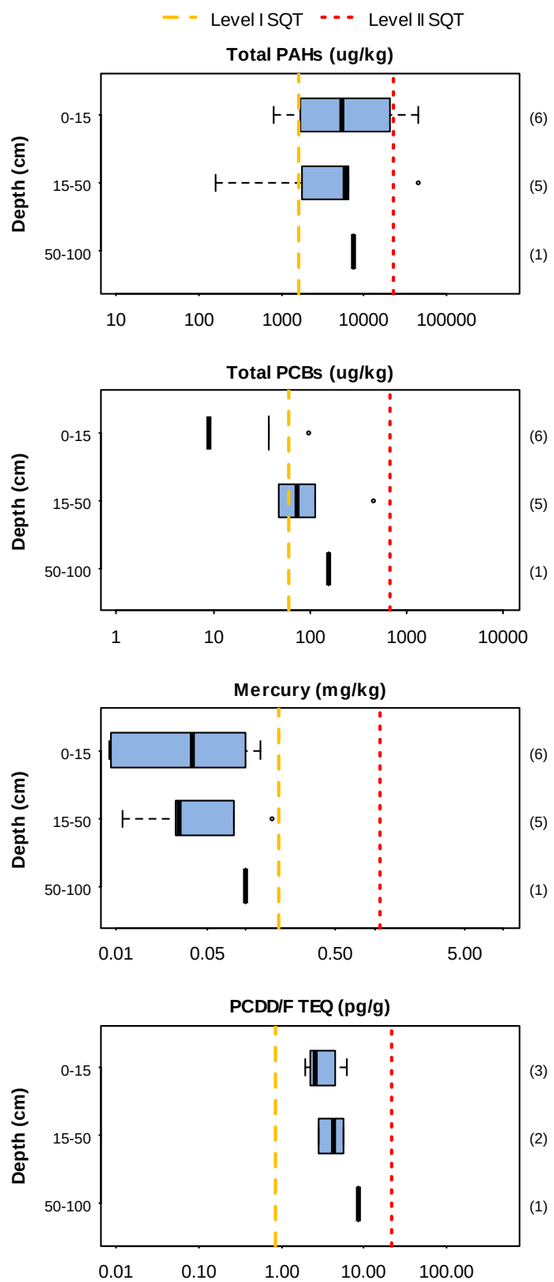
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(9) | 12(19) | 120(190) |
| Mercury | 6(9) | 12(19) | 12(19) |
| PAHs | 6(9) | 12(19) | 468(594) |
| PCBs | 6(6) | 12(12) | 84(84) |
| PCDD/Fs | 3(3) | 6(6) | 150(150) |
| Pesticides | 3(3) | 6(6) | 150(150) |
| Other parameters | 6(9) | 12(19) | 498(561) |
| TOC | 6(9) | 12(19) | 12(19) |
| Grain size | 6(9) | 12(19) | 24(31) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

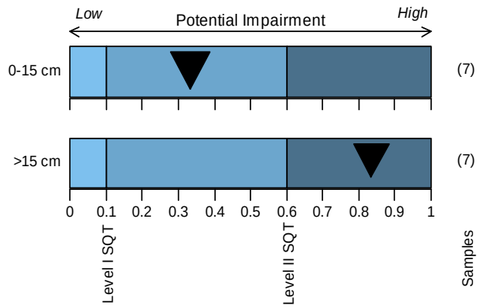
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 28(Azcon Corp / Duluth SPG. G. Slip C)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

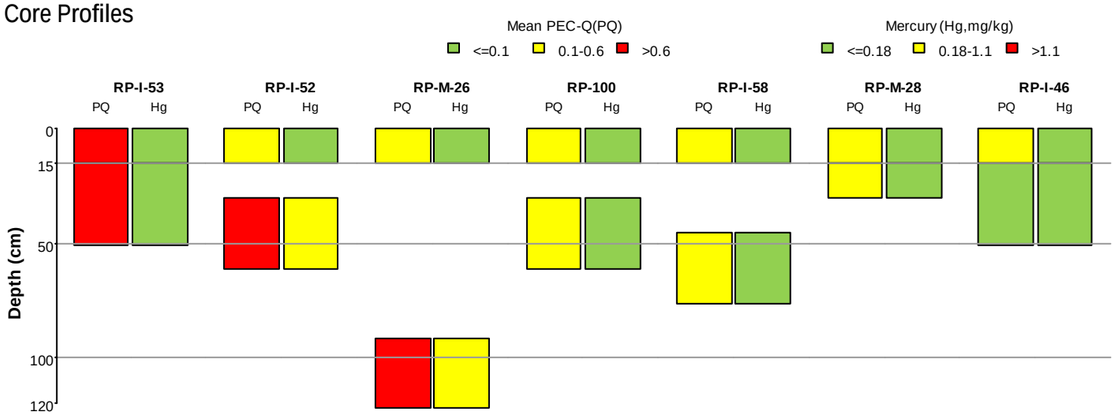
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (7 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



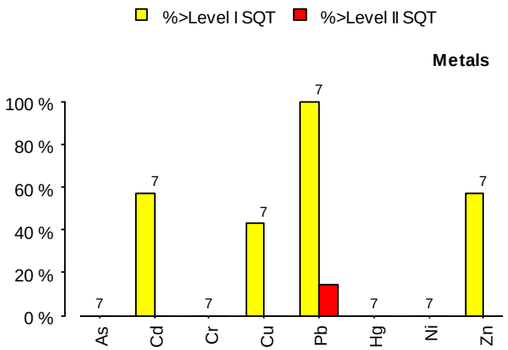

# Sediment Assessment Area Chemistry Characterization

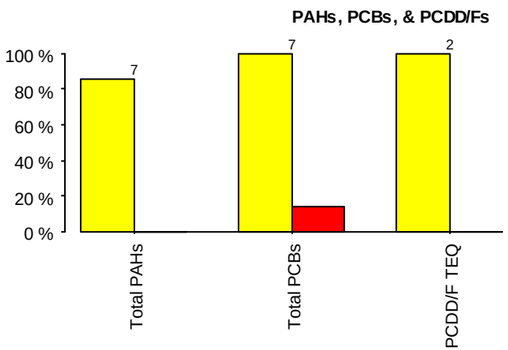
## Data Summary

**Available data in studies used for characterization (All available data)**

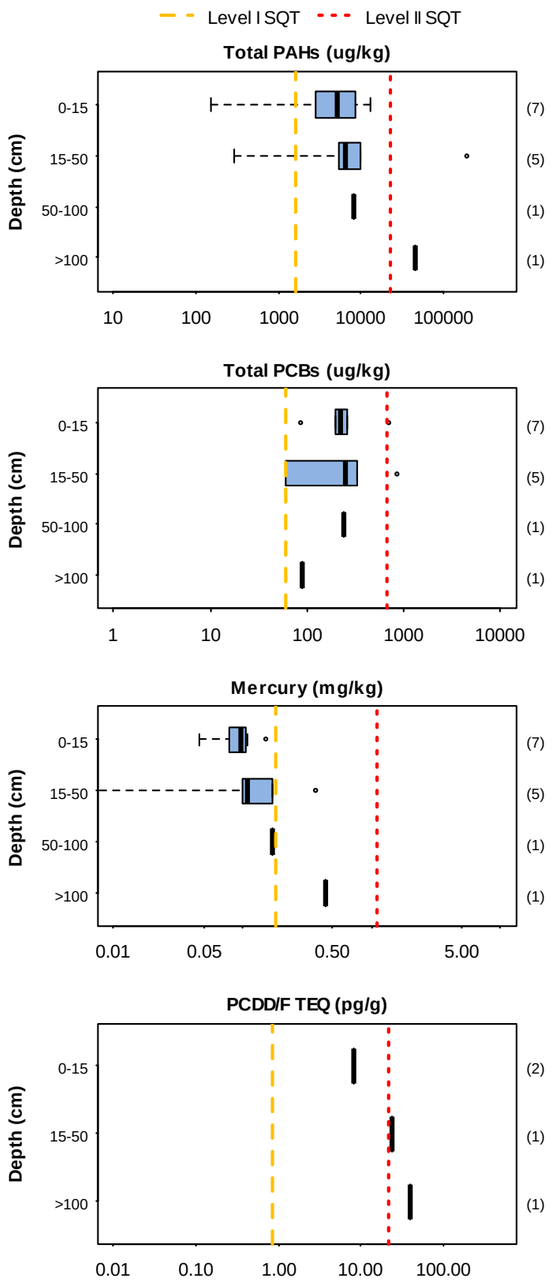
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 7(7) | 14(14) | 140(140) |
| Mercury | 7(7) | 14(14) | 14(14) |
| PAHs | 7(7) | 14(14) | 540(540) |
| PCBs | 7(7) | 14(14) | 98(98) |
| PCDD/Fs | 2(2) | 4(4) | 100(100) |
| Pesticides | 2(2) | 4(4) | 99(99) |
| Other parameters | 7(7) | 14(14) | 433(433) |
| TOC | 7(7) | 14(14) | 14(14) |
| Grain size | 7(7) | 14(14) | 28(28) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

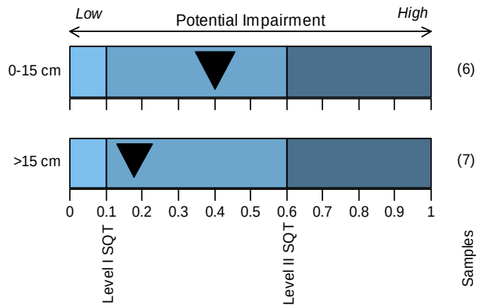
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 29(Duluth Seaway Port Author. G. Slip D)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

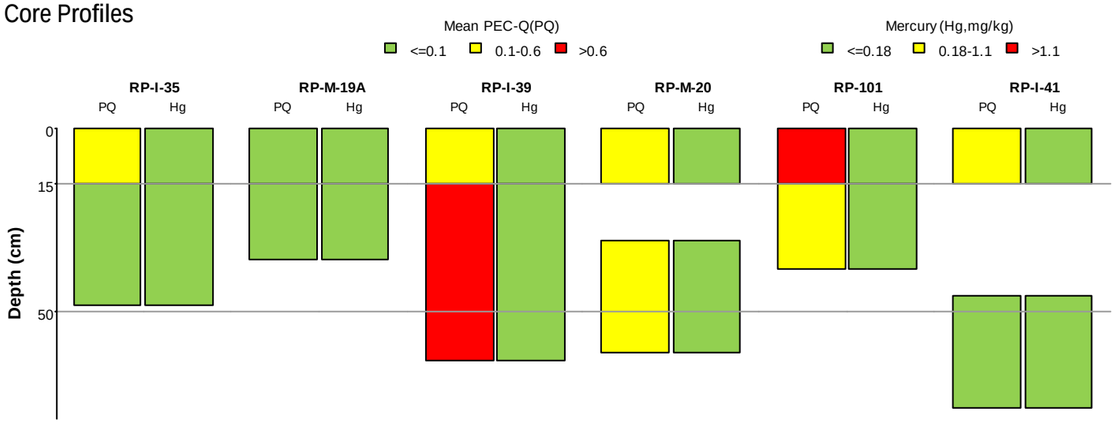
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (7 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



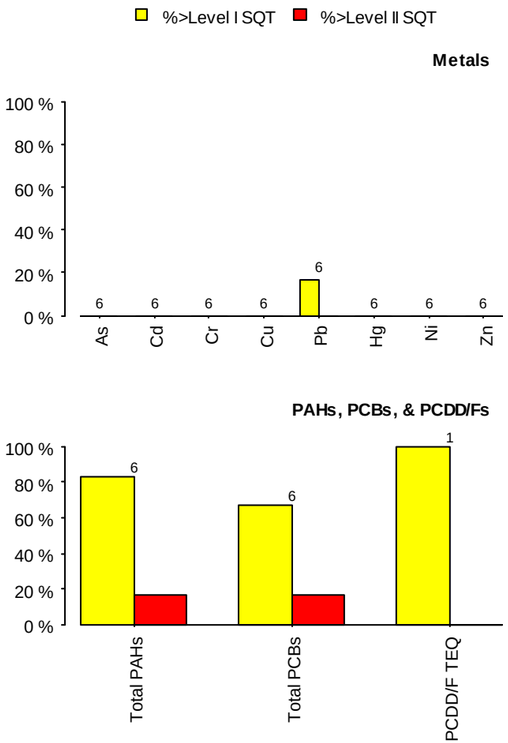

# Sediment Assessment Area Chemistry Characterization

## Data Summary

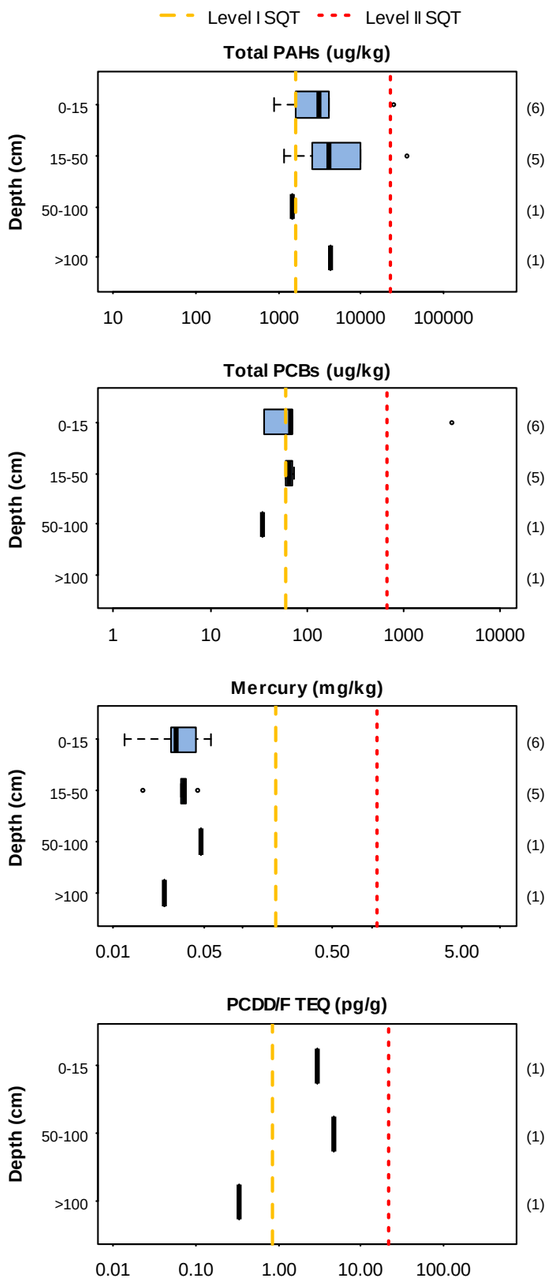
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 7(7) | 13(13) | 131(131) |
| Mercury | 7(7) | 13(13) | 13(13) |
| PAHs | 7(7) | 13(13) | 479(479) |
| PCBs | 7(7) | 13(13) | 91(91) |
| PCDD/Fs | 2(2) | 3(3) | 75(75) |
| Pesticides | 2(2) | 3(3) | 53(53) |
| Other parameters | 7(7) | 13(13) | 364(364) |
| TOC | 7(7) | 13(13) | 13(13) |
| Grain size | 7(7) | 13(13) | 25(25) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

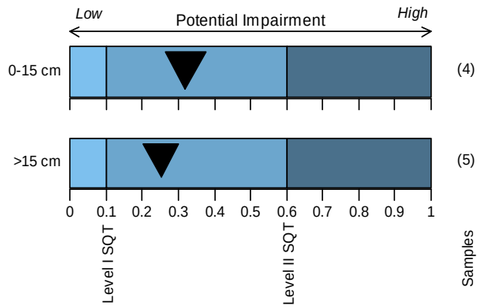
# Sediment Assessment Area Chemistry Characterization

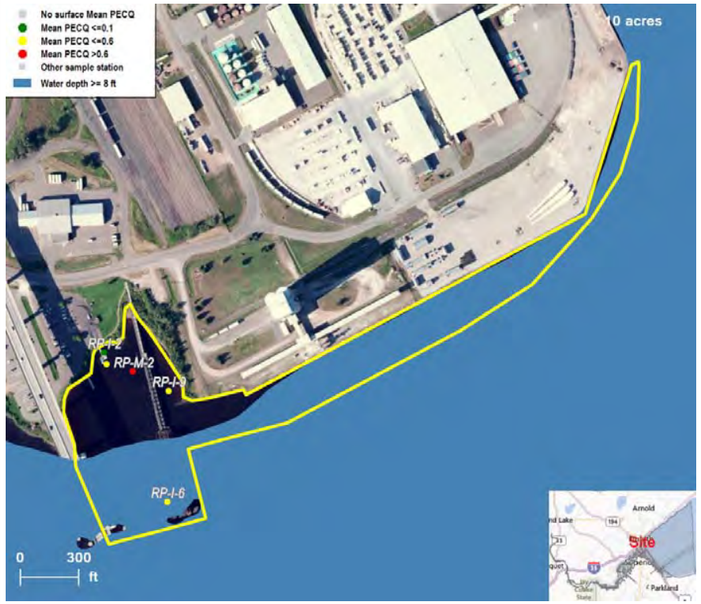
## Assessment Area # 30(Rices Point Off-Channel East)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

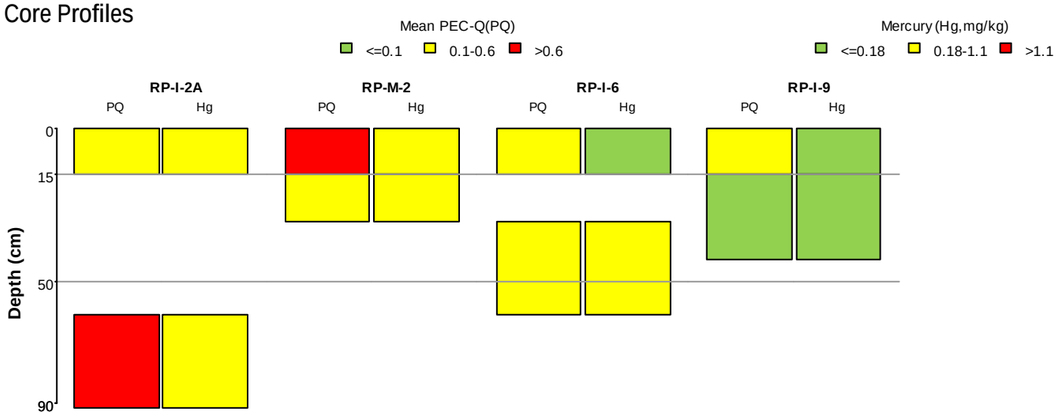
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (5 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles



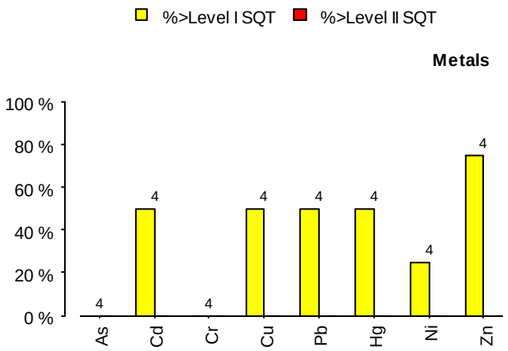

# Sediment Assessment Area Chemistry Characterization

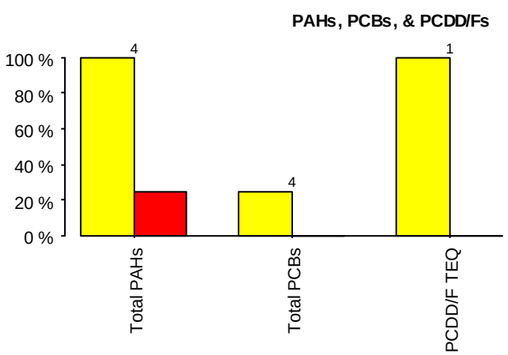
## Data Summary

**Available data in studies used for characterization (All available data)**

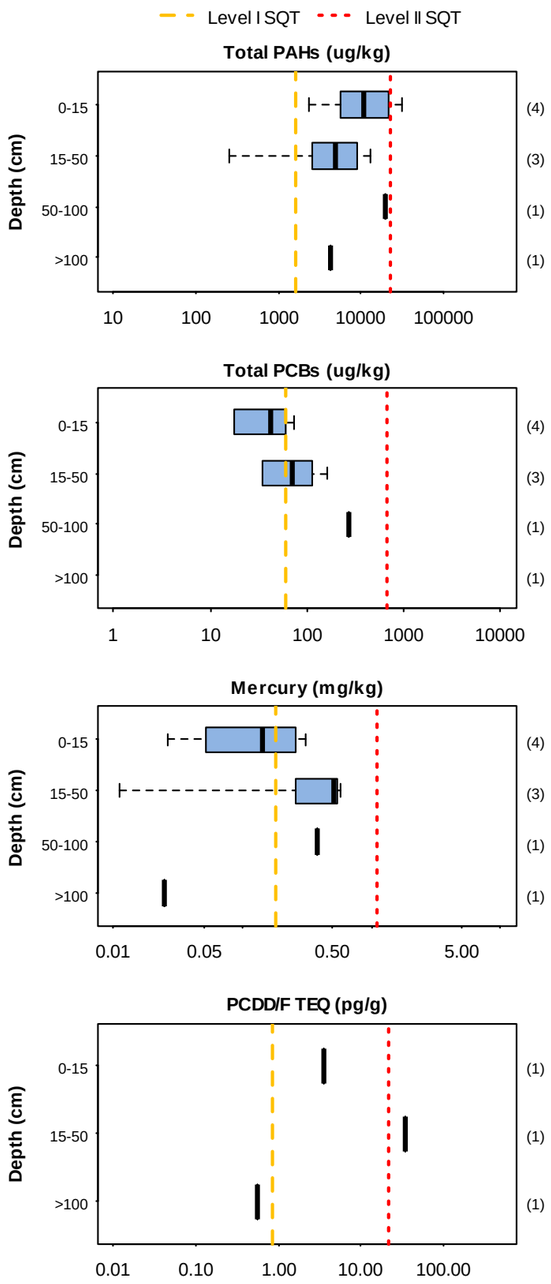
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 5(5) | 9(9) | 91(91) |
| Mercury | 5(5) | 9(9) | 9(9) |
| PAHs | 5(5) | 9(9) | 327(327) |
| PCBs | 5(5) | 9(9) | 63(63) |
| PCDD/Fs | 2(2) | 3(3) | 75(75) |
| Pesticides | 2(2) | 3(3) | 53(53) |
| Other parameters | 5(5) | 9(9) | 296(296) |
| TOC | 5(5) | 9(9) | 9(9) |
| Grain size | 5(5) | 9(9) | 17(17) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 31(Duluth Harbor Basin Off-Channel)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation


## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*Duluth-Superior Harbor Study, 1995 (1 stations).*

*Macro-invertebrate studies:*
*Duluth-Superior Harbor Study, 1995.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(8) |
| Mercury | 0(0) | 0(0) | 0(1) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(7) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(18) |
| Other parameters | 0(0) | 0(0) | 0(8) |
| TOC | 0(0) | 0(0) | 0(1) |
| Grain size | 0(0) | 0(0) | 0(8) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 32(Duluth Harbor Basin)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation


## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*R-EMAP Study, 1995 (7 stations);USACE DACW35-95-D-0002 DELIVERY ORDER 28 (5);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (5);Duluth-Superior Harbor Study, 1995 (4);Superior Bay - 21st Ave., 2008&10 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;USACE DACW35-95-D-0002 DELIVERY ORDER 28;USACE DACW35-93-D-0005 DELIVERY ORDER 29;Duluth-Superior Harbor Study, 1995;Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(158) |
| Mercury | 0(0) | 0(0) | 0(20) |
| PAHs | 0(0) | 0(0) | 0(218) |
| PCBs | 0(0) | 0(0) | 0(56) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(108) |
| Other parameters | 0(0) | 0(0) | 0(169) |
| TOC | 0(0) | 0(0) | 0(20) |
| Grain size | 0(0) | 0(0) | 0(141) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

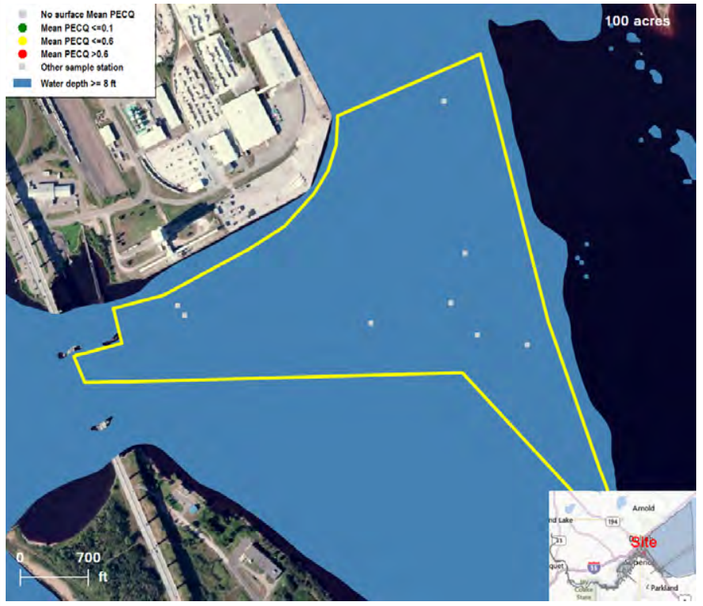
## Assessment Area # 33(East Gate Basin)

*Geographic zone: Superior Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations);R-EMAP Study, 1996 (1);SLRIDT Reference Sites SEG 2004 (6).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;SLRIDT Reference Sites SEG 2004.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(80) |
| Mercury | 0(0) | 0(0) | 0(9) |
| PAHs | 0(0) | 0(0) | 0(138) |
| PCBs | 0(0) | 0(0) | 0(56) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(63) |
| Other parameters | 0(0) | 0(0) | 0(95) |
| TOC | 0(0) | 0(0) | 0(9) |
| Grain size | 0(0) | 0(0) | 0(14) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

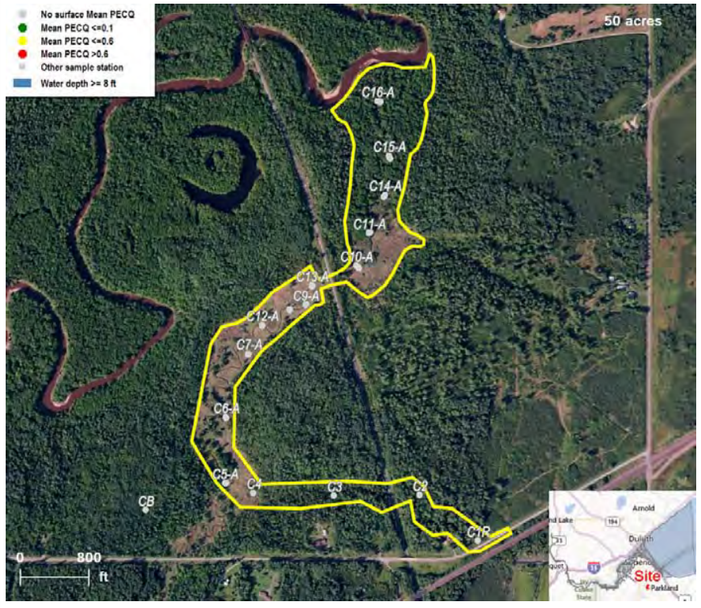
## Assessment Area # 34(Koppers/Crawford Creek)

*Geographic zone: Koppers/Crawford Creek*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*Koppers Industries Study, 1999 (41 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Koppers Industries Study, 1999.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

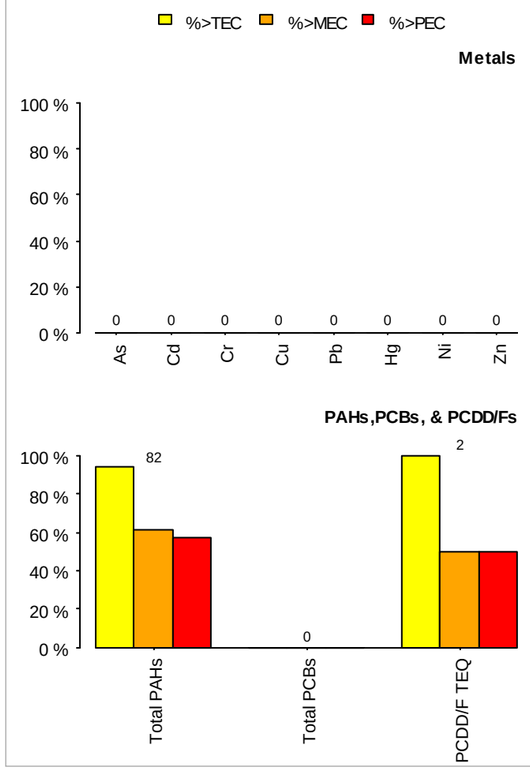
# Sediment Assessment Area Chemistry Characterization

## Data Summary

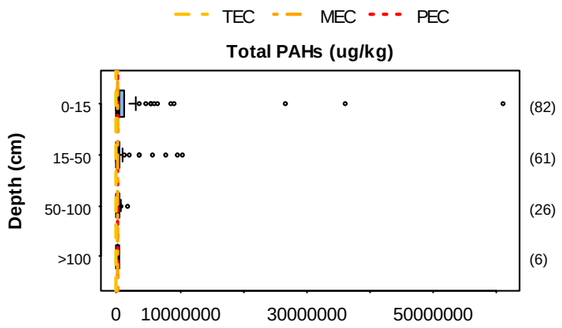
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 41(41) | 175(175) | 2800(2800) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 6(6) | 8(8) | 224(224) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 41(41) | 181(181) | 1947(1947) |
| TOC | 41(41) | 175(175) | 175(175) |
| Grain size | 8(8) | 10(10) | 50(50) |

## Results Exceeding Thresholds (0-15 cm samples)

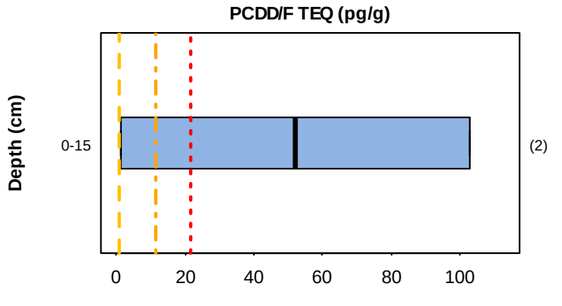



## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples

No samples analyzed for mercury




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

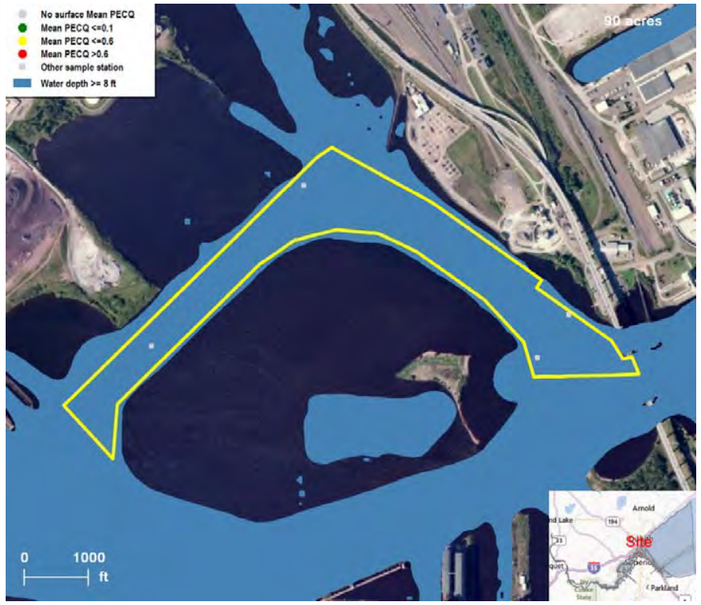
## Assessment Area # 35(North Channel - Interstate)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (2);Superior Bay - 21st Ave., 2008&10 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;USACE DACW35-93-D-0005 DELIVERY ORDER 29;Superior Bay - 21st Ave., 2008&10;21st Ave Macroinvertebrate Survey, 2011.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(47) |
| Mercury | 0(0) | 0(0) | 0(5) |
| PAHs | 0(0) | 0(0) | 0(112) |
| PCBs | 0(0) | 0(0) | 0(14) |
| PCDD/Fs | 0(0) | 0(0) | 0(50) |
| Pesticides | 0(0) | 0(0) | 0(50) |
| Other parameters | 0(0) | 0(0) | 0(159) |
| TOC | 0(0) | 0(0) | 0(5) |
| Grain size | 0(0) | 0(0) | 0(27) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

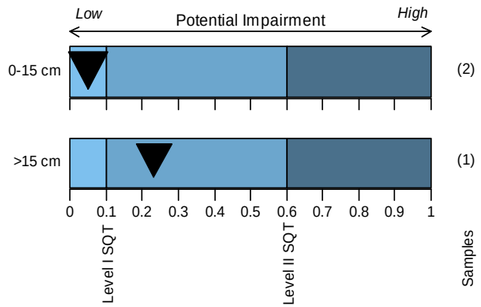
# Sediment Assessment Area Chemistry Characterization

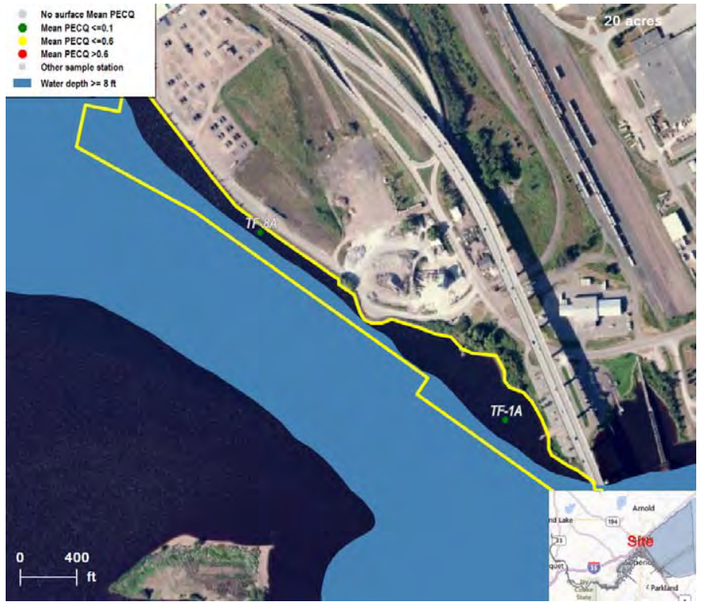
## Assessment Area # 36(Rices Point Off-Channel West)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

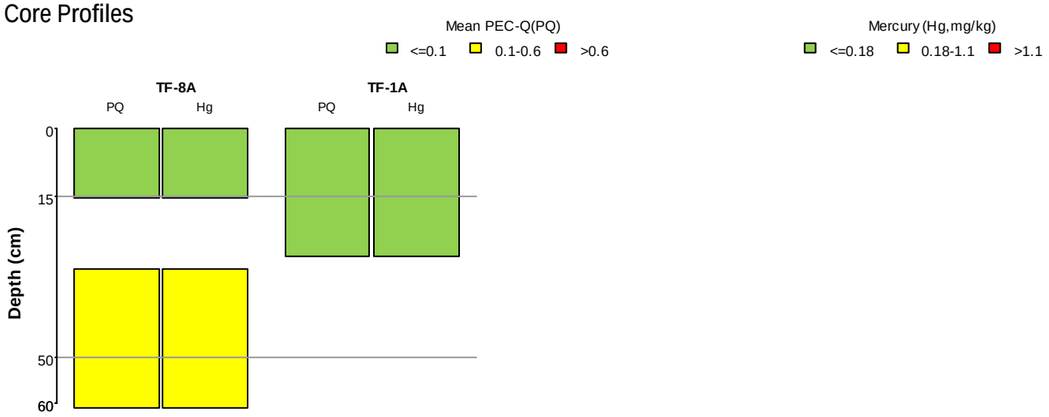
*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (2 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10;21st Ave Macroinvertebrate Survey, 2011.*

*Fish tissue studies:*

## Core Profiles



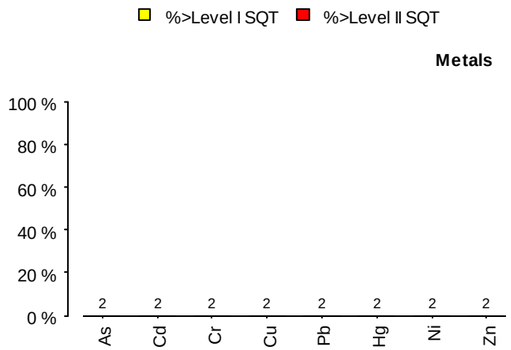

# Sediment Assessment Area Chemistry Characterization

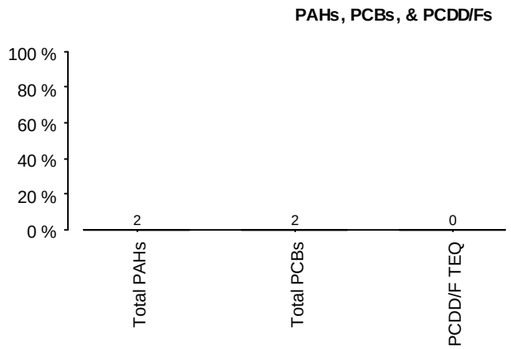
## Data Summary

**Available data in studies used for characterization (All available data)**

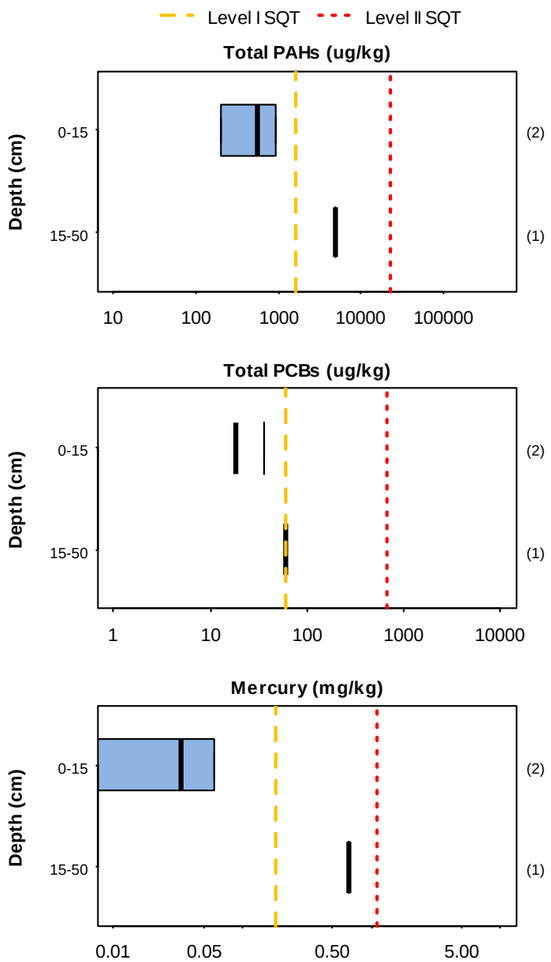
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 3(3) | 30(30) |
| Mercury | 2(2) | 3(3) | 3(3) |
| PAHs | 2(2) | 3(3) | 114(114) |
| PCBs | 2(2) | 3(3) | 21(21) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 2(2) | 3(3) | 52(52) |
| TOC | 2(2) | 3(3) | 3(3) |
| Grain size | 2(2) | 3(3) | 6(6) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

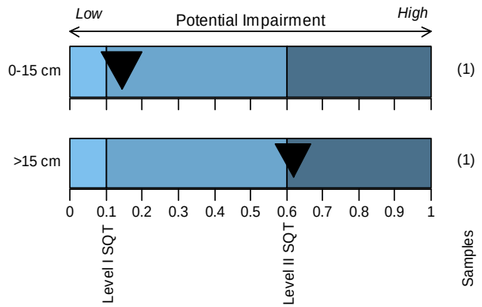
# Sediment Assessment Area Chemistry Characterization

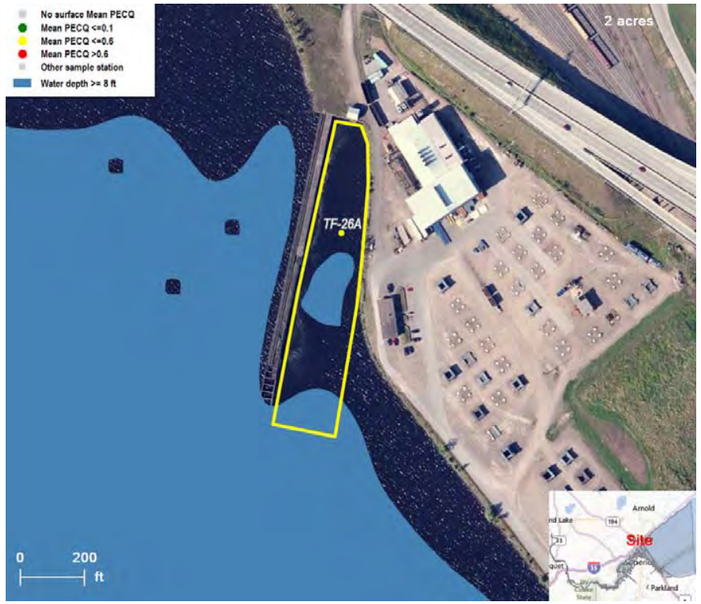
## Assessment Area # 37(Slip near 21st Ave W)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*Superior Bay - 21st Ave., 2008&10 (1 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Superior Bay - 21st Ave., 2008&10.*

*Fish tissue studies:*

## Core Profiles

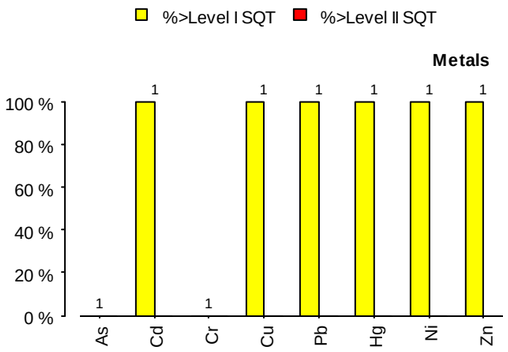

# Sediment Assessment Area Chemistry Characterization

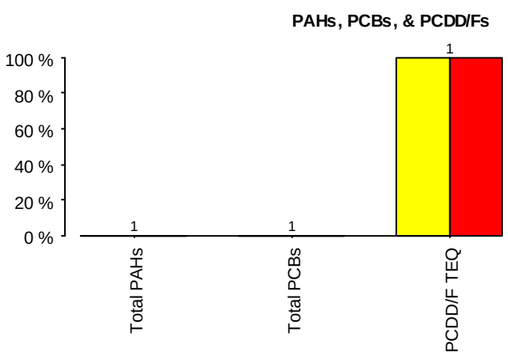
## Data Summary

**Available data in studies used for characterization (All available data)**

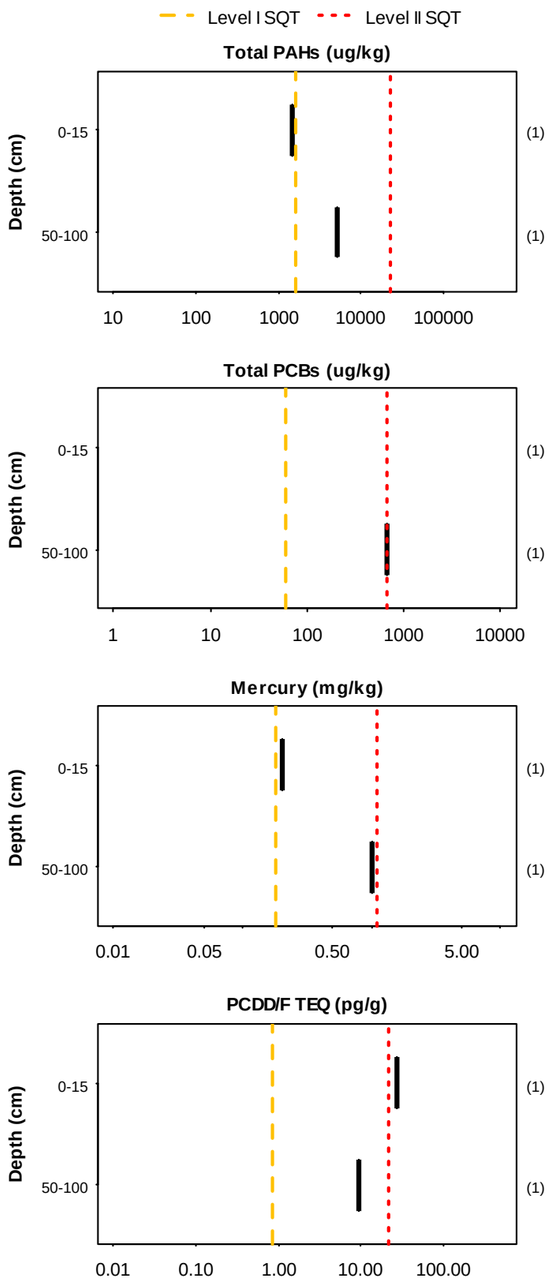
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 1(1) | 2(2) | 20(20) |
| Mercury | 1(1) | 2(2) | 2(2) |
| PAHs | 1(1) | 2(2) | 80(80) |
| PCBs | 1(1) | 2(2) | 14(14) |
| PCDD/Fs | 1(1) | 2(2) | 50(50) |
| Pesticides | 1(1) | 2(2) | 50(50) |
| Other parameters | 1(1) | 2(2) | 132(132) |
| TOC | 1(1) | 2(2) | 2(2) |
| Grain size | 1(1) | 2(2) | 4(4) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

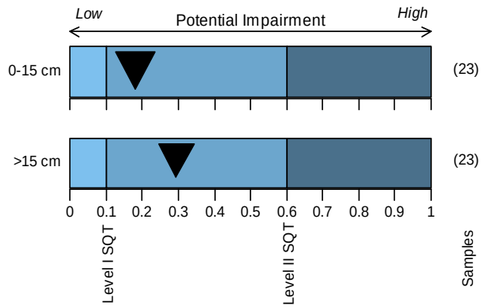
# Sediment Assessment Area Chemistry Characterization

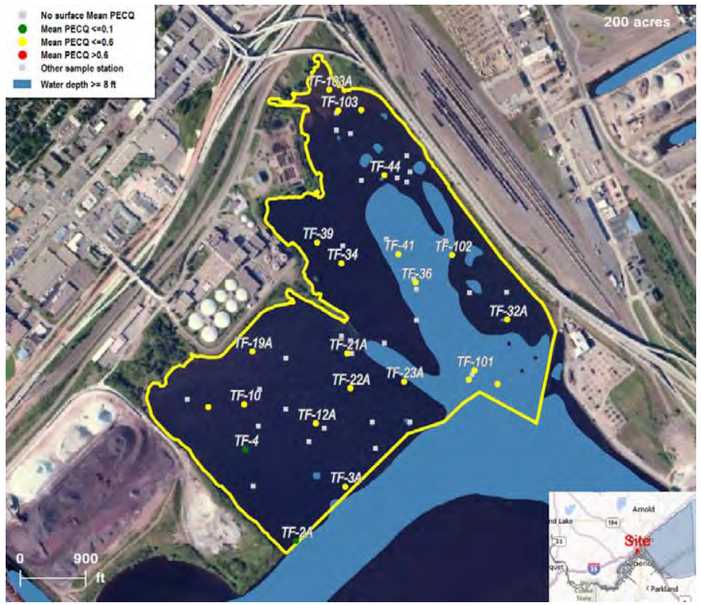
## Assessment Area # 38(21st Avenue)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

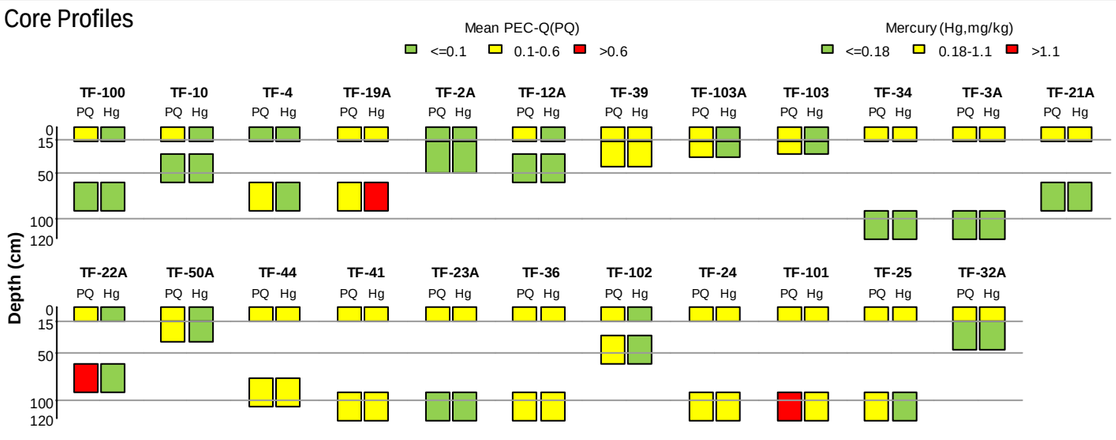
*Chemical studies used in the characterization: Superior Bay - 21st Ave., 2008&10 (23 stations).*

*Other chemical studies: R-EMAP Study, 1995 (3 stations);Hotspot Study, 1994 (19);R-EMAP Study, 1996 (2);Toxaphene Study, 1996 (8);PBDE Study, 2001 (1);Duluth-Superior Harbor Study, 1993 (6);USACE DACW35-91-D-0001 DELIVERY ORDER 40 (3).*

*Macro-invertebrate studies: R-EMAP Study, 1995;Hotspot Study, 1994;R-EMAP Study, 1996;Toxaphene Study, 1996;PBDE Study, 2001;Duluth-Superior Harbor Study, 1993;USACE DACW35-91-D-0001 DELIVERY ORDER 40;Superior Bay - 21st Ave., 2008&10;21st Ave Macroinvertebrate Survey, 2011.*

*Fish tissue studies: Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



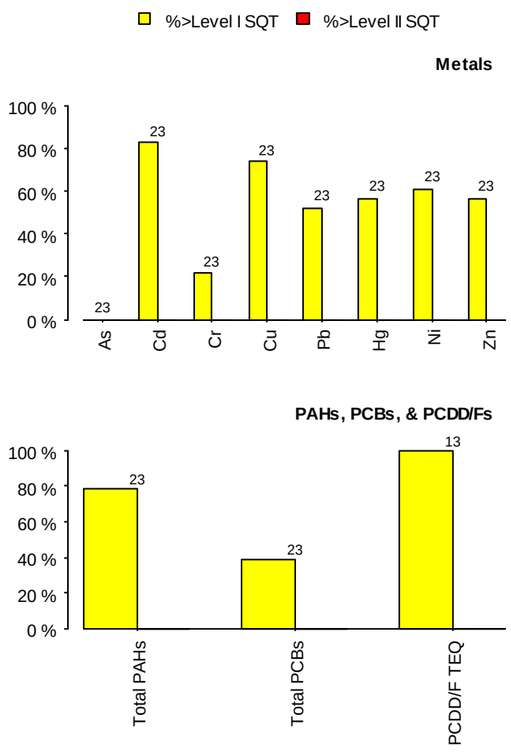

# Sediment Assessment Area Chemistry Characterization

## Data Summary

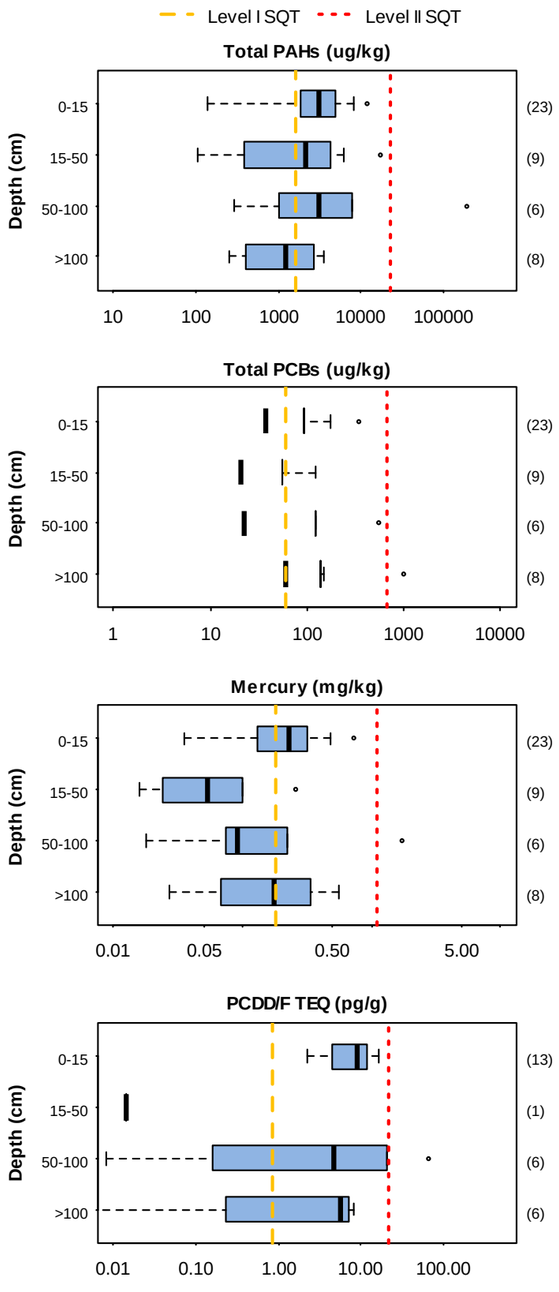
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 23(31) | 46(54) | 460(518) |
| Mercury | 23(56) | 46(152) | 46(152) |
| PAHs | 23(49) | 46(91) | 1674(2407) |
| PCBs | 23(45) | 46(124) | 322(5692) |
| PCDD/Fs | 13(32) | 26(59) | 650(716) |
| Pesticides | 13(24) | 26(37) | 654(748) |
| Other parameters | 23(57) | 46(152) | 2188(3074) |
| TOC | 23(57) | 46(153) | 46(153) |
| Grain size | 23(50) | 46(130) | 86(820) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

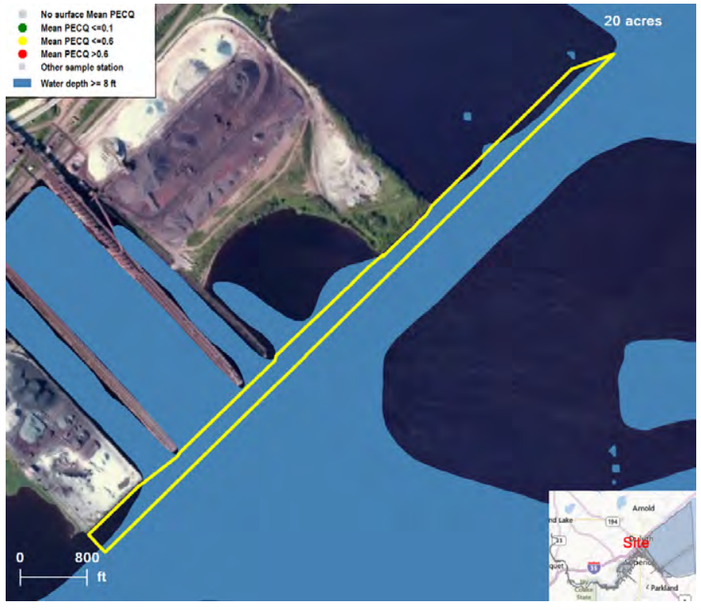
## Assessment Area # 39(Interstate Island Off-Channel)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

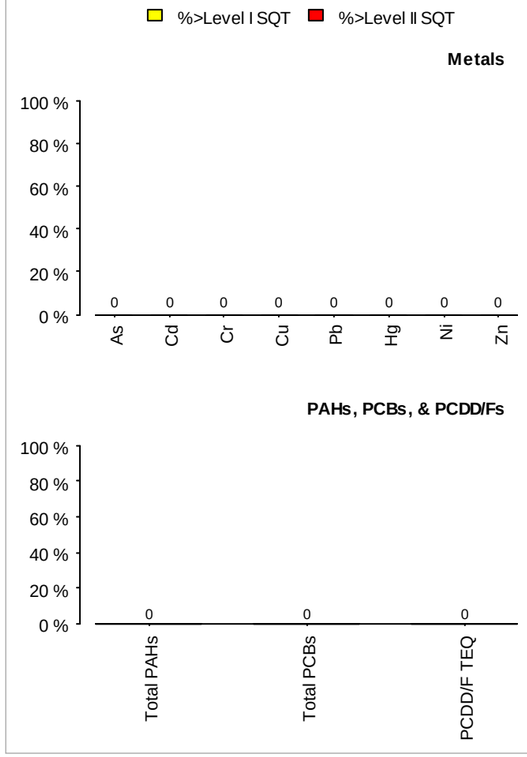
# Sediment Assessment Area Chemistry Characterization

## Data Summary

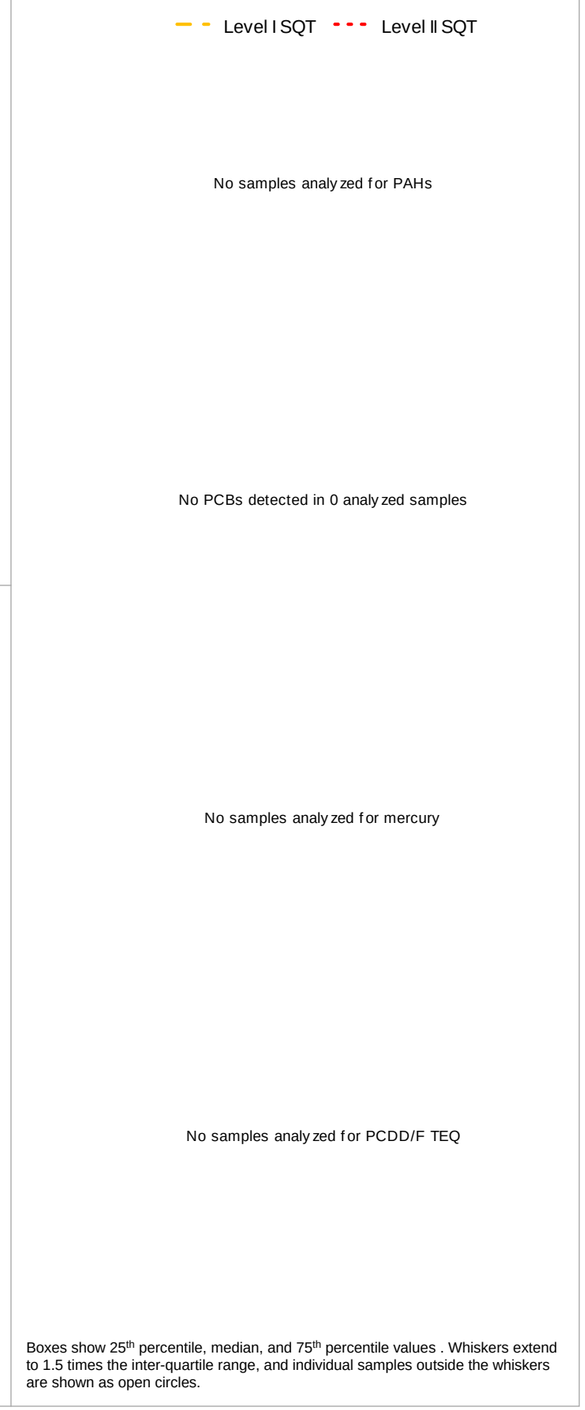
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

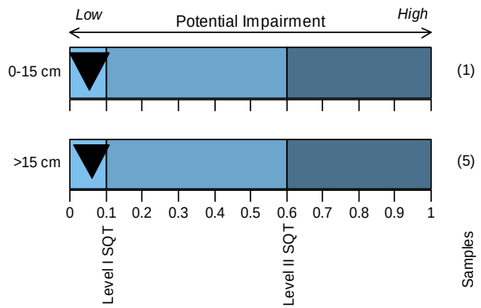
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 40(Bay NE of Canadian National)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

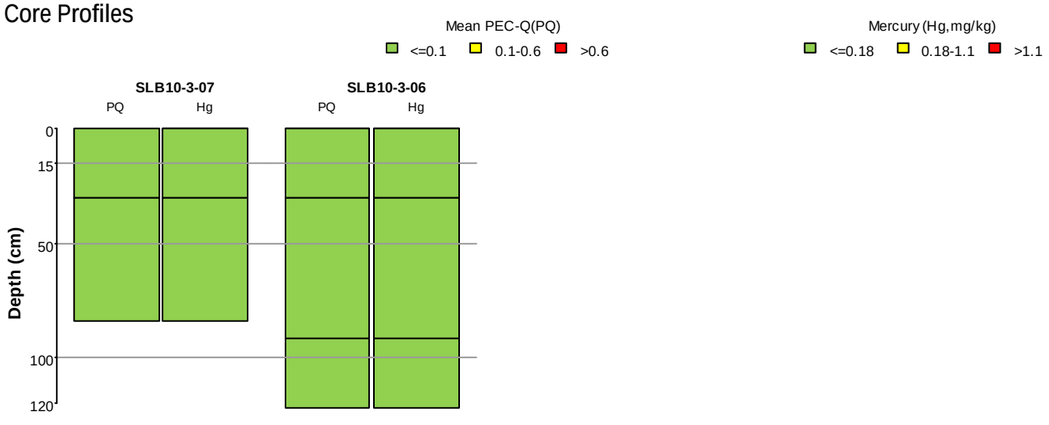
*Chemical studies used in the characterization: St. Louis Bay 40th Ave., 2010 (2 stations).*

*Other chemical studies: Hotspot Study, 1994 (4 stations);Duluth-Superior Harbor Study, 1993 (1);USACE DACW35-91-D-0001 DELIVERY ORDER 40 (2).*

*Macro-invertebrate studies: Hotspot Study, 1994;Duluth-Superior Harbor Study, 1993;USACE DACW35-91-D-0001 DELIVERY ORDER 40;St. Louis Bay 40th Ave., 2010.*

*Fish tissue studies:*

## Core Profiles



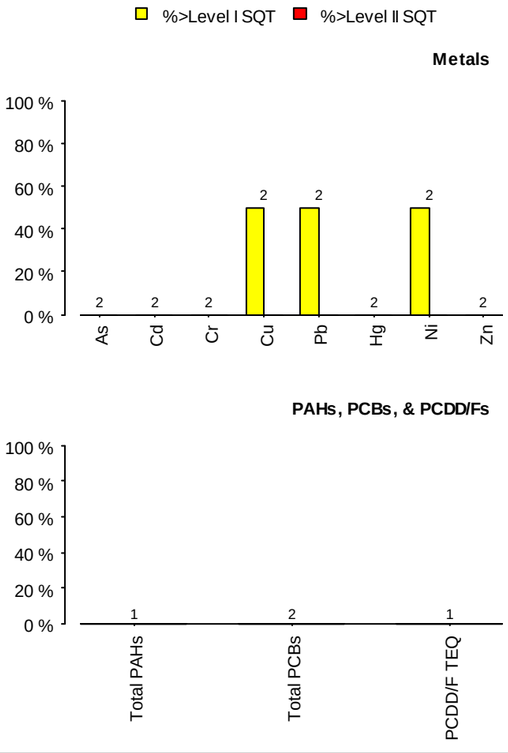

# Sediment Assessment Area Chemistry Characterization

## Data Summary

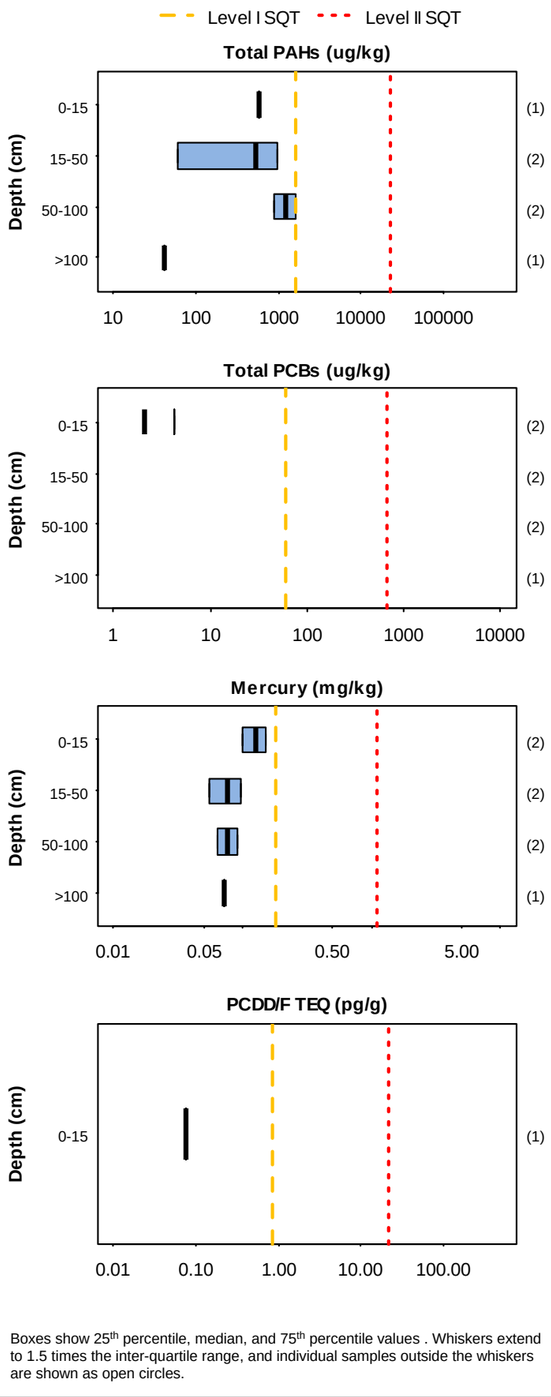
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(8) | 7(13) | 154(196) |
| Mercury | 2(5) | 7(13) | 7(13) |
| PAHs | 2(3) | 6(7) | 102(120) |
| PCBs | 2(4) | 7(9) | 272(286) |
| PCDD/Fs | 1(1) | 1(1) | 25(25) |
| Pesticides | 0(2) | 0(2) | 0(35) |
| Other parameters | 2(9) | 7(17) | 109(189) |
| TOC | 2(9) | 7(17) | 7(17) |
| Grain size | 2(8) | 6(12) | 42(88) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

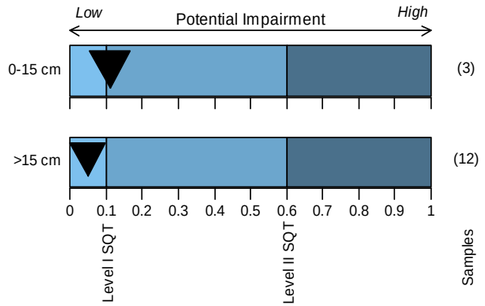
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 41(Interstate Island Flats)

*Geographic zone: St. Louis Bay*
*Date Generated : 7/2/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

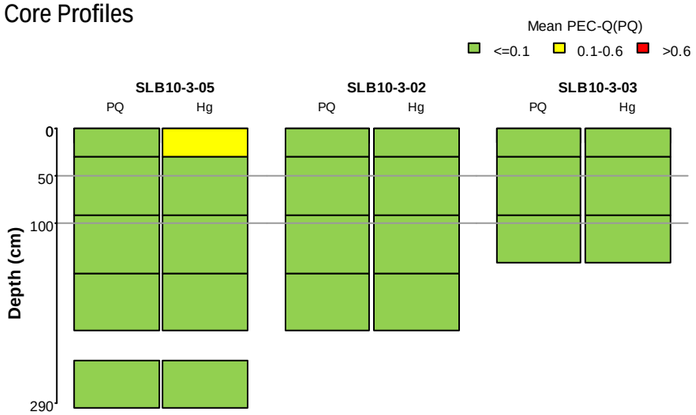
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (3 stations).*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations);R-EMAP Study, 1996 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;St. Louis Bay 40th Ave., 2010;21st Ave Macroinvertebrate Survey, 2011.*

*Fish tissue studies:*

## Core Profiles



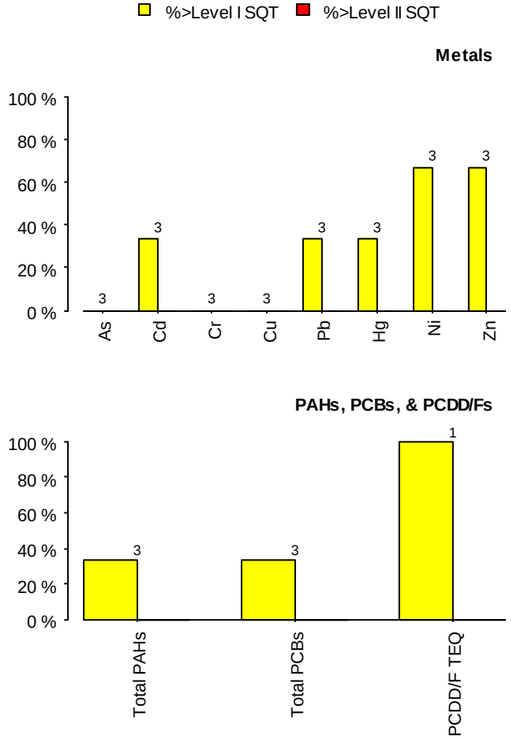

# Sediment Assessment Area Chemistry Characterization

## Data Summary

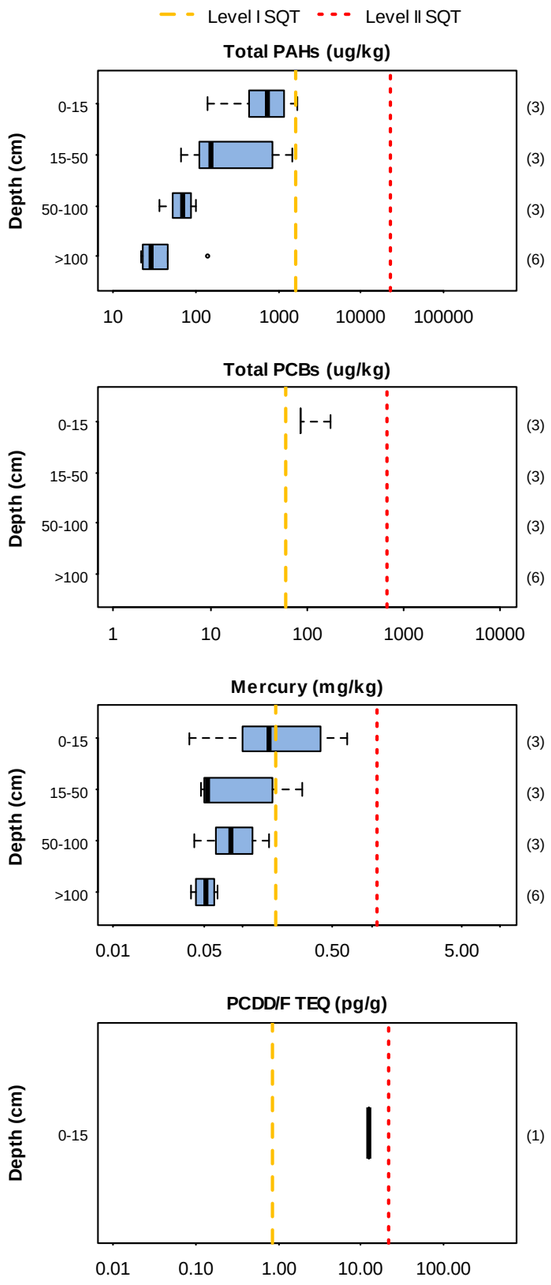
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(5) | 15(17) | 330(340) |
| Mercury | 3(5) | 15(17) | 15(17) |
| PAHs | 3(5) | 15(17) | 277(313) |
| PCBs | 3(3) | 15(15) | 344(344) |
| PCDD/Fs | 1(1) | 1(1) | 25(25) |
| Pesticides | 1(1) | 1(1) | 21(21) |
| Other parameters | 3(5) | 15(17) | 248(268) |
| TOC | 3(5) | 15(17) | 15(17) |
| Grain size | 3(5) | 15(17) | 105(119) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

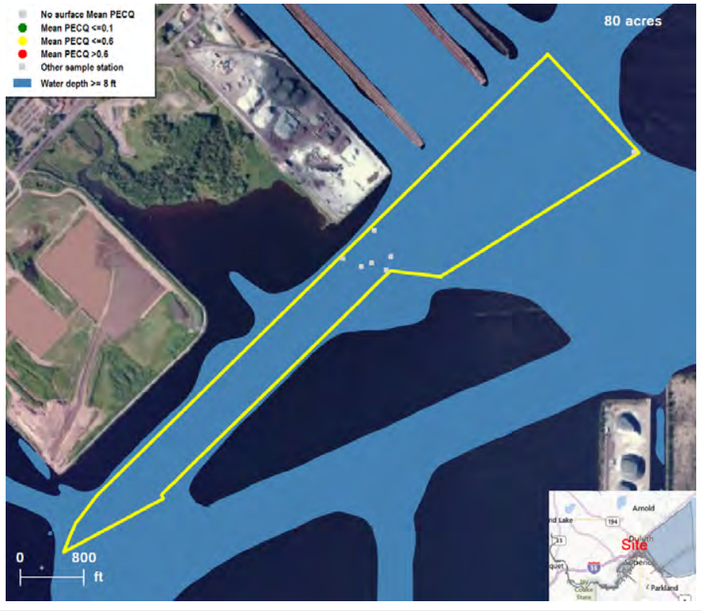
## Assessment Area # 42(North Channel - St. Louis Bay)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (2);SLRIDT Reference Sites SEG 2004 (4).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;USACE DACW35-93-D-0005 DELIVERY ORDER 29;SLRIDT Reference Sites SEG 2004.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(87) |
| Mercury | 0(0) | 0(0) | 0(8) |
| PAHs | 0(0) | 0(0) | 0(134) |
| PCBs | 0(0) | 0(0) | 0(40) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(45) |
| Other parameters | 0(0) | 0(0) | 0(95) |
| TOC | 0(0) | 0(0) | 0(8) |
| Grain size | 0(0) | 0(0) | 0(23) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

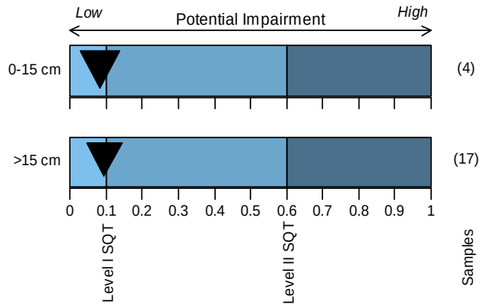
# Sediment Assessment Area Chemistry Characterization

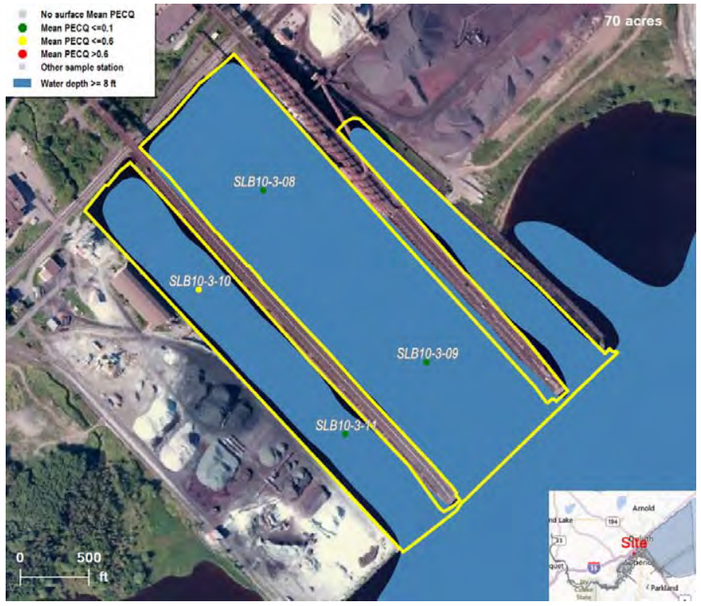
## Assessment Area # 43(DM&IR)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

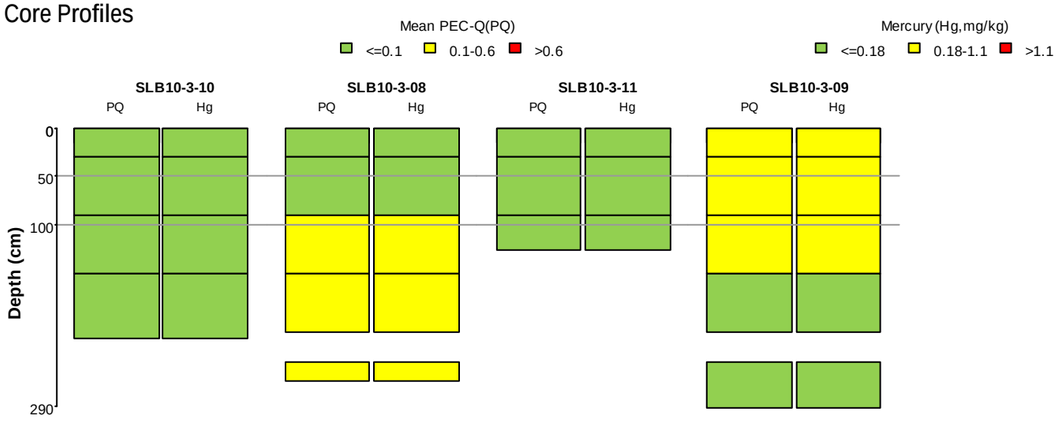
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (4 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;St. Louis Bay 40th Ave., 2010.*

*Fish tissue studies:*

## Core Profiles



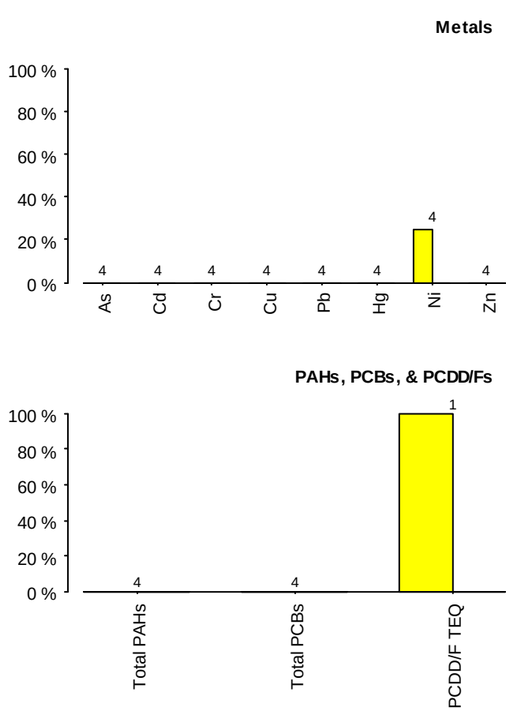

# Sediment Assessment Area Chemistry Characterization

## Data Summary

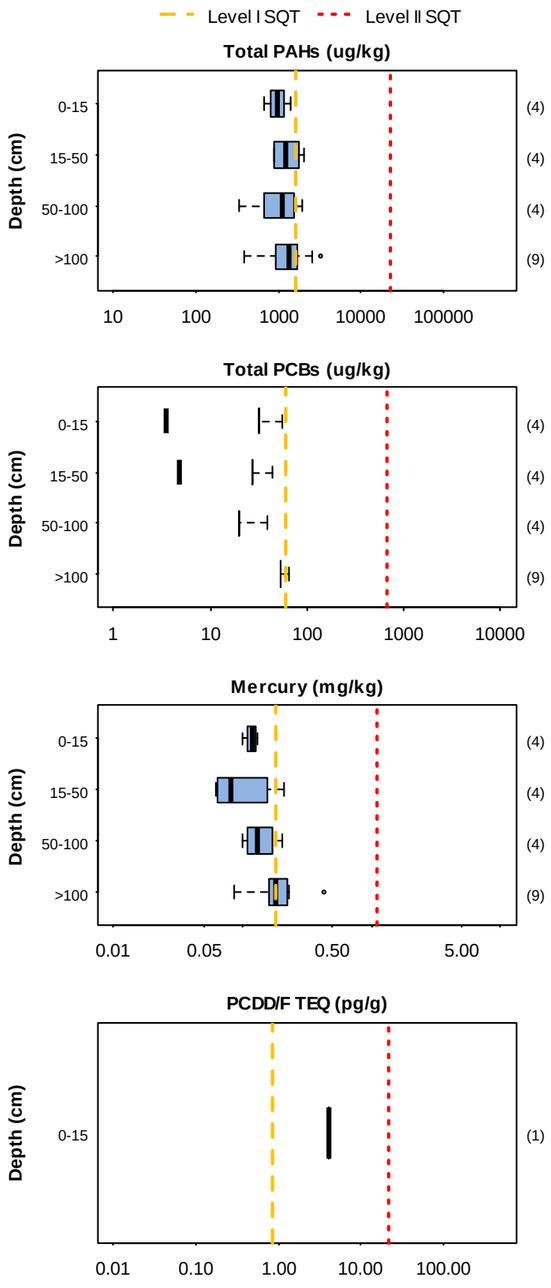
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(4) | 21(21) | 462(462) |
| Mercury | 4(4) | 21(21) | 21(21) |
| PAHs | 4(4) | 21(21) | 379(379) |
| PCBs | 4(4) | 21(21) | 398(398) |
| PCDD/Fs | 1(1) | 1(1) | 25(25) |
| Pesticides | 1(1) | 1(1) | 21(21) |
| Other parameters | 4(4) | 22(22) | 344(344) |
| TOC | 4(4) | 21(21) | 21(21) |
| Grain size | 4(4) | 17(17) | 119(119) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

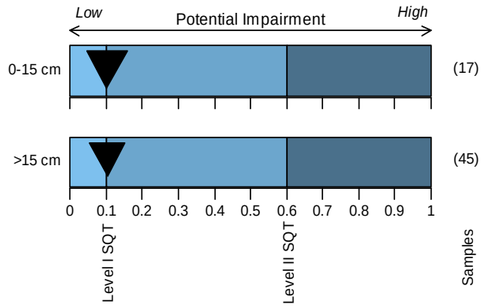
# Sediment Assessment Area Chemistry Characterization

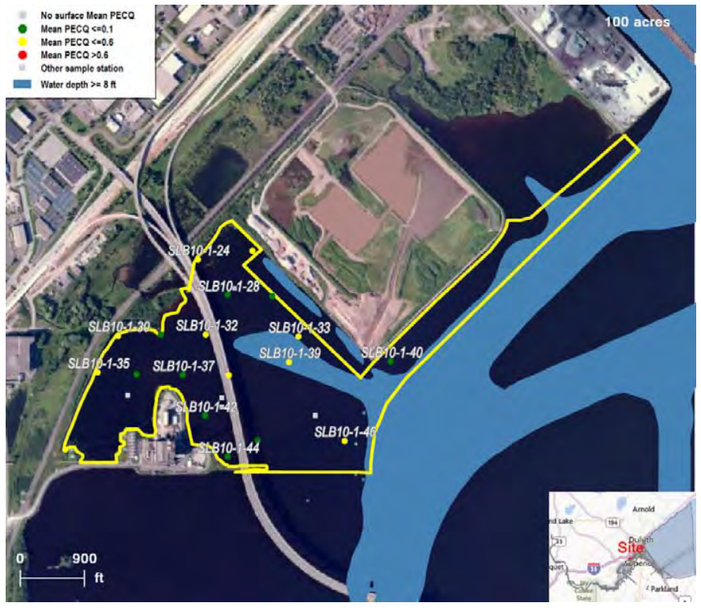
## Assessment Area # 44(Hibbard)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

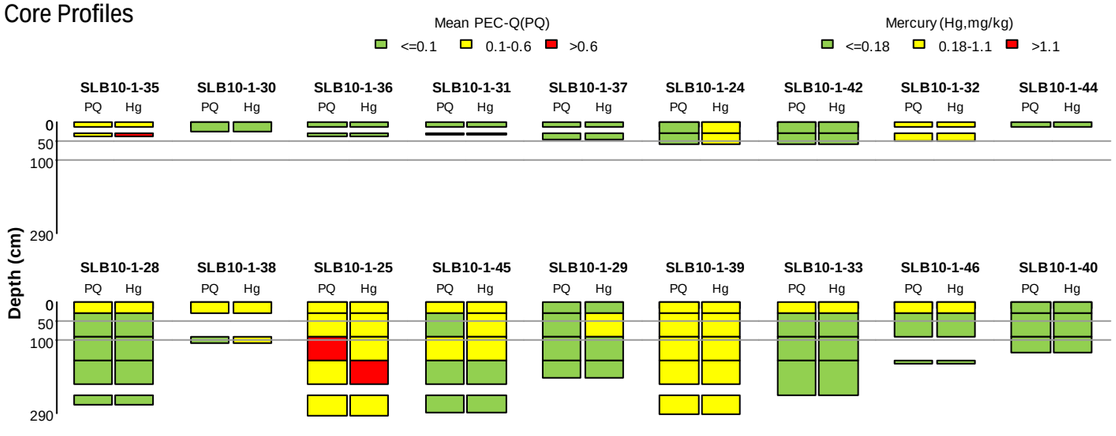
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (18 stations).*

*Other chemical studies:*
*Hotspot Study, 1994 (4 stations);Duluth-Superior Harbor Study, 1993 (1).*

*Macro-invertebrate studies:*
*Hotspot Study, 1994;Duluth-Superior Harbor Study, 1993;St. Louis Bay 40th Ave., 2010;40th Ave Macroinvertebrate Survey, 2010.*

*Fish tissue studies:*

## Core Profiles



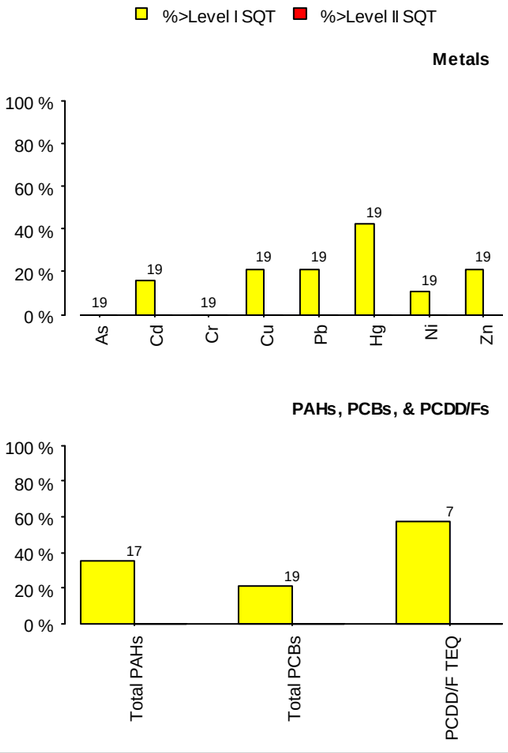

# Sediment Assessment Area Chemistry Characterization

## Data Summary

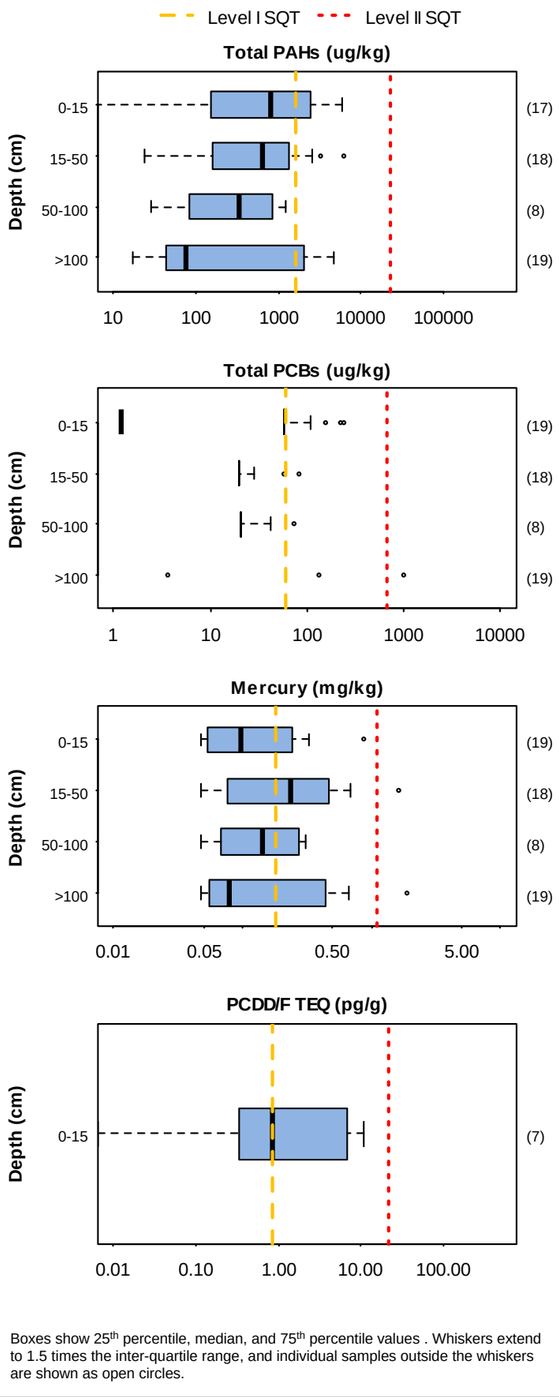
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 18(22) | 64(72) | 1408(1448) |
| Mercury | 18(23) | 64(76) | 64(76) |
| PAHs | 18(22) | 62(70) | 1164(1292) |
| PCBs | 18(18) | 64(64) | 2039(2039) |
| PCDD/Fs | 7(7) | 7(7) | 175(175) |
| Pesticides | 5(5) | 5(5) | 105(105) |
| Other parameters | 18(23) | 75(87) | 1045(1133) |
| TOC | 15(20) | 54(66) | 54(66) |
| Grain size | 18(22) | 61(68) | 427(490) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

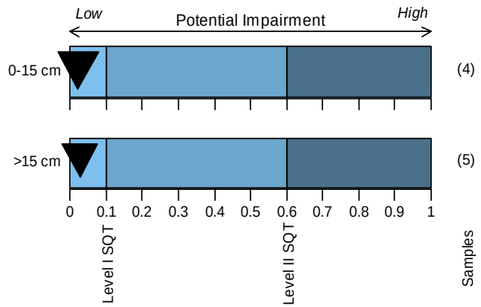
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 45(Bay NE Side of Erie Pier)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

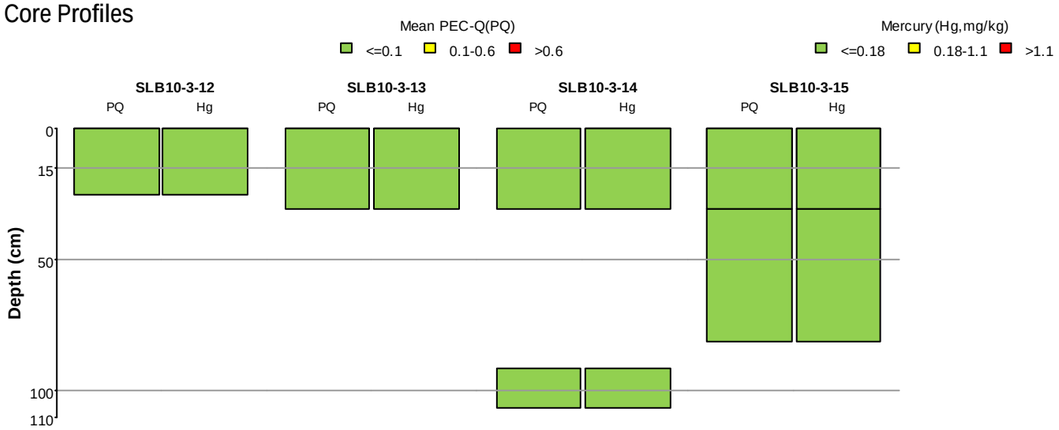
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (4 stations).*

*Other chemical studies:*
*Hotspot Study, 1994 (5 stations);Duluth-Superior Harbor Study, 1993 (1).*

*Macro-invertebrate studies:*
*Hotspot Study, 1994;Duluth-Superior Harbor Study, 1993;St. Louis Bay 40th Ave., 2010;40th Ave Macroinvertebrate Survey, 2010.*

*Fish tissue studies:*
*Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



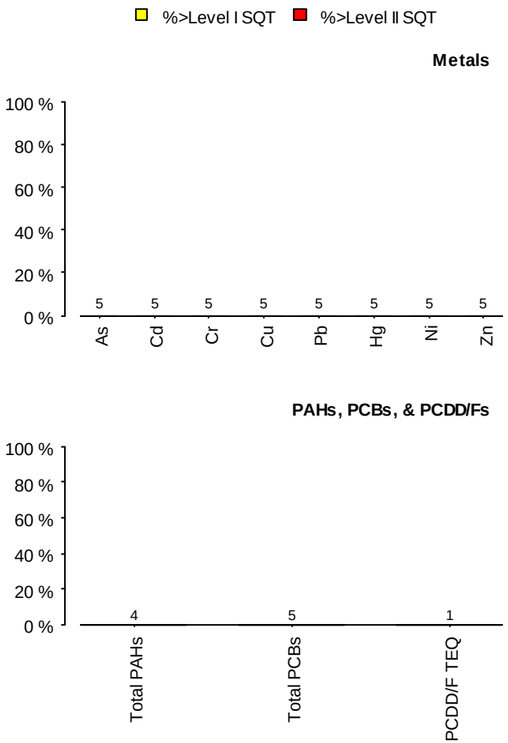

# Sediment Assessment Area Chemistry Characterization

## Data Summary

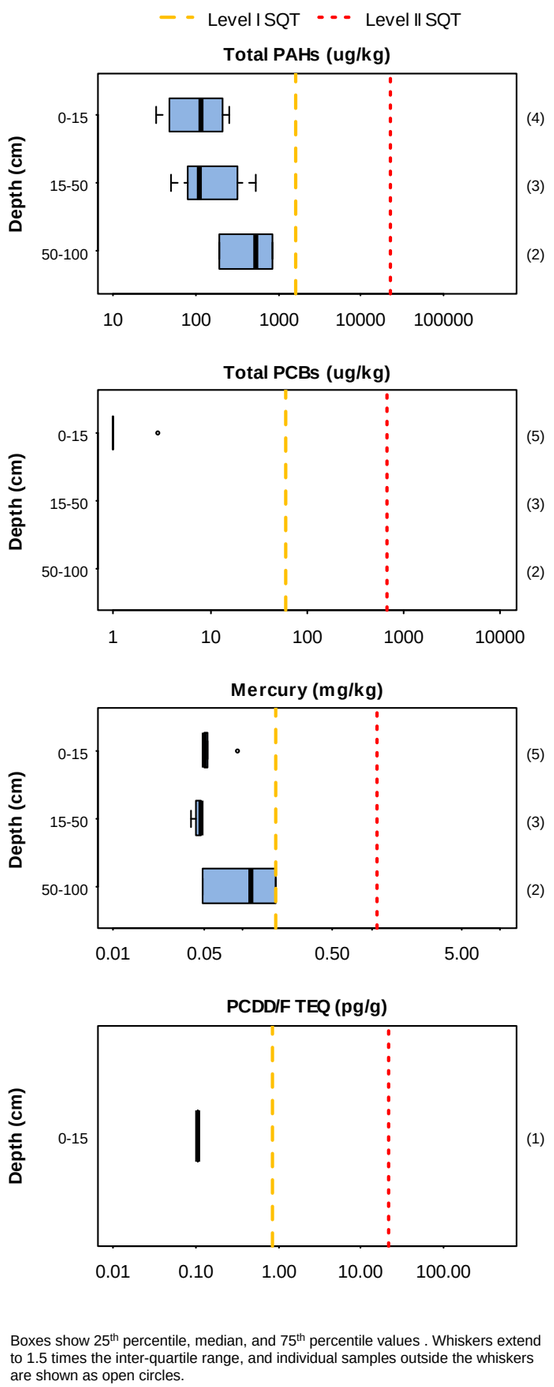
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(9) | 10(15) | 220(245) |
| Mercury | 4(5) | 10(14) | 10(14) |
| PAHs | 4(4) | 9(9) | 153(153) |
| PCBs | 4(4) | 10(10) | 299(299) |
| PCDD/Fs | 1(1) | 1(1) | 25(25) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 4(10) | 13(22) | 156(169) |
| TOC | 4(10) | 9(18) | 9(18) |
| Grain size | 3(8) | 7(12) | 49(94) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

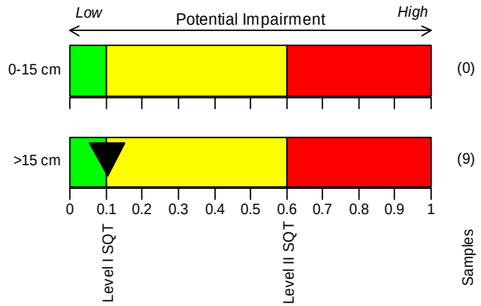
# Sediment Assessment Area Chemistry Characterization

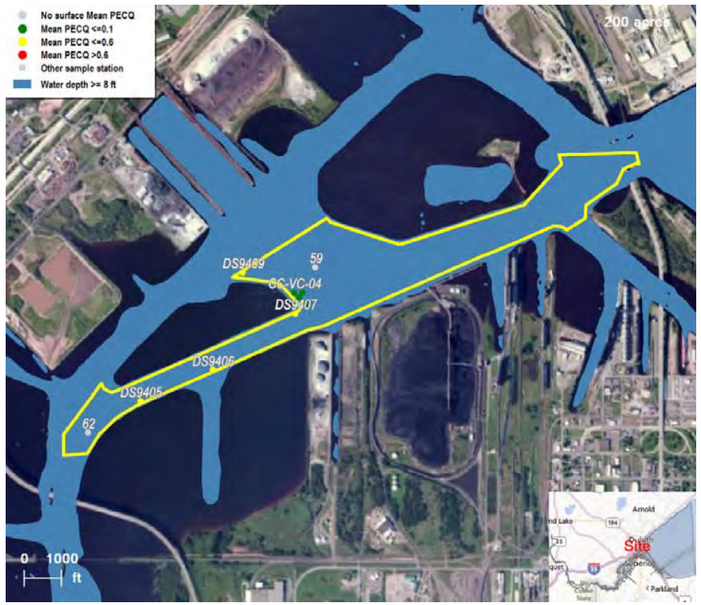
## Assessment Area # 47.1(St. Louis Bay Flats NC)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

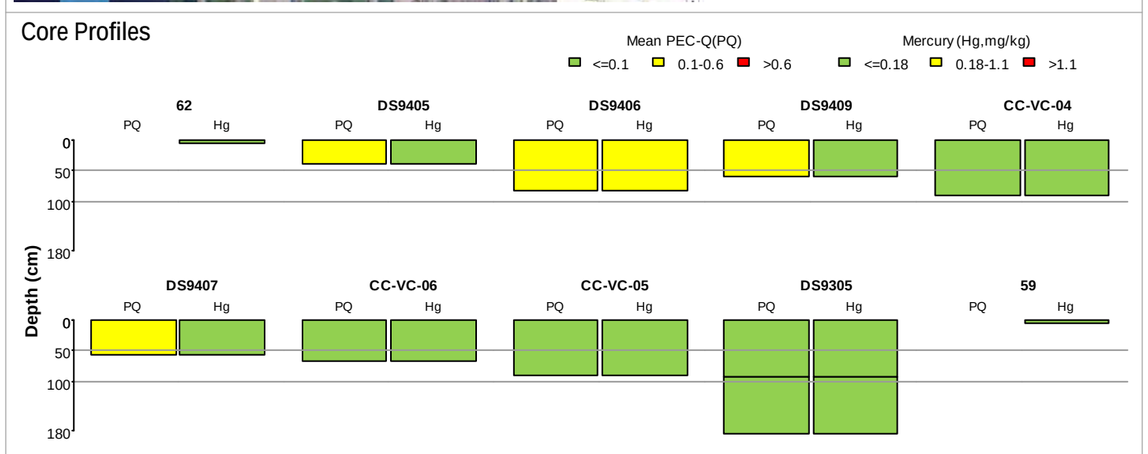
*Chemical studies used in the characterization: R-EMAP Study, 1995 (2 stations);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (4);USACE DACW35-93-D-0005 DELIVERY ORDER 16 (1);SLRIDT Reference Sites SEG 2004 (3).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;USACE DACW35-93-D-0005 DELIVERY ORDER 29;USACE DACW35-93-D-0005 DELIVERY ORDER 16;SLRIDT Reference Sites SEG 2004.*

*Fish tissue studies:*

## Core Profiles



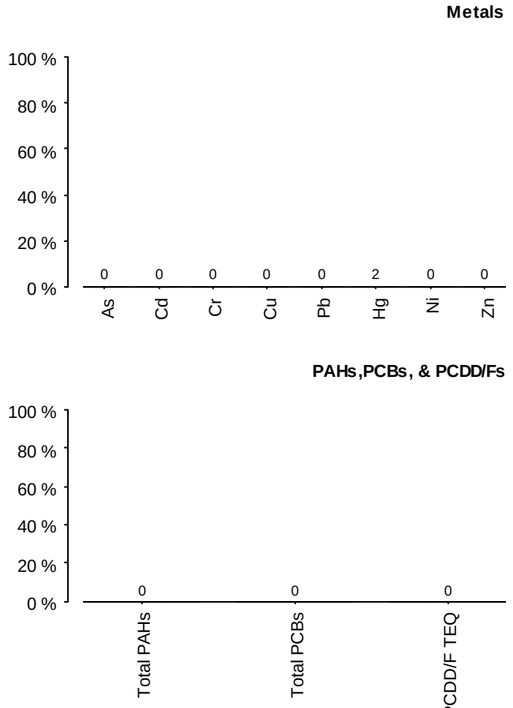

# Sediment Assessment Area Chemistry Characterization

## Data Summary

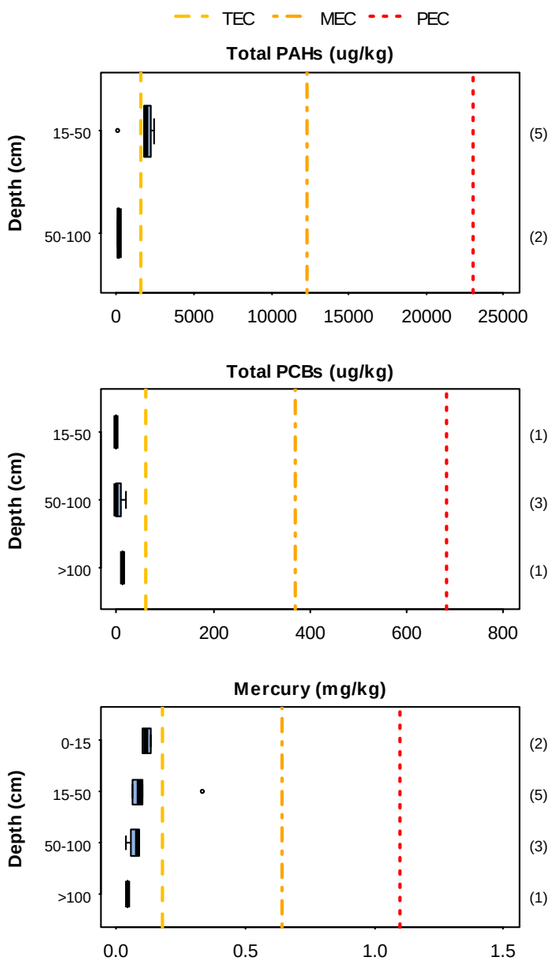
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 10(10) | 11(11) | 112(112) |
| Mercury | 10(10) | 11(11) | 11(11) |
| PAHs | 7(7) | 7(7) | 115(115) |
| PCBs | 4(4) | 5(5) | 38(38) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 4(4) | 5(5) | 63(63) |
| Other parameters | 10(10) | 11(11) | 97(97) |
| TOC | 10(10) | 11(11) | 11(11) |
| Grain size | 6(6) | 6(6) | 46(46) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

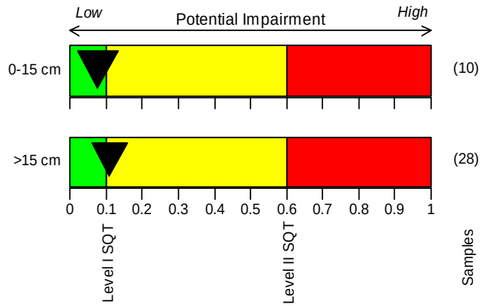
# Sediment Assessment Area Chemistry Characterization

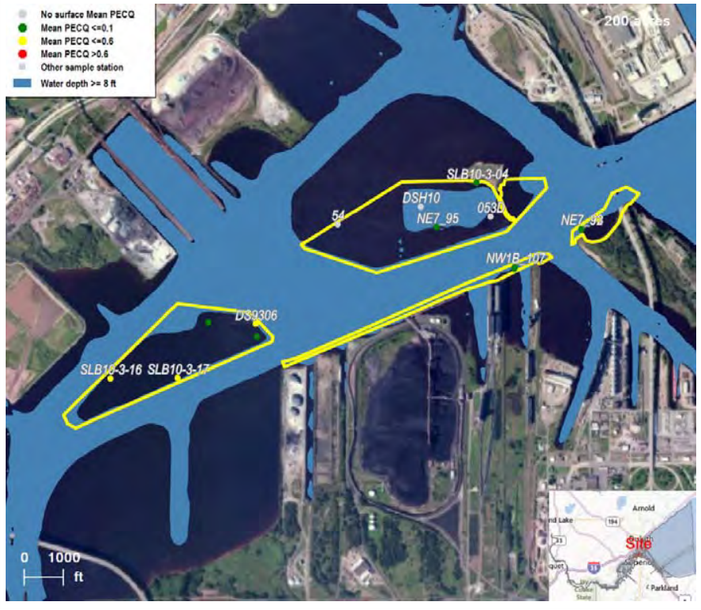
## Assessment Area # 47(St. Louis Bay Flats)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

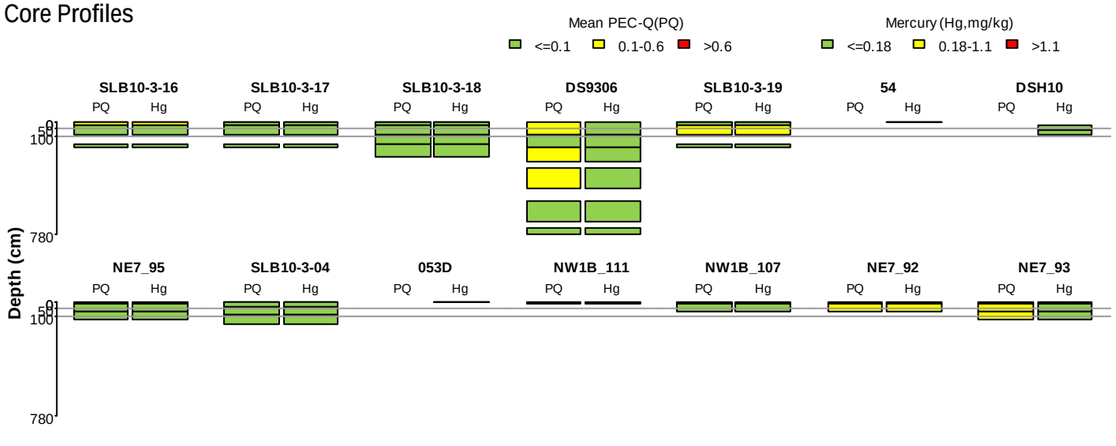
*Chemical studies used in the characterization: R-EMAP Study, 1995 (2 stations);Duluth-Superior Harbor Study, 1993 (1);USACE DACW35-93-D-0005 DELIVERY ORDER 16 (1);St. Louis Bay 40th Ave., 2010 (5);Wisconsin Sampling, 2007 (8).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;Duluth-Superior Harbor Study, 1993;USACE DACW35-93-D-0005 DELIVERY ORDER 16;St. Louis Bay 40th Ave., 2010;Wisconsin Sampling, 2007;21st Ave Macroinvertebrate Survey, 2011.*

*Fish tissue studies:*

## Core Profiles



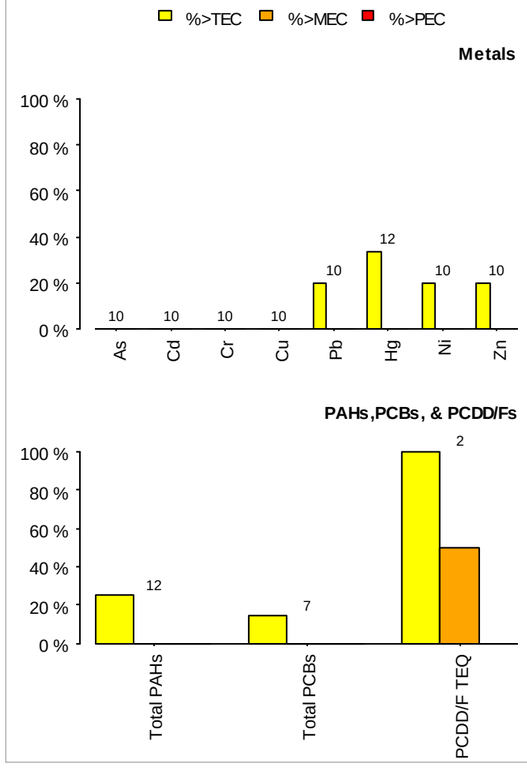

# Sediment Assessment Area Chemistry Characterization

## Data Summary

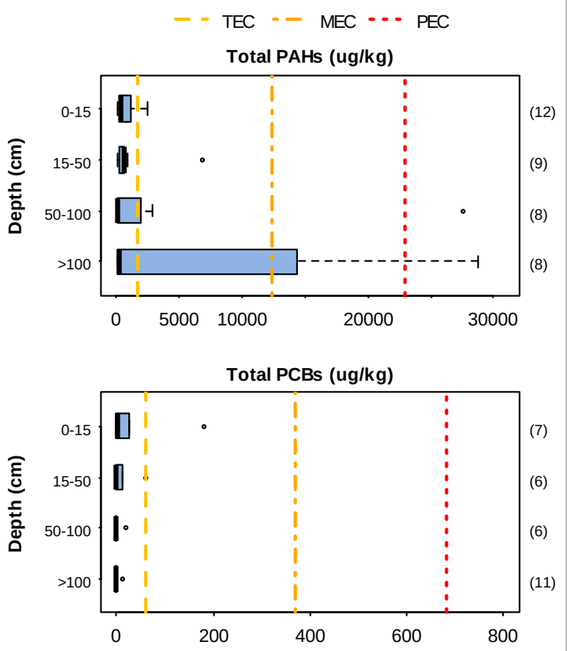
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 14(14) | 41(41) | 651(651) |
| Mercury | 14(14) | 42(42) | 42(42) |
| PAHs | 13(13) | 37(37) | 742(742) |
| PCBs | 8(8) | 30(30) | 682(682) |
| PCDD/Fs | 2(2) | 2(2) | 50(50) |
| Pesticides | 8(8) | 19(19) | 163(163) |
| Other parameters | 15(15) | 45(45) | 568(568) |
| TOC | 14(14) | 42(42) | 42(42) |
| Grain size | 16(16) | 40(40) | 216(216) |

## Results Exceeding Thresholds (0-15 cm samples)

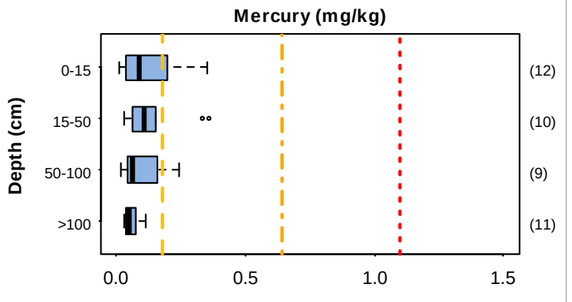


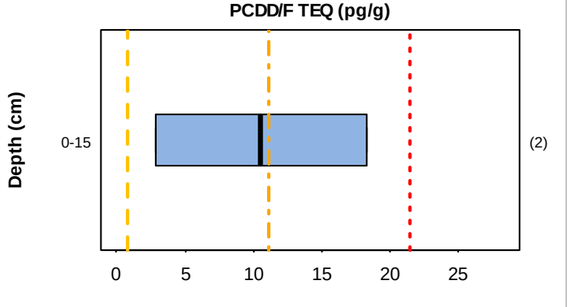

## Distributions of Constituent Concentrations










Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

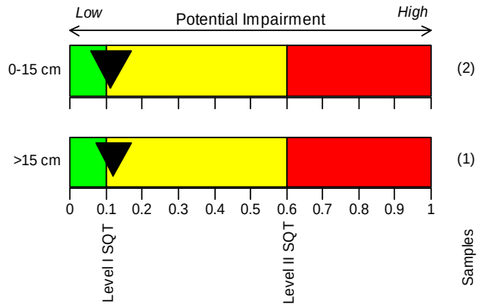
# Sediment Assessment Area Chemistry Characterization

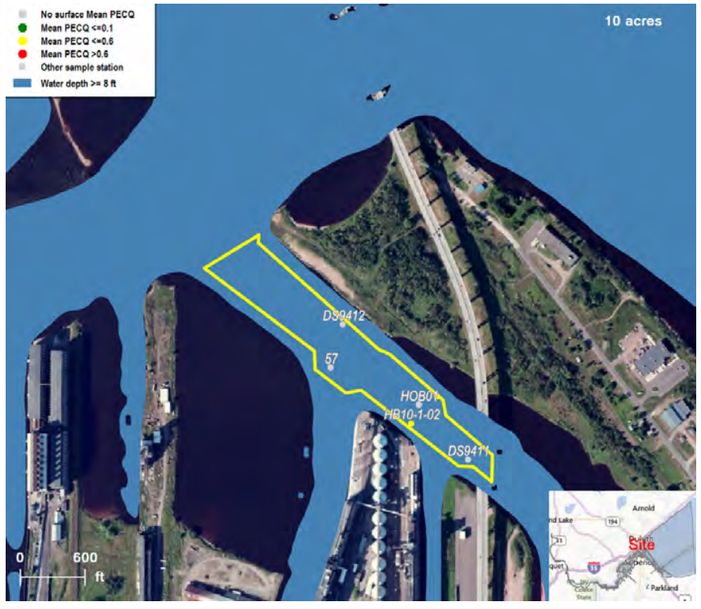
## Assessment Area # 48.1(Howards Bay West NC)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

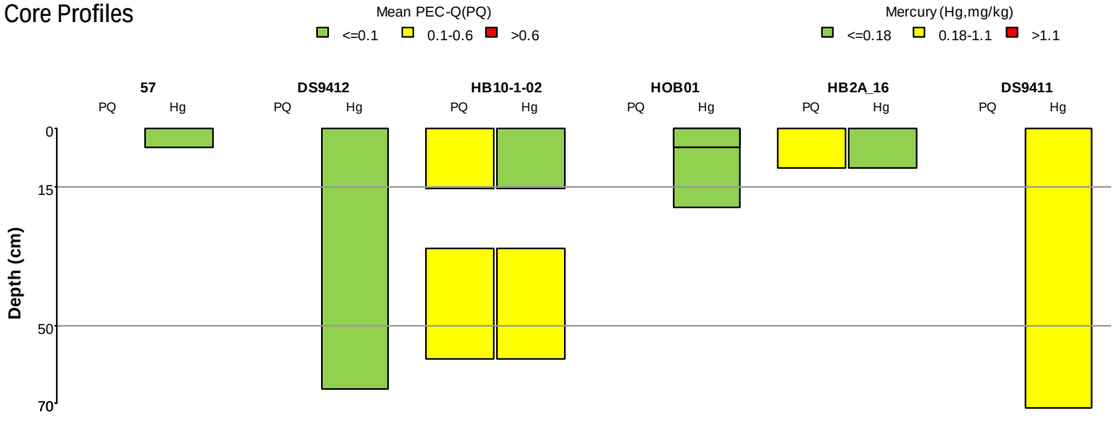
*Chemical studies used in the characterization: R-EMAP Study, 1995 (1 stations);Hotspot Study, 1994 (1);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (2);Howards Bay - St. Louis River AOC, 2010 (1);Wisconsin Sampling, 2007 (1).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;Hotspot Study, 1994;USACE DACW35-93-D-0005 DELIVERY ORDER 29;Howards Bay - St. Louis River AOC, 2010;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



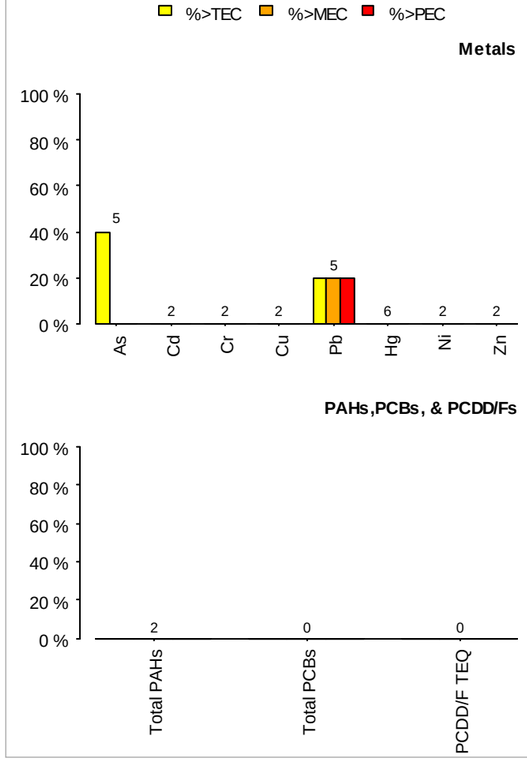

# Sediment Assessment Area Chemistry Characterization

## Data Summary

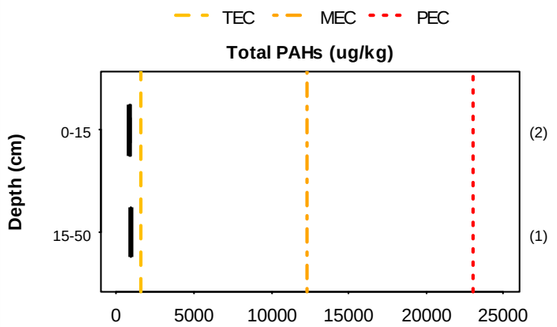
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 9(9) | 107(107) |
| Mercury | 6(6) | 9(9) | 9(9) |
| PAHs | 2(2) | 3(3) | 72(72) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 2(2) | 3(3) | 43(43) |
| Other parameters | 6(6) | 9(9) | 55(55) |
| TOC | 6(6) | 7(7) | 7(7) |
| Grain size | 6(6) | 7(7) | 48(48) |

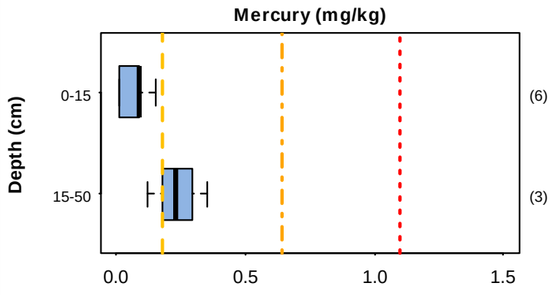
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

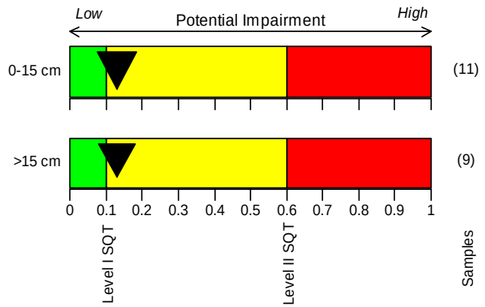
# Sediment Assessment Area Chemistry Characterization

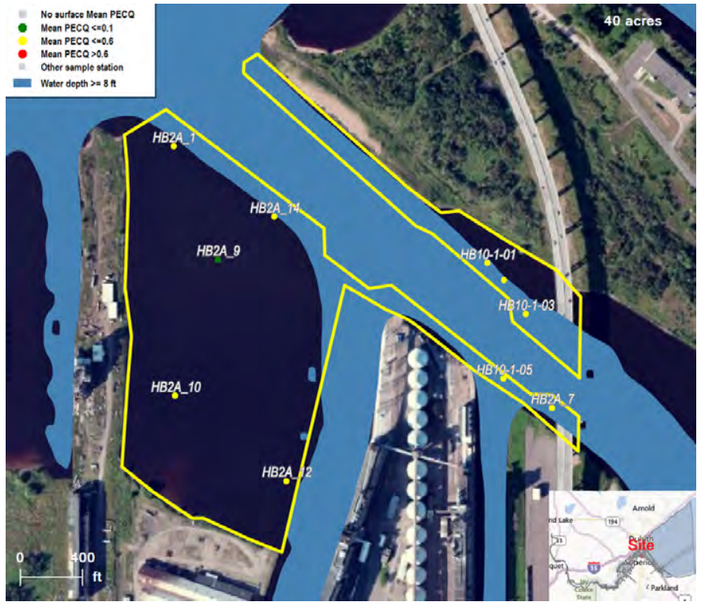
## Assessment Area # 48(Howards Bay West)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

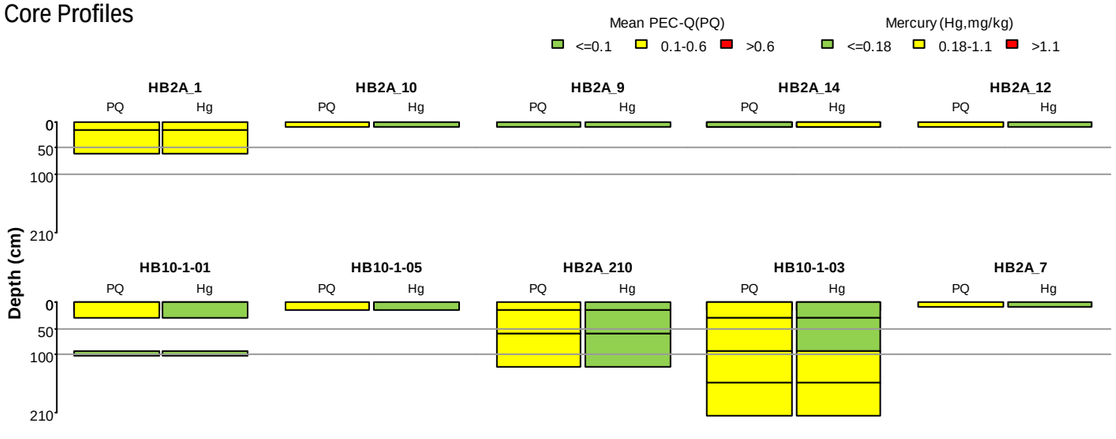
*Chemical studies used in the characterization:*
*Howards Bay - St. Louis River AOC, 2010 (3 stations);Wisconsin Sampling, 2007 (7).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Howards Bay - St. Louis River AOC, 2010;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



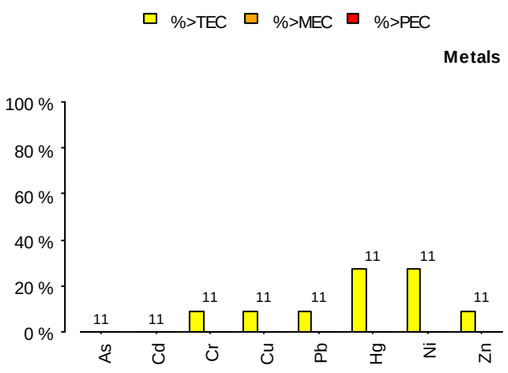

# Sediment Assessment Area Chemistry Characterization

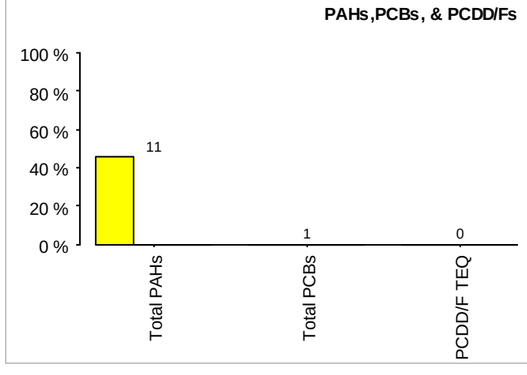
## Data Summary

**Available data in studies used for characterization (All available data)**

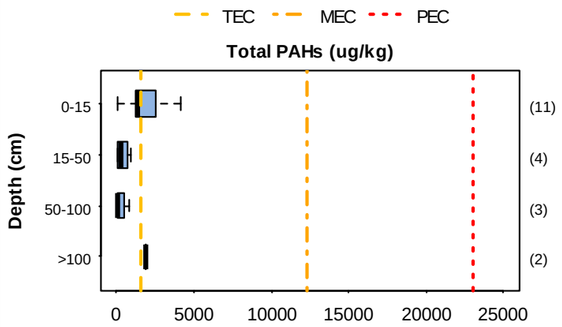
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 10(10) | 20(20) | 318(318) |
| Mercury | 10(10) | 20(20) | 20(20) |
| PAHs | 10(10) | 20(20) | 485(485) |
| PCBs | 1(1) | 1(1) | 9(9) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 10(10) | 19(19) | 200(200) |
| Other parameters | 10(10) | 20(20) | 284(284) |
| TOC | 10(10) | 19(19) | 19(19) |
| Grain size | 10(10) | 19(19) | 83(83) |

## Results Exceeding Thresholds (0-15 cm samples)

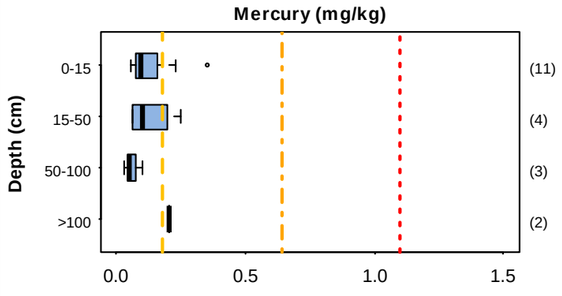



## Distributions of Constituent Concentrations




No PCBs detected in 1 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

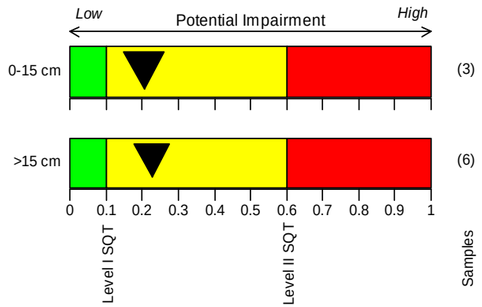
# Sediment Assessment Area Chemistry Characterization

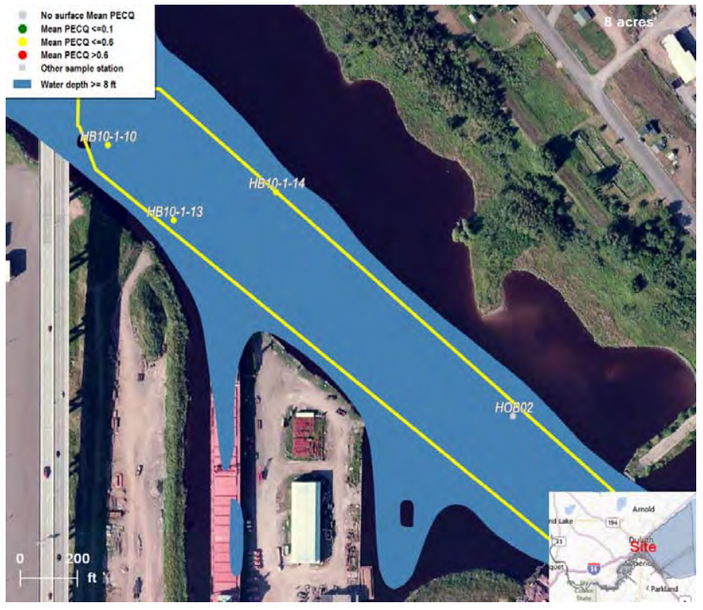
## Assessment Area # 49.1(Howards Bay Middle NC)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

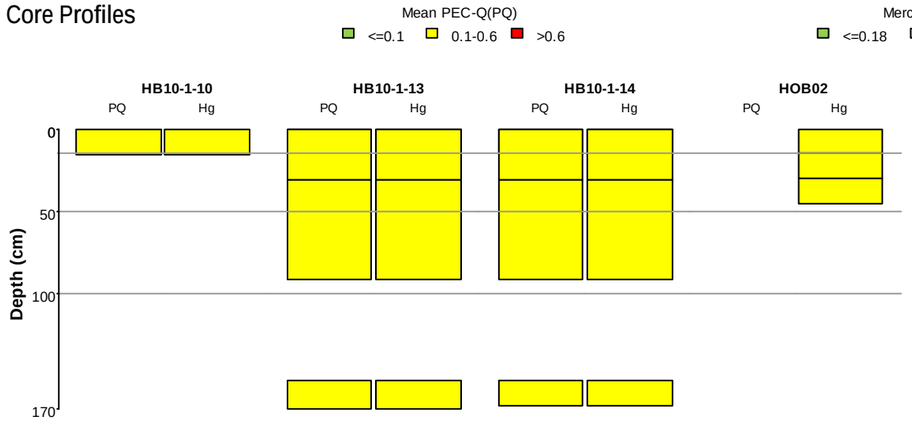
*Chemical studies used in the characterization:*
*Hotspot Study, 1994 (1 stations);Howards Bay - St. Louis River AOC, 2010 (3).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Hotspot Study, 1994;Howards Bay - St. Louis River AOC, 2010.*

*Fish tissue studies:*

## Core Profiles



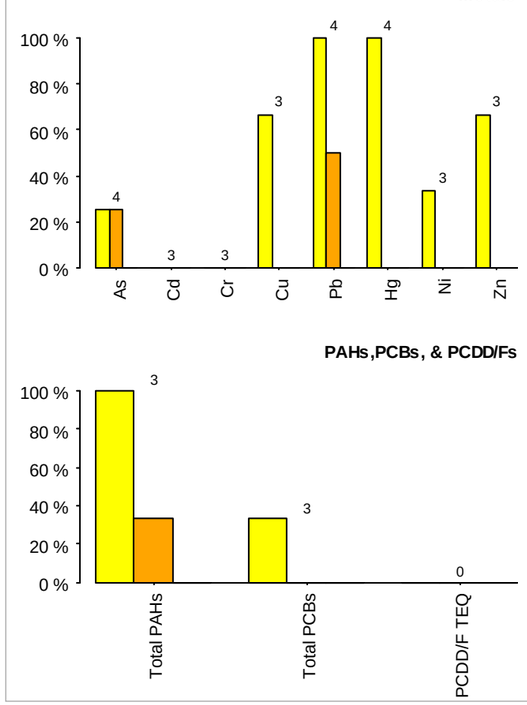

# Sediment Assessment Area Chemistry Characterization

## Data Summary

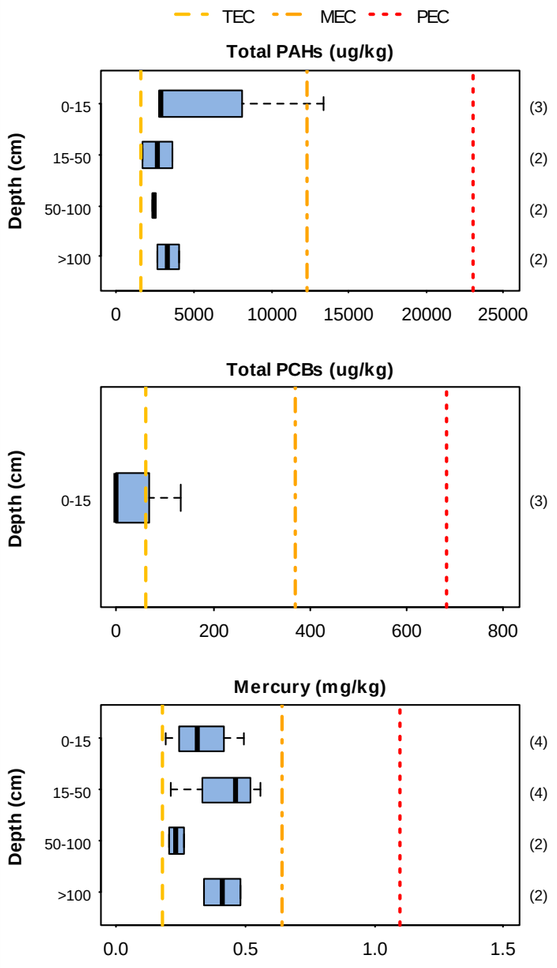
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(4) | 12(12) | 219(219) |
| Mercury | 4(4) | 12(12) | 12(12) |
| PAHs | 3(3) | 9(9) | 219(219) |
| PCBs | 3(3) | 3(3) | 27(27) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 3(3) | 9(9) | 192(192) |
| Other parameters | 4(4) | 12(12) | 177(177) |
| TOC | 4(4) | 12(12) | 12(12) |
| Grain size | 4(4) | 12(12) | 90(90) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

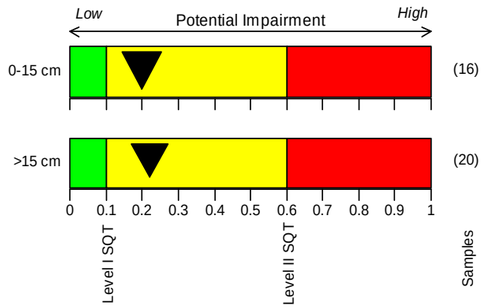
# Sediment Assessment Area Chemistry Characterization

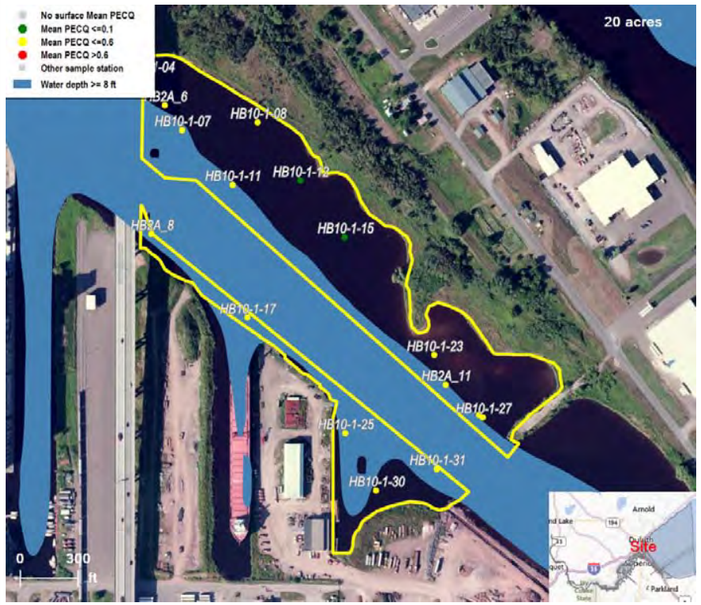
## Assessment Area # 49(Howards Bay Middle)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

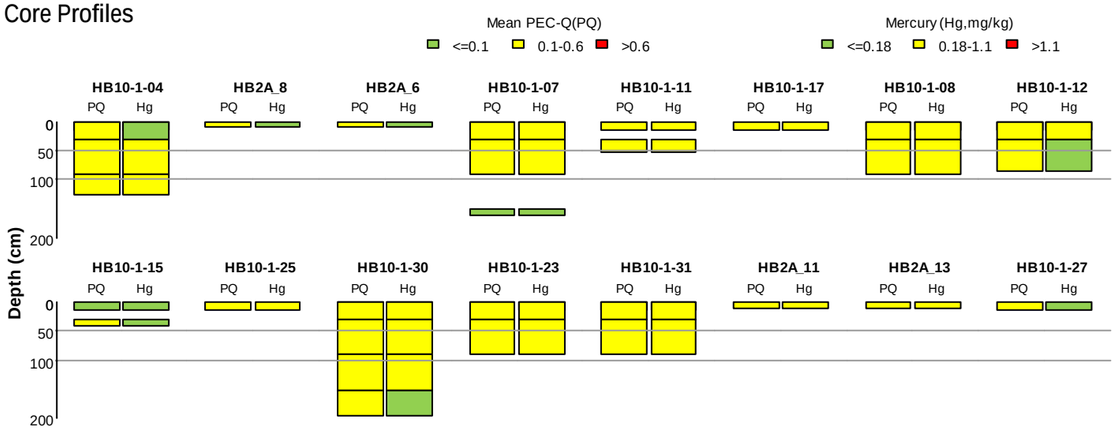
*Chemical studies used in the characterization:*
*Howards Bay - St. Louis River AOC, 2010 (12 stations);Wisconsin Sampling, 2007 (4).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Howards Bay - St. Louis River AOC, 2010;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



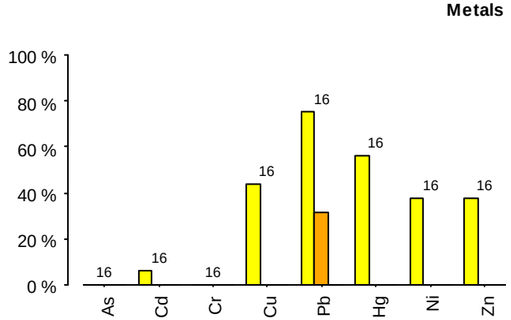

# Sediment Assessment Area Chemistry Characterization

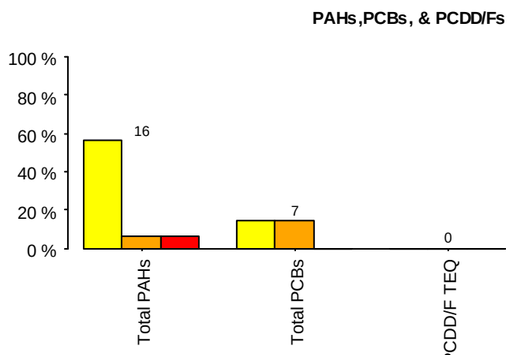
## Data Summary

**Available data in studies used for characterization (All available data)**

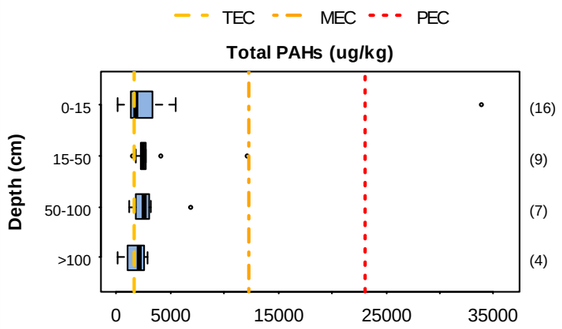
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 16(16) | 36(36) | 747(747) |
| Mercury | 16(16) | 36(36) | 36(36) |
| PAHs | 16(16) | 36(36) | 850(850) |
| PCBs | 7(7) | 7(7) | 63(63) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 16(16) | 36(36) | 683(683) |
| Other parameters | 16(16) | 36(36) | 645(645) |
| TOC | 16(16) | 36(36) | 36(36) |
| Grain size | 16(16) | 36(36) | 232(232) |

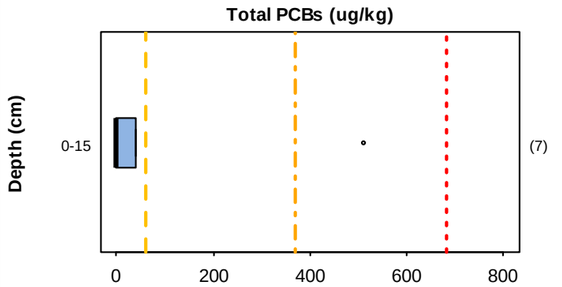
## Results Exceeding Thresholds (0-15 cm samples)

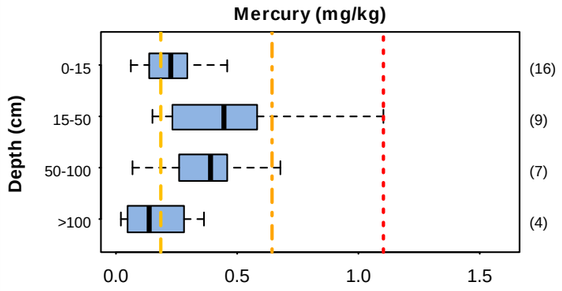



## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

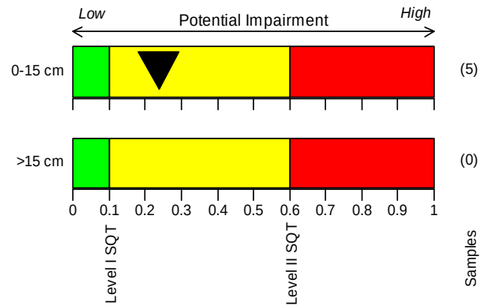
# Sediment Assessment Area Chemistry Characterization

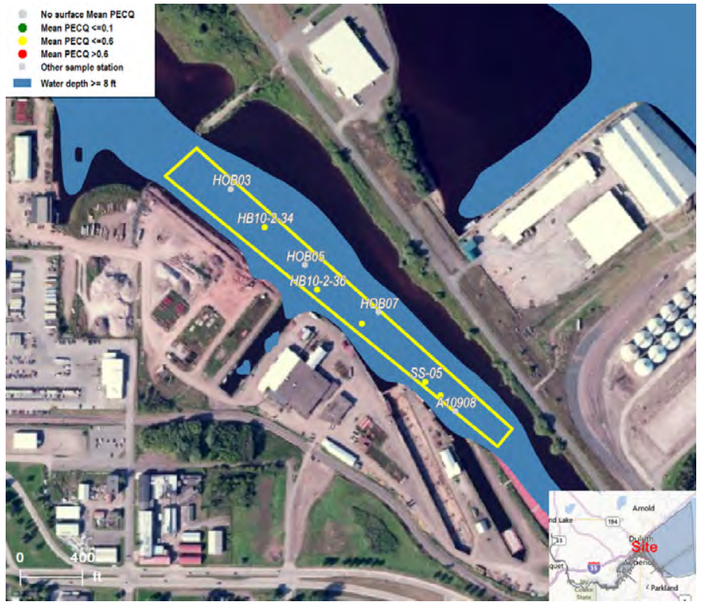
## Assessment Area # 50.1(Howards Bay East NC)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

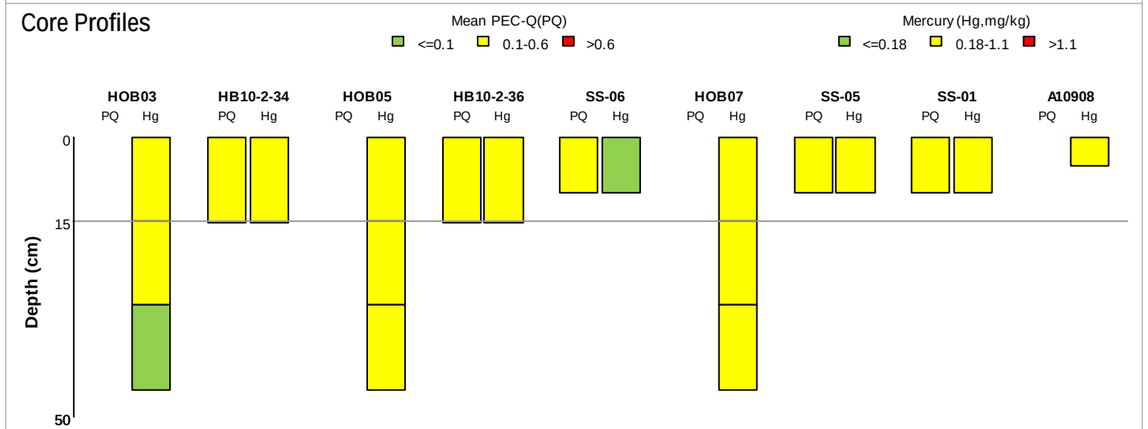
*Chemical studies used in the characterization: Hotspot Study, 1994 (3 stations);R-EMAP Study, 1996 (1);Fraser Shipyards/Howard's Pocket, 2002 (3);Howards Bay - St. Louis River AOC, 2010 (2).*

*Other chemical studies:*

*Macro-invertebrate studies: Hotspot Study, 1994;R-EMAP Study, 1996;Fraser Shipyards/Howard's Pocket, 2002;Howards Bay - St. Louis River AOC, 2010.*

*Fish tissue studies:*

## Core Profiles



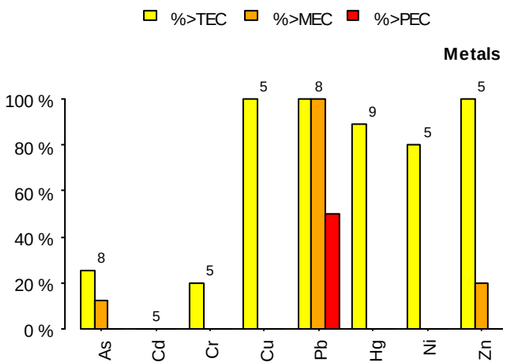

# Sediment Assessment Area Chemistry Characterization

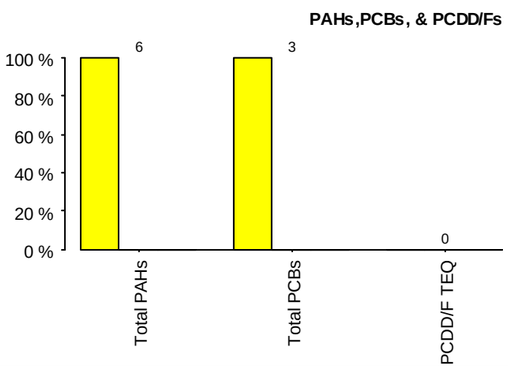
## Data Summary

**Available data in studies used for characterization (All available data)**

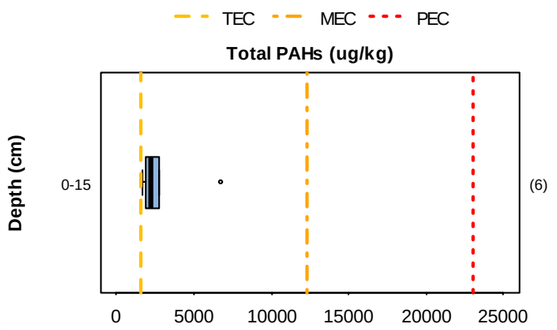
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 9(9) | 15(15) | 178(178) |
| Mercury | 9(9) | 15(15) | 15(15) |
| PAHs | 6(6) | 6(6) | 113(113) |
| PCBs | 3(3) | 3(3) | 21(21) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 5(5) | 5(5) | 117(117) |
| Other parameters | 9(9) | 15(15) | 362(362) |
| TOC | 6(6) | 12(12) | 12(12) |
| Grain size | 9(9) | 15(15) | 105(105) |

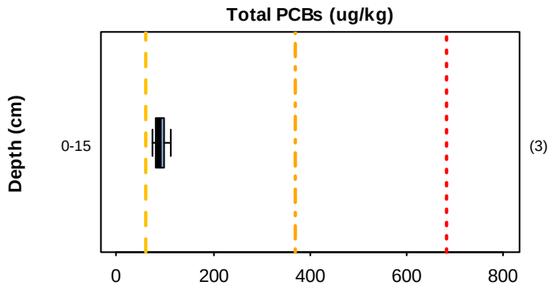
## Results Exceeding Thresholds (0-15 cm samples)

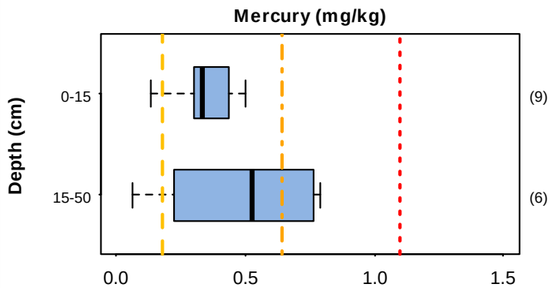



## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

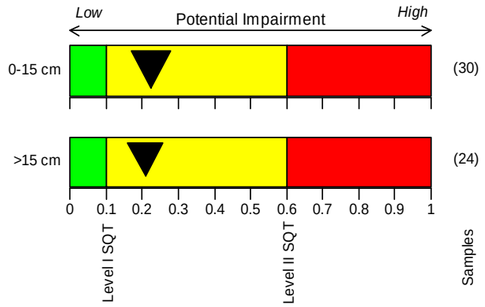
# Sediment Assessment Area Chemistry Characterization

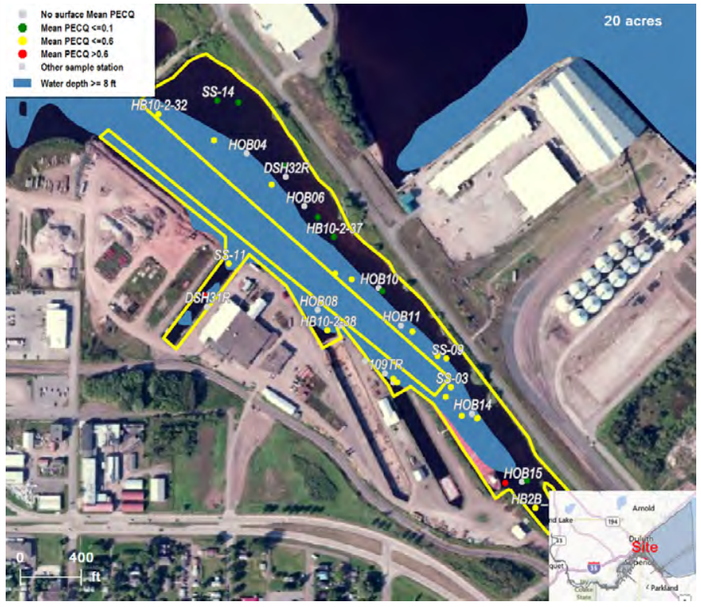
## Assessment Area # 50(Howards Bay East)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

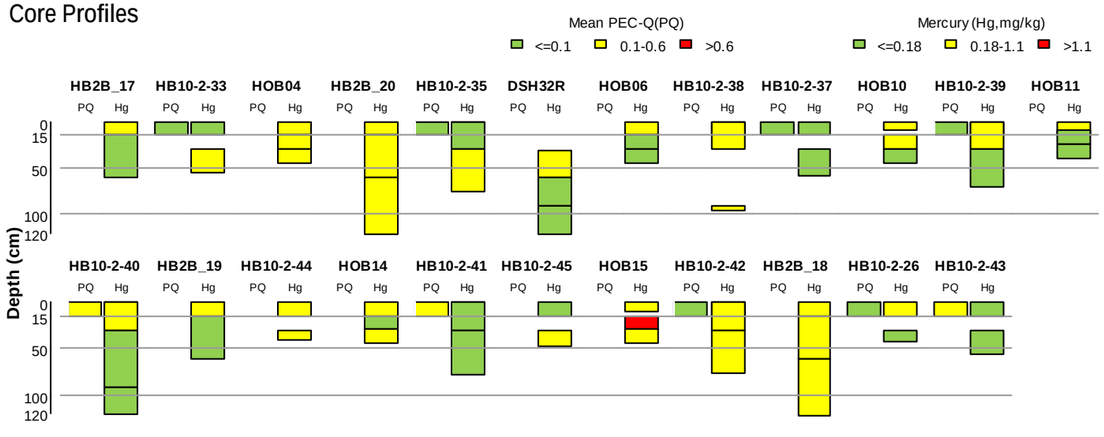
*Chemical studies used in the characterization: R-EMAP Study, 1995 (1 stations);Hotspot Study, 1994 (10);Duluth-Superior Harbor Study, 1993 (2);Fraser Shipyards/Howard's Pocket, 2002 (10);Howards Bay - St. Louis River AOC, 2010 (14);Wisconsin Sampling, 2007 (6).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;Hotspot Study, 1994;R-EMAP Study, 1996;Duluth-Superior Harbor Study, 1993;Fraser Shipyards/Howard's Pocket, 2002;Howards Bay - St. Louis River AOC, 2010;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



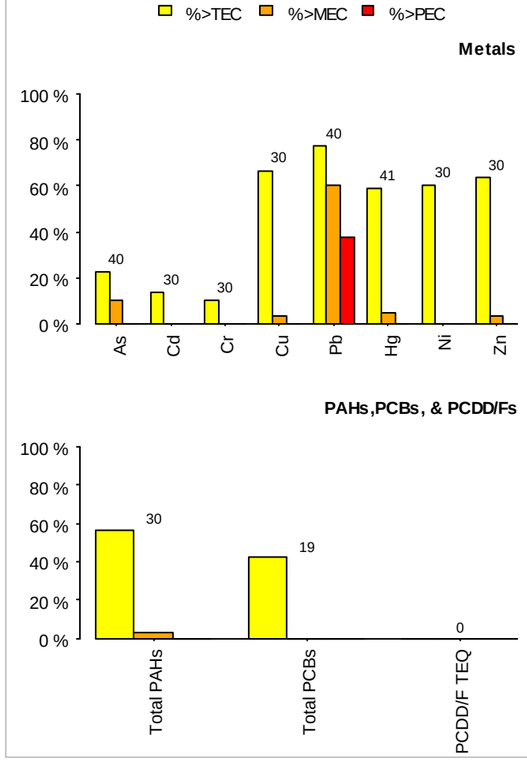

# Sediment Assessment Area Chemistry Characterization

## Data Summary

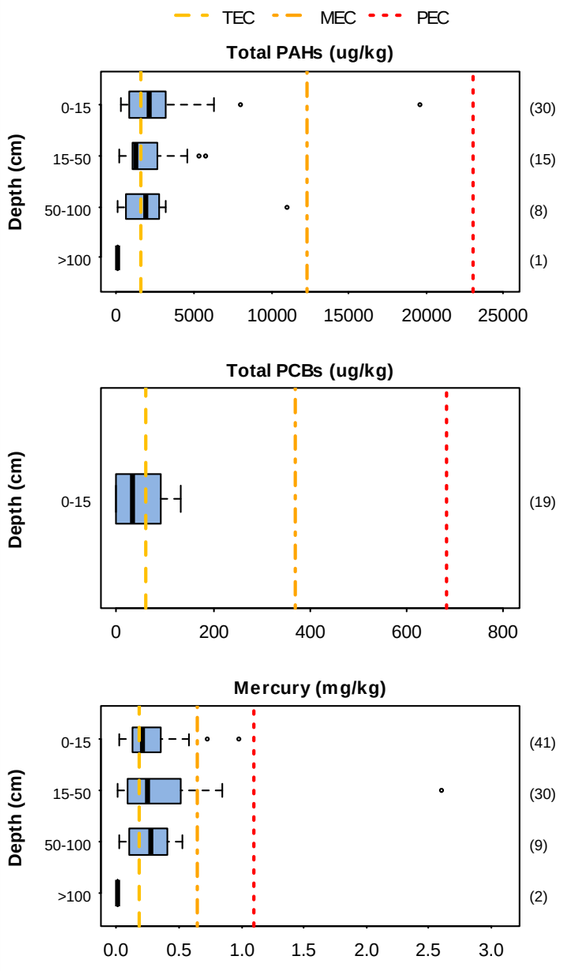
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 41(41) | 78(78) | 1211(1211) |
| Mercury | 43(43) | 82(82) | 82(82) |
| PAHs | 30(30) | 55(55) | 1219(1219) |
| PCBs | 19(19) | 19(19) | 151(151) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 30(30) | 55(55) | 964(964) |
| Other parameters | 43(43) | 82(82) | 1809(1809) |
| TOC | 33(33) | 72(72) | 72(72) |
| Grain size | 41(41) | 78(78) | 470(470) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

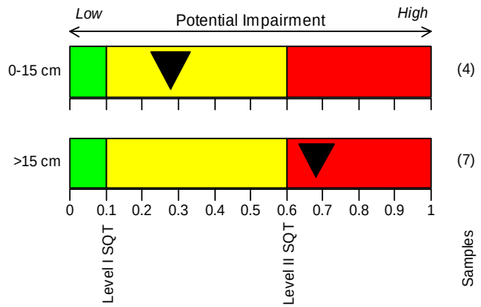
# Sediment Assessment Area Chemistry Characterization

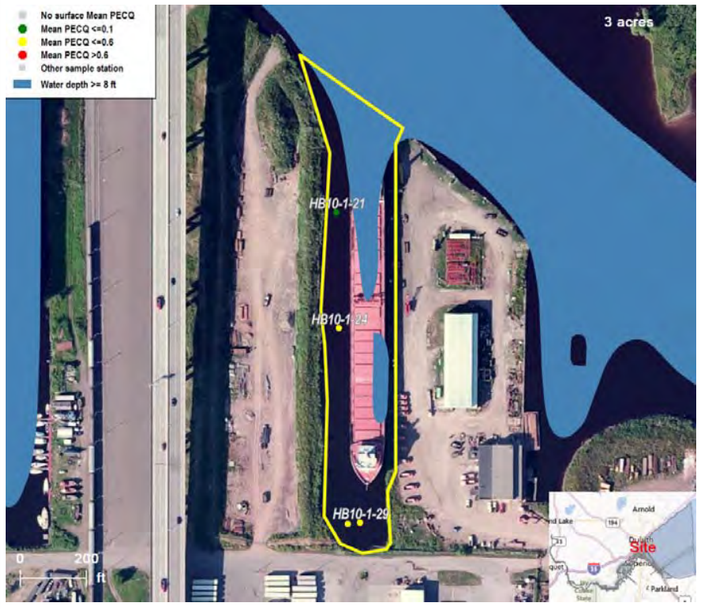
## Assessment Area # 51(Cummings Avenue Slip)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

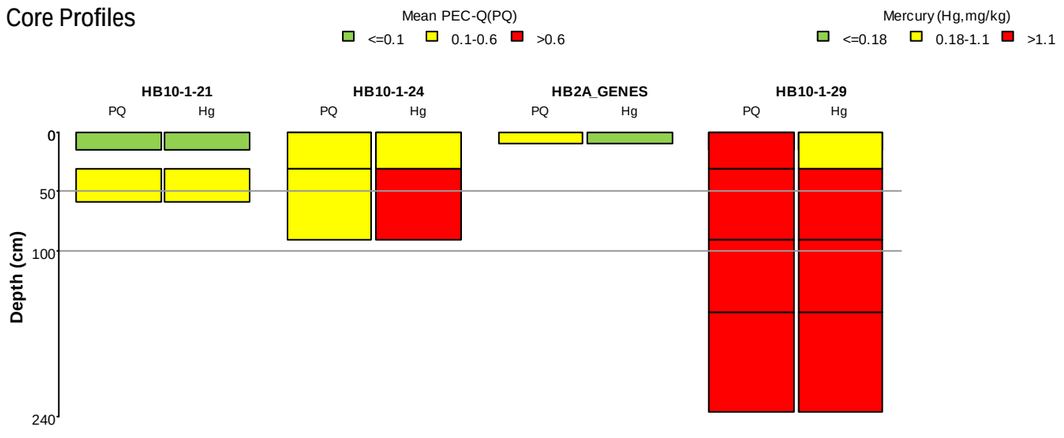
*Chemical studies used in the characterization:*
*Howards Bay - St. Louis River AOC, 2010 (3 stations);Wisconsin Sampling, 2007 (1).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Howards Bay - St. Louis River AOC, 2010;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



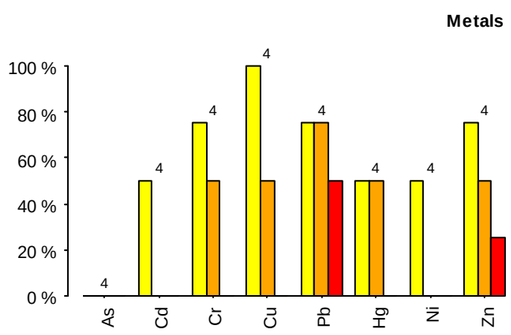

# Sediment Assessment Area Chemistry Characterization

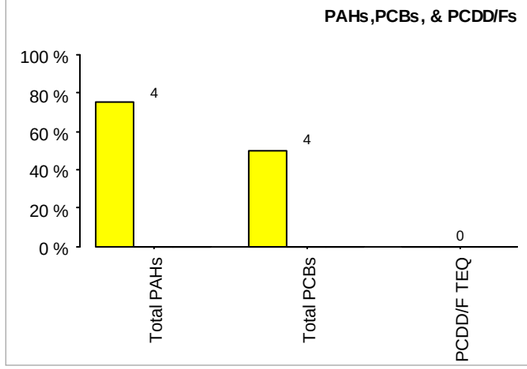
## Data Summary

**Available data in studies used for characterization (All available data)**

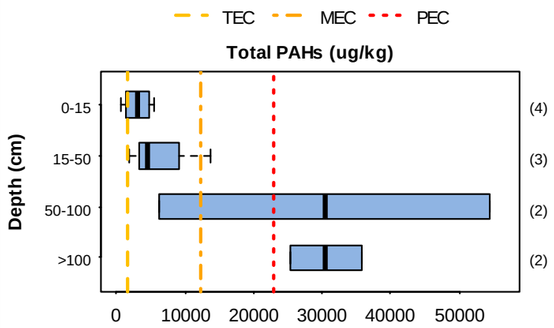
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(4) | 11(11) | 236(236) |
| Mercury | 4(4) | 11(11) | 11(11) |
| PAHs | 4(4) | 11(11) | 429(429) |
| PCBs | 4(4) | 11(11) | 101(101) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 4(4) | 11(11) | 239(239) |
| Other parameters | 4(4) | 11(11) | 258(258) |
| TOC | 4(4) | 11(11) | 11(11) |
| Grain size | 4(4) | 11(11) | 72(72) |

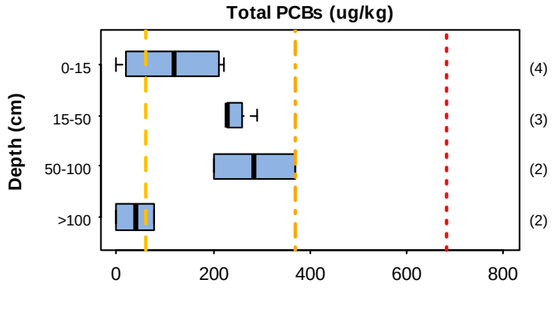
## Results Exceeding Thresholds (0-15 cm samples)

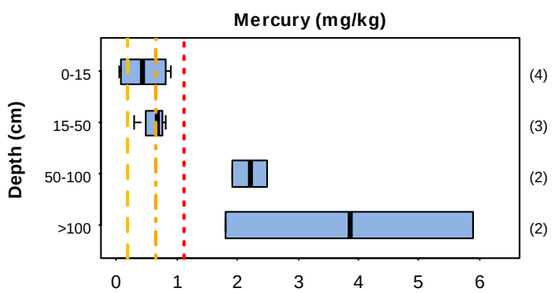



## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

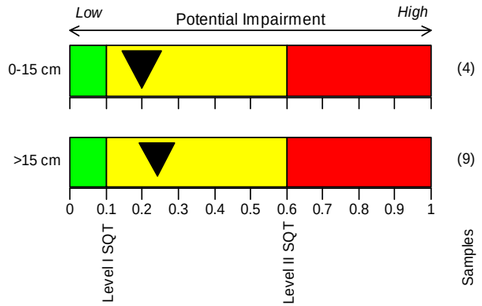
# Sediment Assessment Area Chemistry Characterization

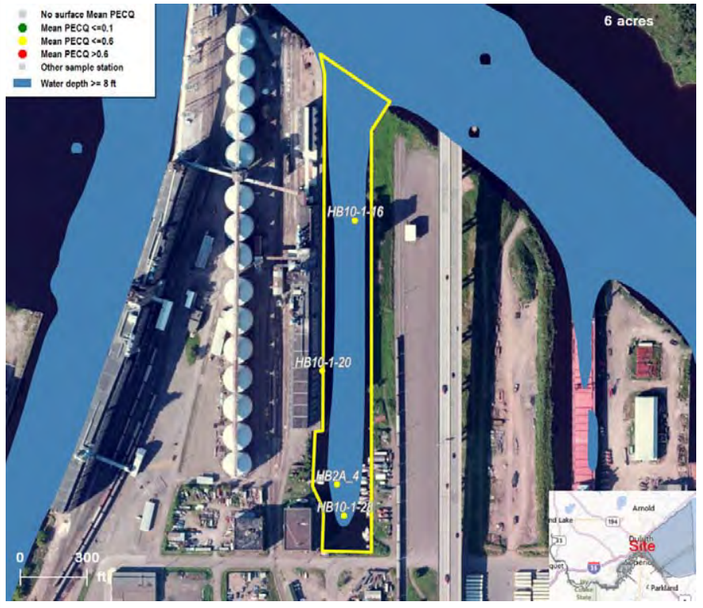
## Assessment Area # 52(Hughitt Slip)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

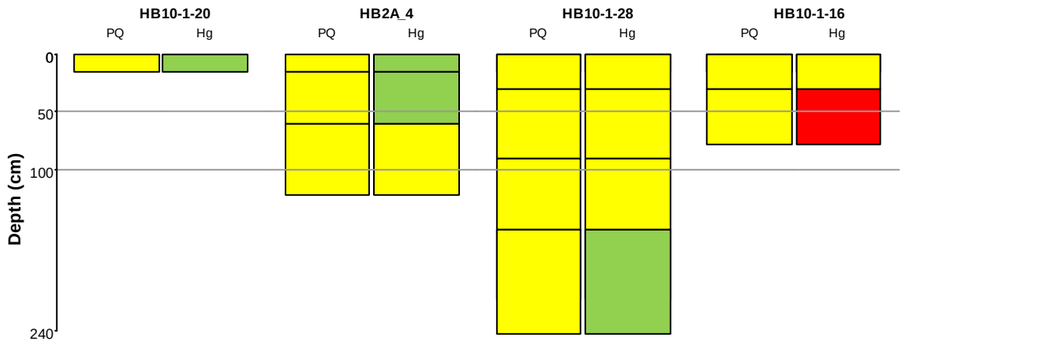
*Chemical studies used in the characterization:*
*Howards Bay - St. Louis River AOC, 2010 (3 stations);Wisconsin Sampling, 2007 (1).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Howards Bay - St. Louis River AOC, 2010;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



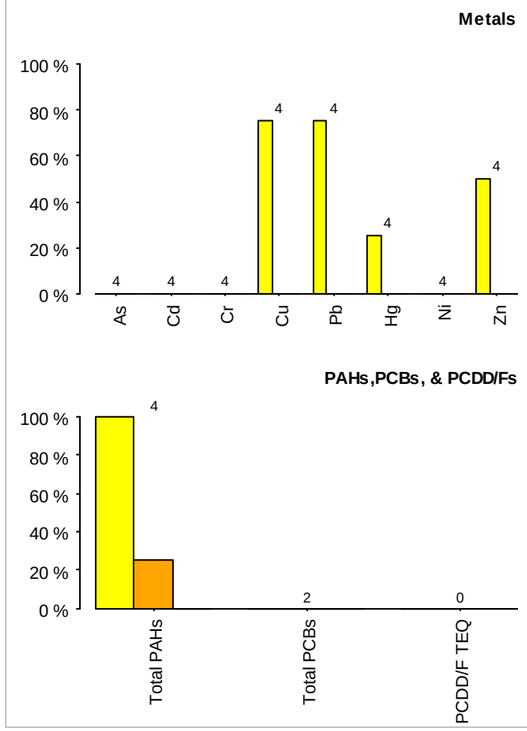

# Sediment Assessment Area Chemistry Characterization

## Data Summary

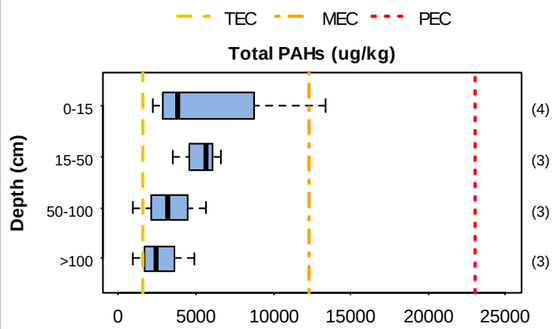
**Available data in studies used for characterization (All available data)**

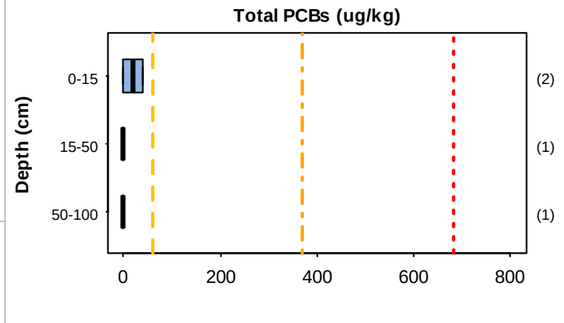
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(4) | 13(13) | 247(247) |
| Mercury | 4(4) | 13(13) | 13(13) |
| PAHs | 4(4) | 13(13) | 318(318) |
| PCBs | 2(2) | 4(4) | 36(36) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 4(4) | 13(13) | 217(217) |
| Other parameters | 4(4) | 13(13) | 228(228) |
| TOC | 4(4) | 13(13) | 13(13) |
| Grain size | 4(4) | 13(13) | 76(76) |

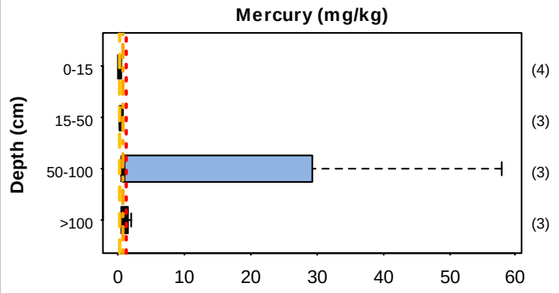
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

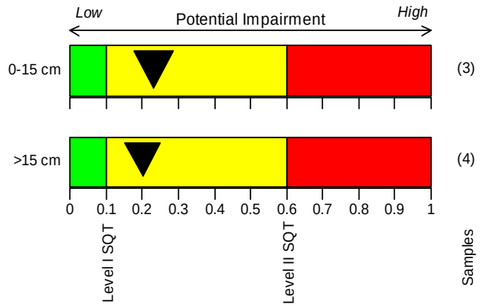
# Sediment Assessment Area Chemistry Characterization

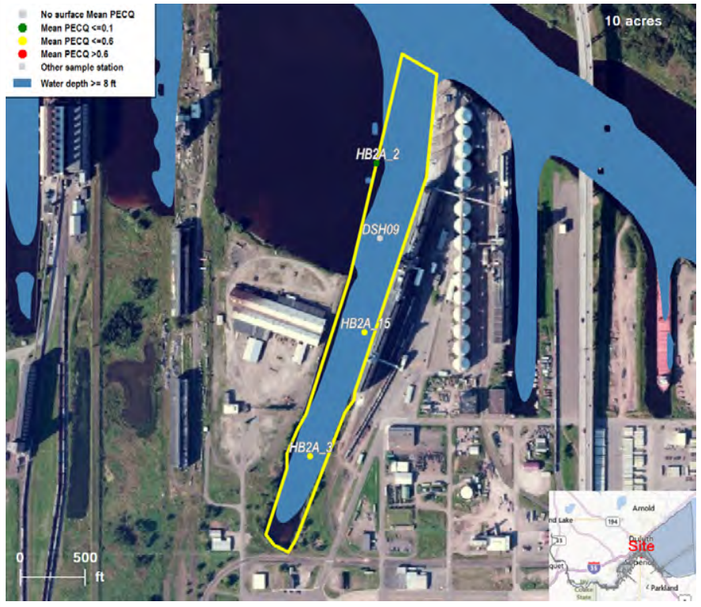
## Assessment Area # 53(Tower Bay Slip)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

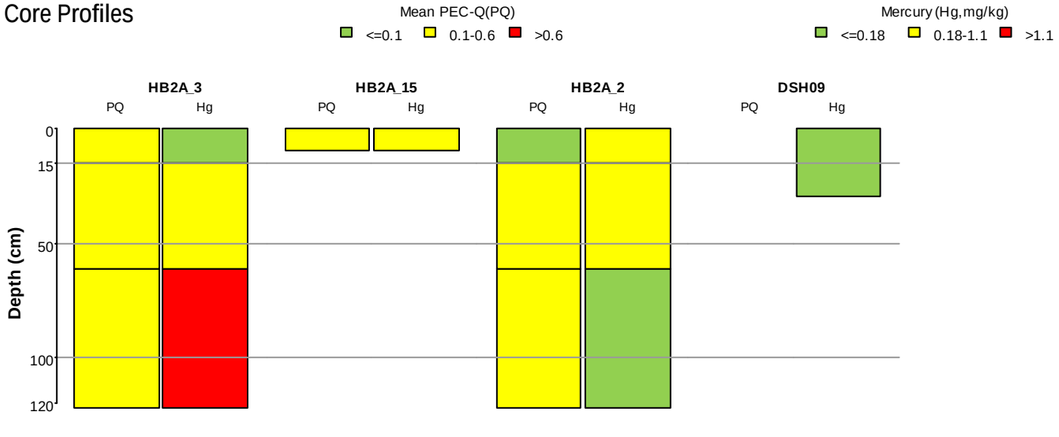
*Chemical studies used in the characterization:*
*Duluth-Superior Harbor Study, 1993 (1 stations);Wisconsin Sampling, 2007 (3).*

*Other chemical studies:*

*Macro-invertebrate studies: Duluth-Superior Harbor Study, 1993;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



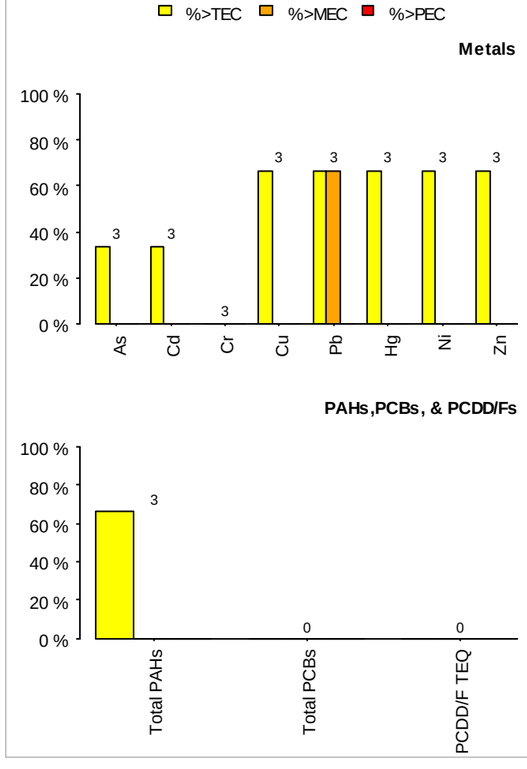

# Sediment Assessment Area Chemistry Characterization

## Data Summary

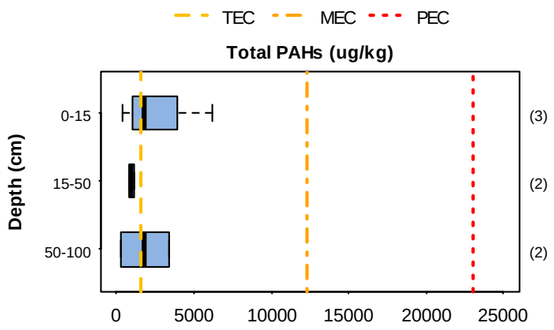
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(3) | 7(7) | 70(70) |
| Mercury | 4(4) | 8(8) | 8(8) |
| PAHs | 3(3) | 7(7) | 158(158) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 3(3) | 7(7) | 7(7) |
| Other parameters | 4(4) | 8(8) | 75(75) |
| TOC | 4(4) | 8(8) | 8(8) |
| Grain size | 3(3) | 7(7) | 14(14) |

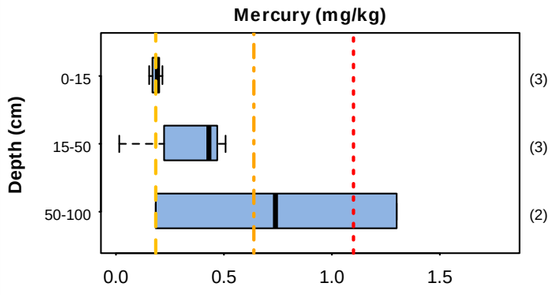
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

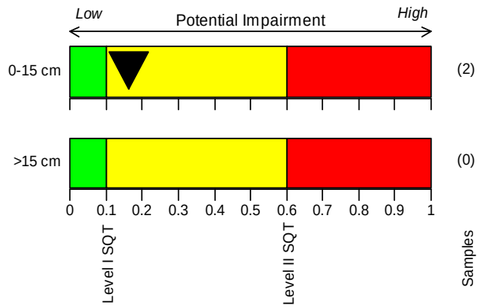
# Sediment Assessment Area Chemistry Characterization

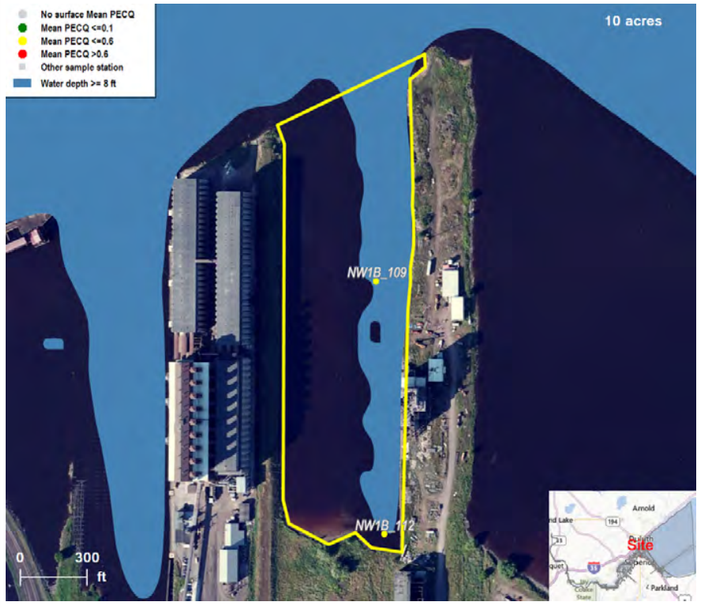
## Assessment Area # 54(Peavey Grain Globe Elevator Slip)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

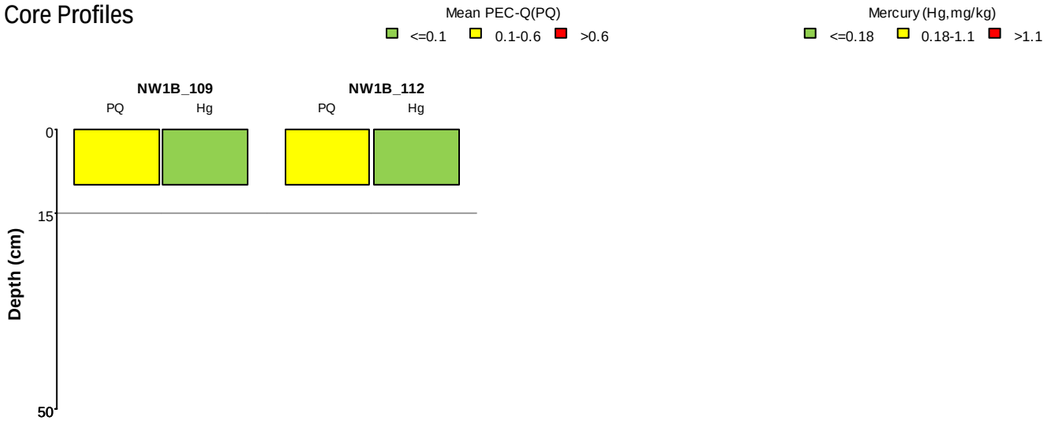
*Chemical studies used in the characterization:*
*Wisconsin Sampling, 2007 (2 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



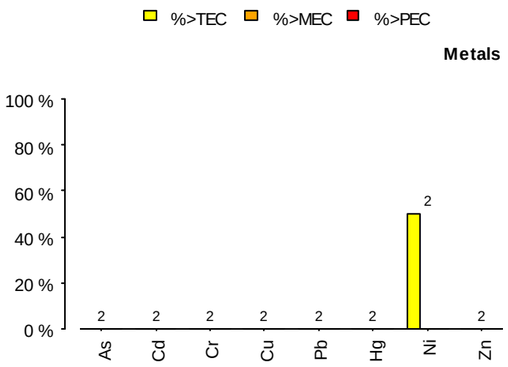

# Sediment Assessment Area Chemistry Characterization

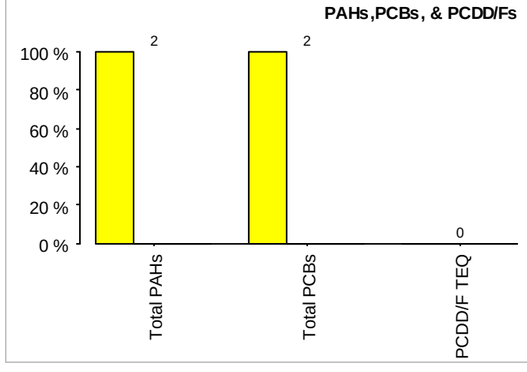
## Data Summary

**Available data in studies used for characterization (All available data)**

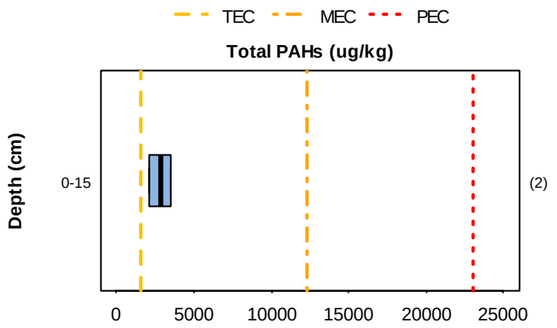
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 2(2) | 32(32) |
| Mercury | 2(2) | 2(2) | 2(2) |
| PAHs | 2(2) | 2(2) | 76(76) |
| PCBs | 2(2) | 2(2) | 22(22) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 2(2) | 2(2) | 4(4) |
| Other parameters | 2(2) | 2(2) | 30(30) |
| TOC | 2(2) | 2(2) | 2(2) |
| Grain size | 2(2) | 2(2) | 4(4) |

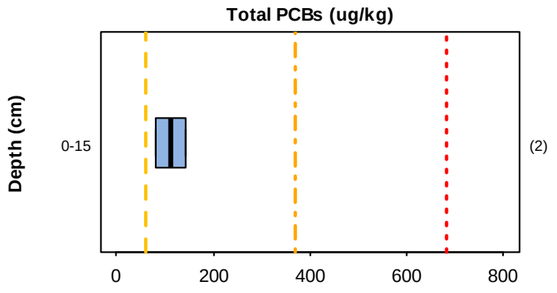
## Results Exceeding Thresholds (0-15 cm samples)

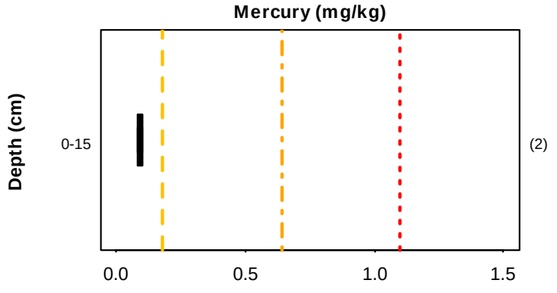



## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

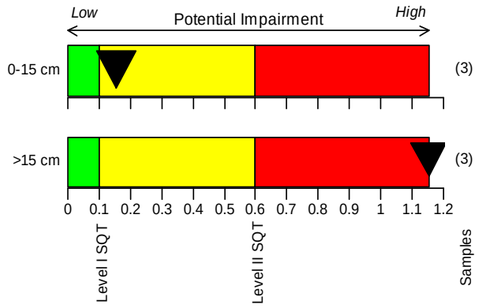
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 55(G. Mills S and X Sup. Term. Slip)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

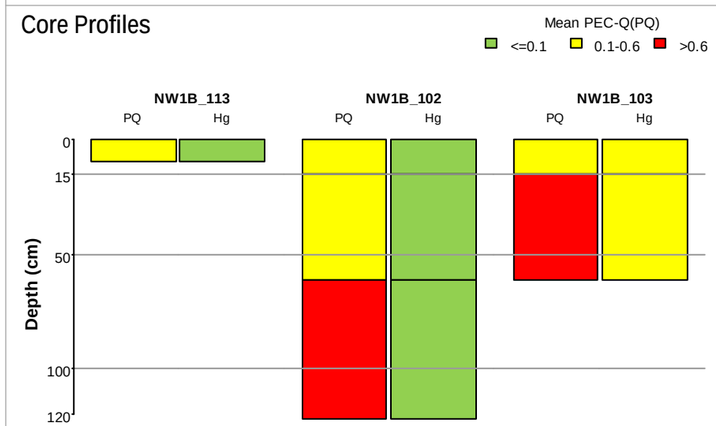
*Chemical studies used in the characterization:*
*Wisconsin Sampling, 2007 (3 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



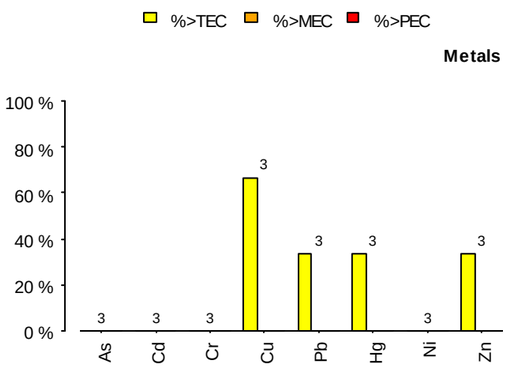

# Sediment Assessment Area Chemistry Characterization

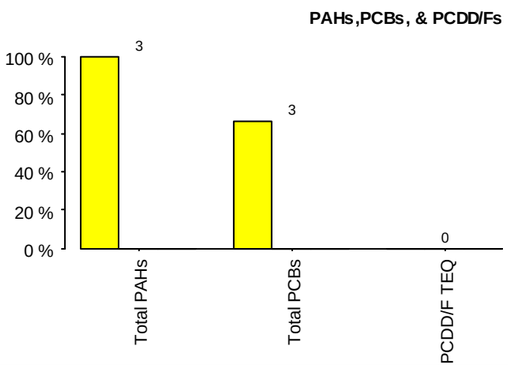
## Data Summary

**Available data in studies used for characterization (All available data)**

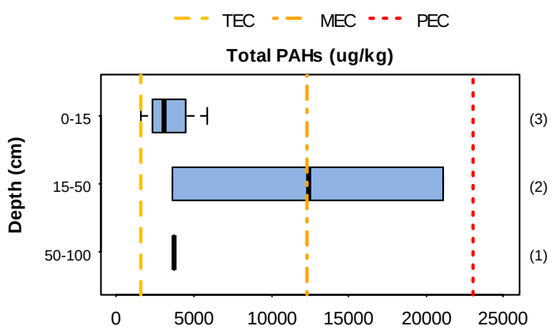
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(3) | 6(6) | 61(61) |
| Mercury | 3(3) | 6(6) | 6(6) |
| PAHs | 3(3) | 6(6) | 138(138) |
| PCBs | 3(3) | 6(6) | 66(66) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 3(3) | 6(6) | 9(9) |
| Other parameters | 3(3) | 6(6) | 75(75) |
| TOC | 3(3) | 6(6) | 6(6) |
| Grain size | 3(3) | 6(6) | 12(12) |

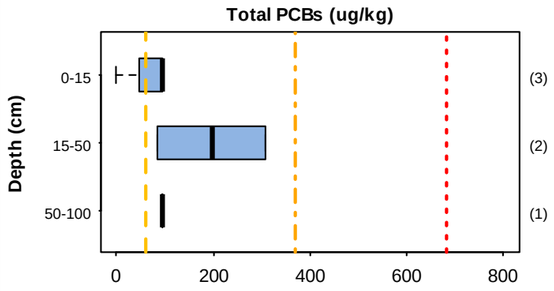
## Results Exceeding Thresholds (0-15 cm samples)

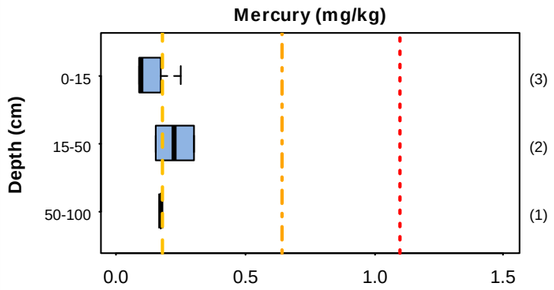



## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

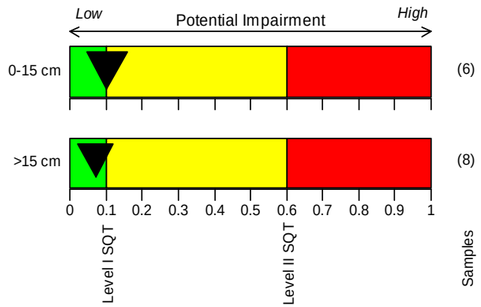
# Sediment Assessment Area Chemistry Characterization

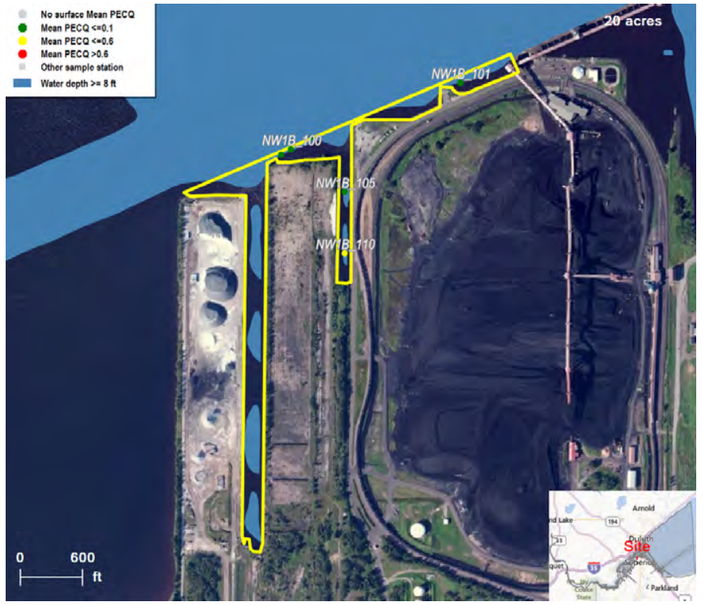
## Assessment Area # 56(Hallet 8 / C. Reiss Berwin Slip)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*Wisconsin Sampling, 2007 (6 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles

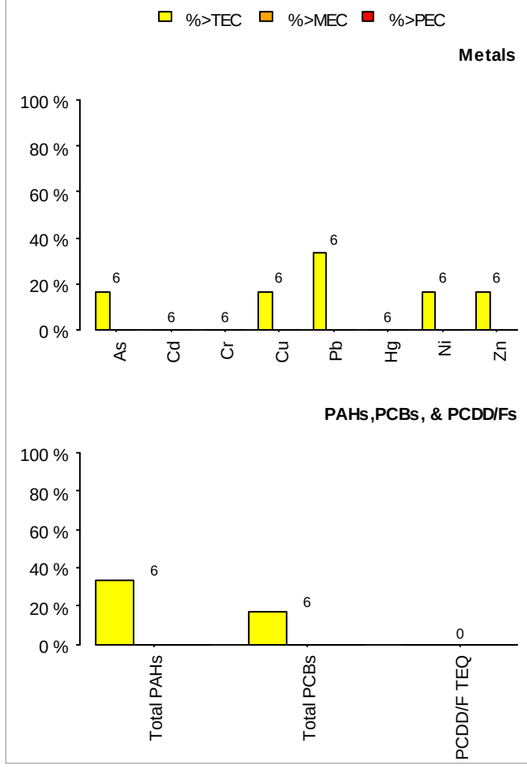

# Sediment Assessment Area Chemistry Characterization

## Data Summary

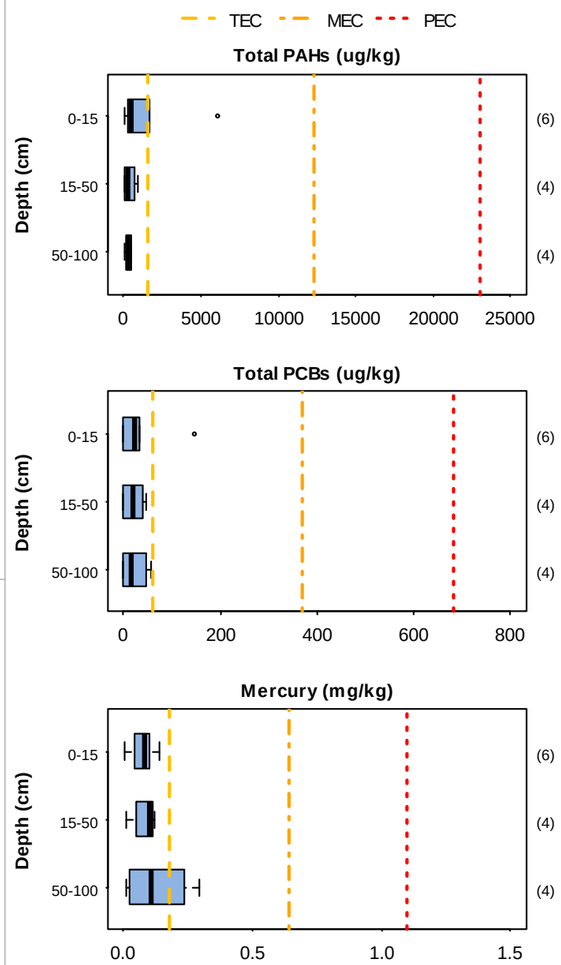
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 14(14) | 140(140) |
| Mercury | 6(6) | 14(14) | 14(14) |
| PAHs | 6(6) | 14(14) | 316(316) |
| PCBs | 6(6) | 14(14) | 154(154) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 6(6) | 14(14) | 20(20) |
| Other parameters | 6(6) | 14(14) | 174(174) |
| TOC | 6(6) | 14(14) | 14(14) |
| Grain size | 6(6) | 14(14) | 28(28) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

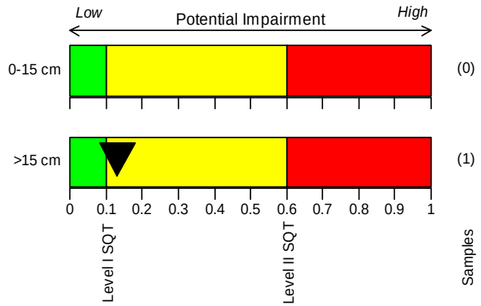
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 57.1(Estuary Flats NC)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*USACE DACW35-93-D-0005 DELIVERY ORDER 29 (1 stations).*

*Other chemical studies:*

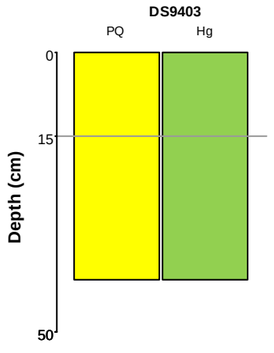
*Macro-invertebrate studies:*
*USACE DACW35-93-D-0005 DELIVERY ORDER 29.*

*Fish tissue studies:*

## Core Profiles

Mean PEC-Q(PQ): <=0.1 | 0.1-0.6 | >0.6

Mercury (Hg,mg/kg): <=0.18 | 0.18-1.1 | >1.1





# Sediment Assessment Area Chemistry Characterization


## Data Summary

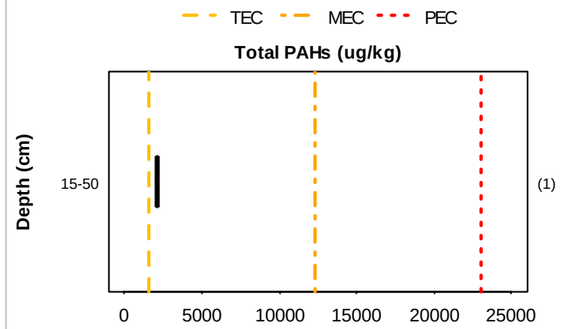
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 1(1) | 1(1) | 11(11) |
| Mercury | 1(1) | 1(1) | 1(1) |
| PAHs | 1(1) | 1(1) | 16(16) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 1(1) | 1(1) | 10(10) |
| TOC | 1(1) | 1(1) | 1(1) |
| Grain size | 1(1) | 1(1) | 8(8) |

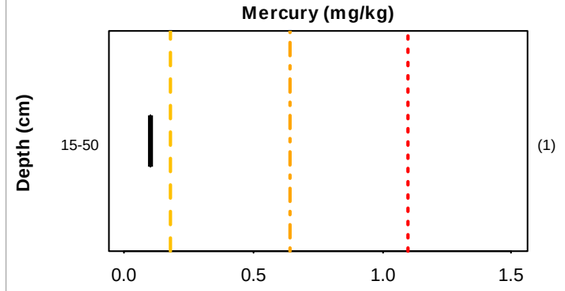
## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

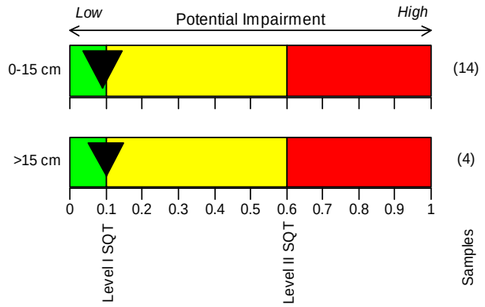
# Sediment Assessment Area Chemistry Characterization

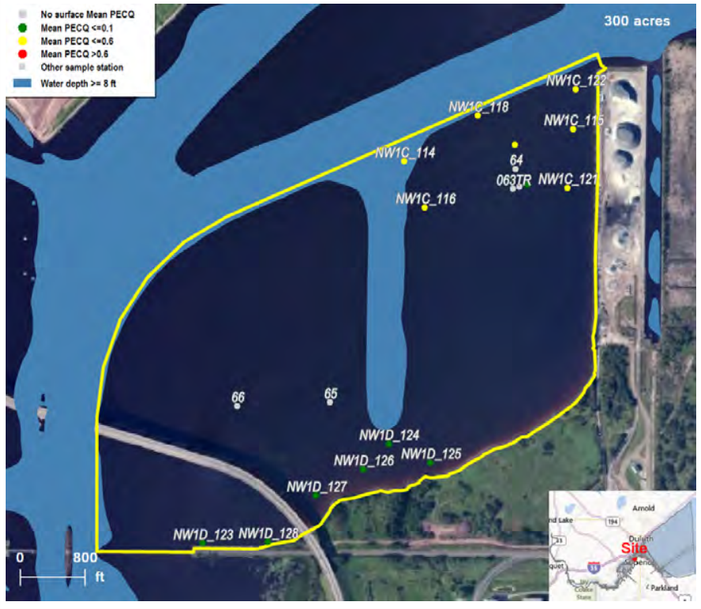
## Assessment Area # 57(Estuary Flats)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

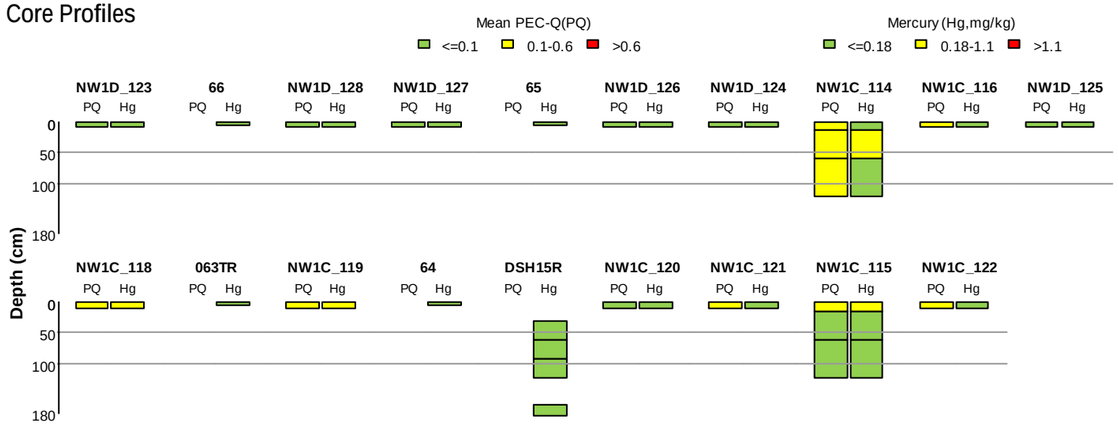
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (4 stations);Duluth-Superior Harbor Study, 1993 (1);Wisconsin Sampling, 2007 (14).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Duluth-Superior Harbor Study, 1993;Wisconsin Sampling, 2007.*

*Fish tissue studies:*

## Core Profiles



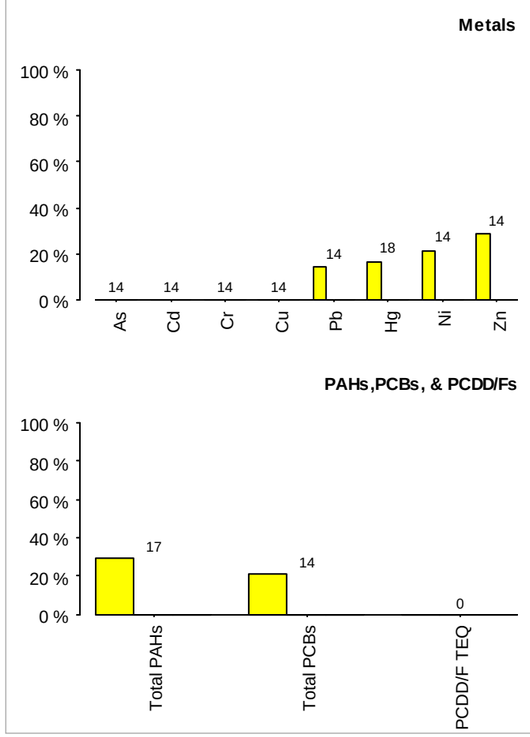

# Sediment Assessment Area Chemistry Characterization

## Data Summary

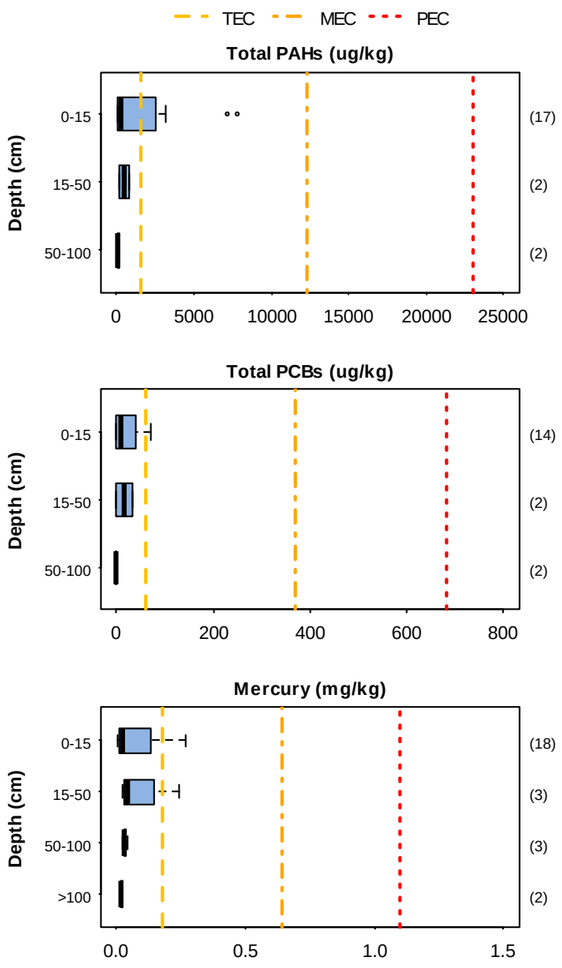
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 18(18) | 22(22) | 252(252) |
| Mercury | 19(19) | 26(26) | 26(26) |
| PAHs | 17(17) | 21(21) | 627(627) |
| PCBs | 14(14) | 18(18) | 198(198) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 14(14) | 18(18) | 32(32) |
| Other parameters | 19(19) | 26(26) | 291(291) |
| TOC | 19(19) | 26(26) | 26(26) |
| Grain size | 18(18) | 22(22) | 64(64) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

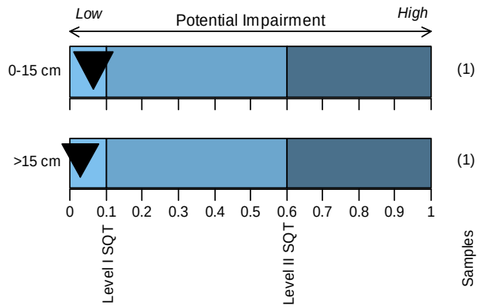
# Sediment Assessment Area Chemistry Characterization

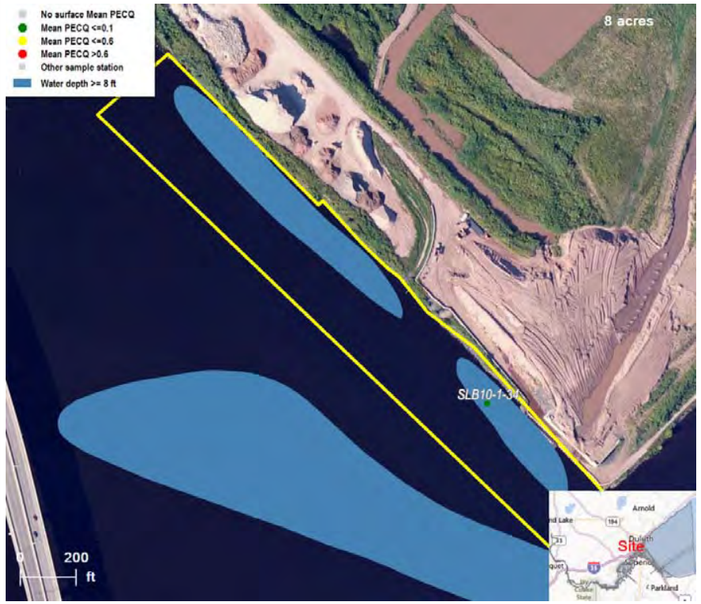
## Assessment Area # 58(Erie Pier Slip)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (1 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*St. Louis Bay 40th Ave., 2010.*

*Fish tissue studies:*

## Core Profiles

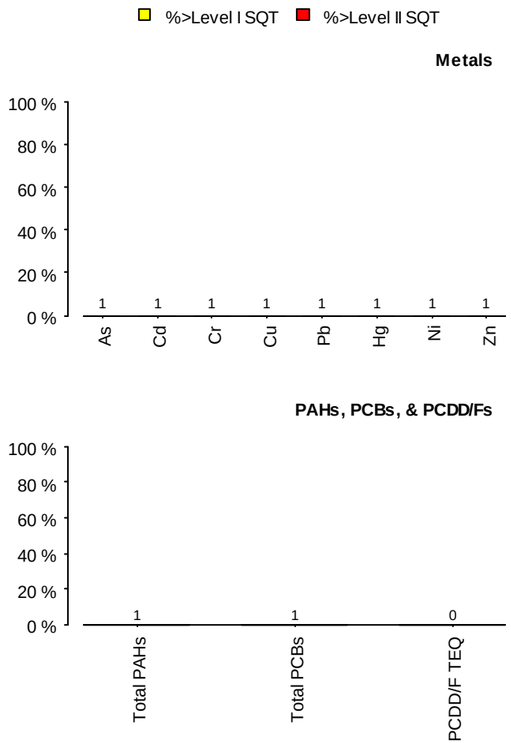

# Sediment Assessment Area Chemistry Characterization

## Data Summary

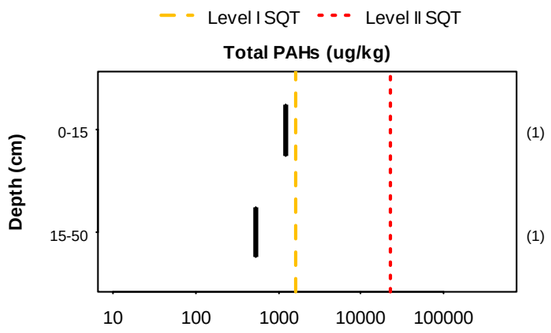
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 1(1) | 2(2) | 44(44) |
| Mercury | 1(1) | 2(2) | 2(2) |
| PAHs | 1(1) | 2(2) | 34(34) |
| PCBs | 1(1) | 2(2) | 18(18) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 1(1) | 2(2) | 32(32) |
| TOC | 1(1) | 2(2) | 2(2) |
| Grain size | 1(1) | 2(2) | 14(14) |

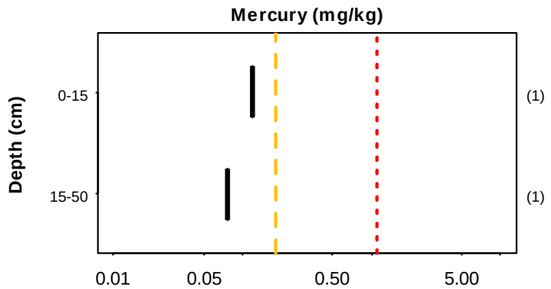
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 2 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

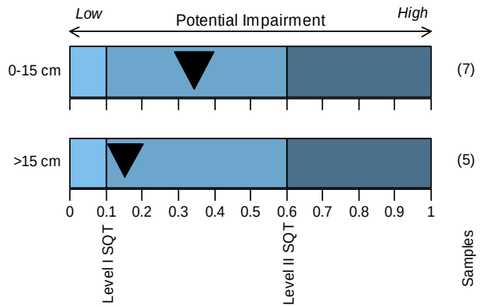
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 59(Ponds behind Erie Pier)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

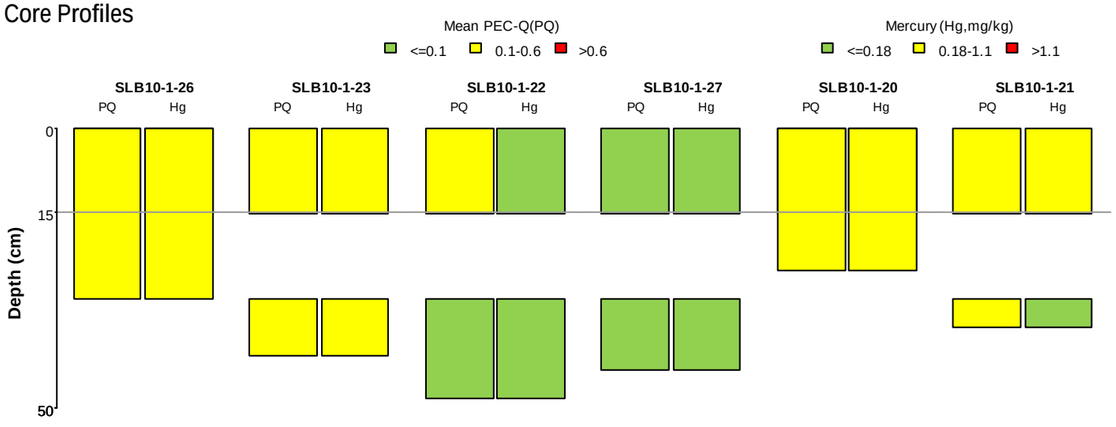
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (6 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*St. Louis Bay 40th Ave., 2010;40th Ave Macroinvertebrate Survey, 2010.*

*Fish tissue studies:*

## Core Profiles





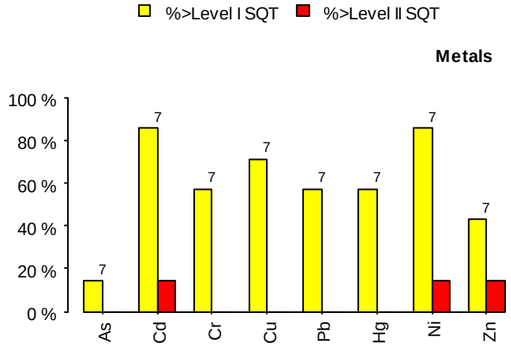
# Sediment Assessment Area Chemistry Characterization

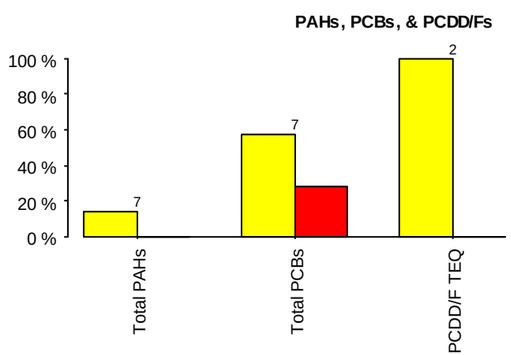

## Data Summary

**Available data in studies used for characterization (All available data)**

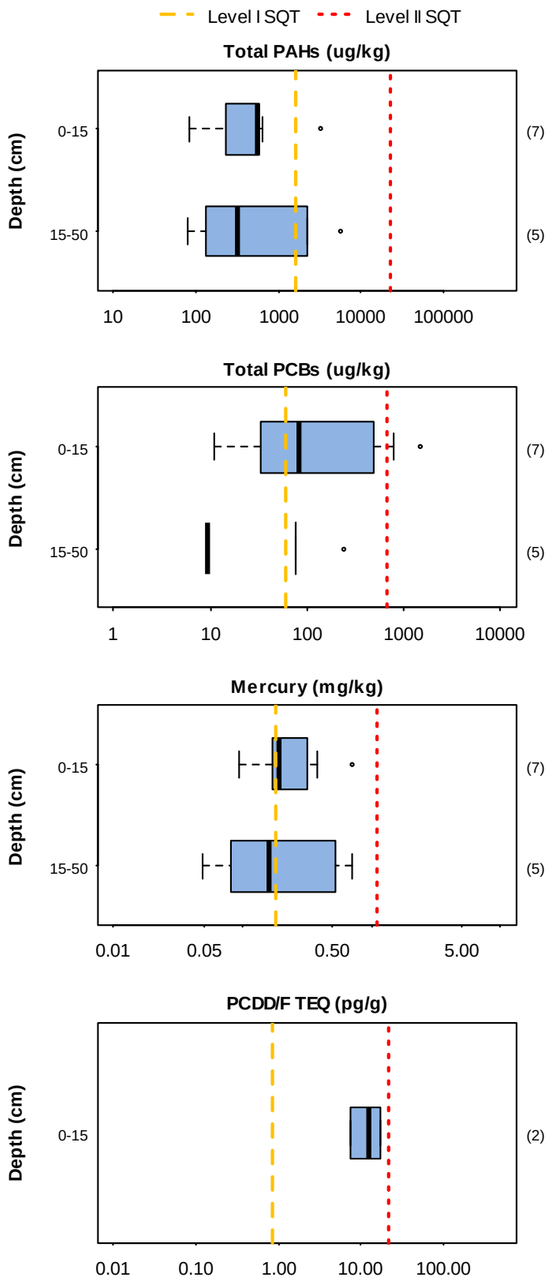
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 12(12) | 264(264) |
| Mercury | 6(6) | 12(12) | 12(12) |
| PAHs | 6(6) | 12(12) | 248(248) |
| PCBs | 6(6) | 12(12) | 526(526) |
| PCDD/Fs | 2(2) | 2(2) | 50(50) |
| Pesticides | 2(2) | 2(2) | 42(42) |
| Other parameters | 6(6) | 18(18) | 204(204) |
| TOC | 6(6) | 10(10) | 10(10) |
| Grain size | 5(5) | 6(6) | 42(42) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

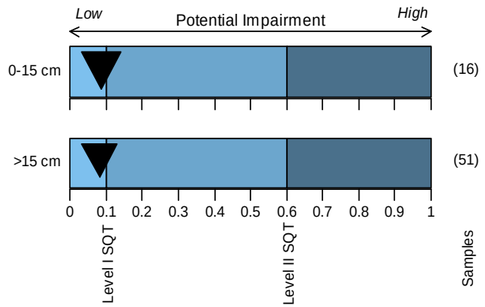
# Sediment Assessment Area Chemistry Characterization

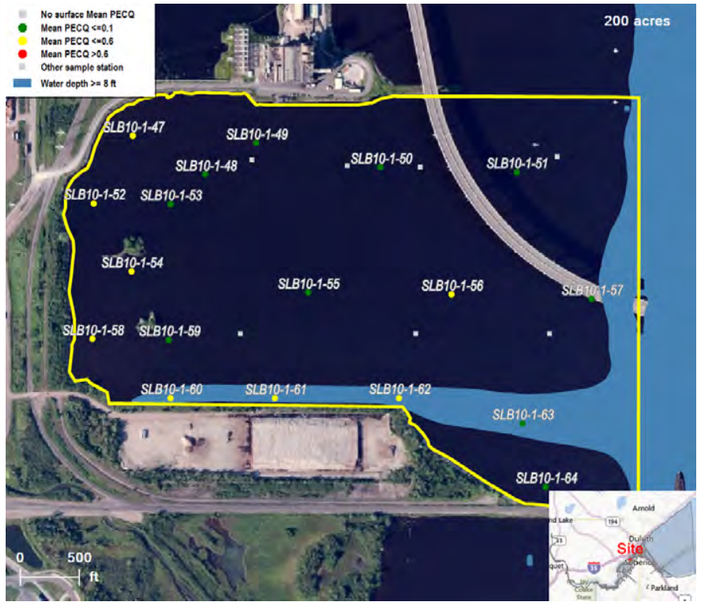
## Assessment Area # 60(Coffee Ground)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

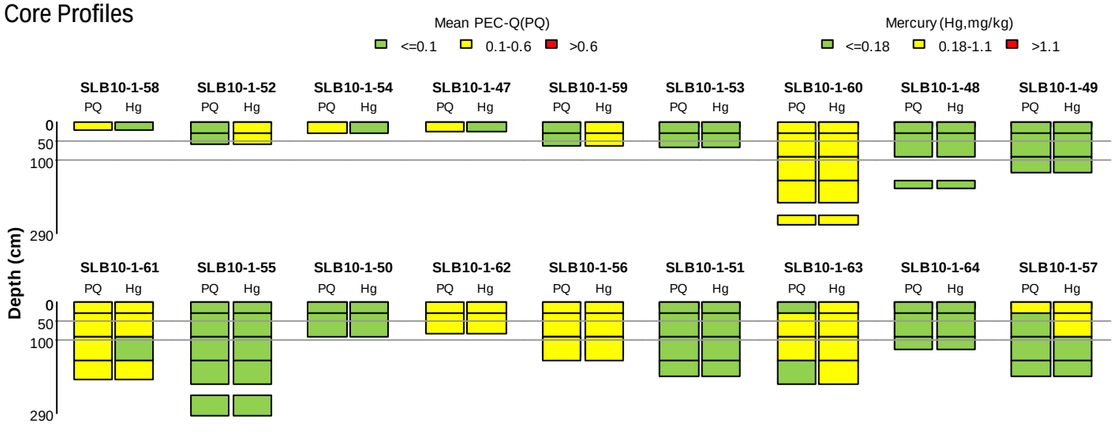
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (18 stations).*

*Other chemical studies:*
*Hotspot Study, 1994 (6 stations);Duluth-Superior Harbor Study, 1993 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Hotspot Study, 1994;Duluth-Superior Harbor Study, 1993;St. Louis Bay 40th Ave., 2010;40th Ave Macroinvertebrate Survey, 2010.*

*Fish tissue studies:*
*Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



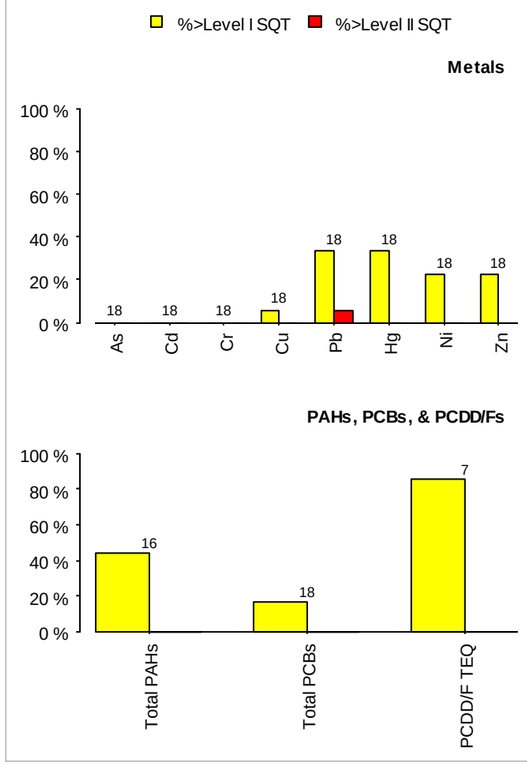

# Sediment Assessment Area Chemistry Characterization

## Data Summary

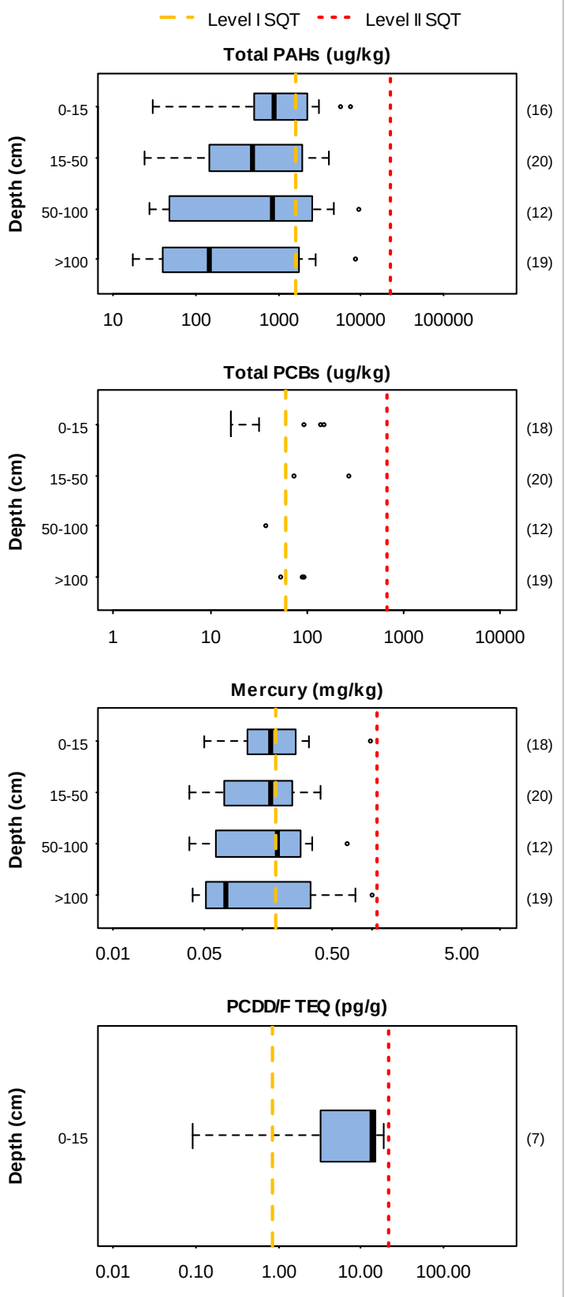
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 18(24) | 69(81) | 1518(1576) |
| Mercury | 18(25) | 69(83) | 69(83) |
| PAHs | 18(24) | 67(79) | 1249(1441) |
| PCBs | 18(18) | 69(69) | 2084(2084) |
| PCDD/Fs | 7(7) | 7(7) | 175(175) |
| Pesticides | 5(5) | 5(5) | 105(105) |
| Other parameters | 18(25) | 73(87) | 1131(1255) |
| TOC | 18(25) | 67(81) | 67(81) |
| Grain size | 18(24) | 65(77) | 455(563) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

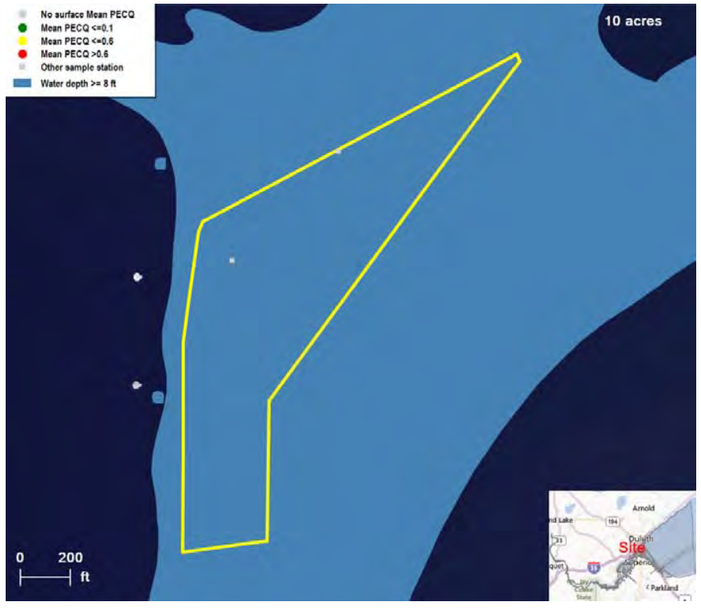
## Assessment Area # 61(South Channel - St. Louis Bay)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;USACE DACW35-93-D-0005 DELIVERY ORDER 29.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(16) |
| Mercury | 0(0) | 0(0) | 0(2) |
| PAHs | 0(0) | 0(0) | 0(16) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(11) |
| TOC | 0(0) | 0(0) | 0(2) |
| Grain size | 0(0) | 0(0) | 0(15) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

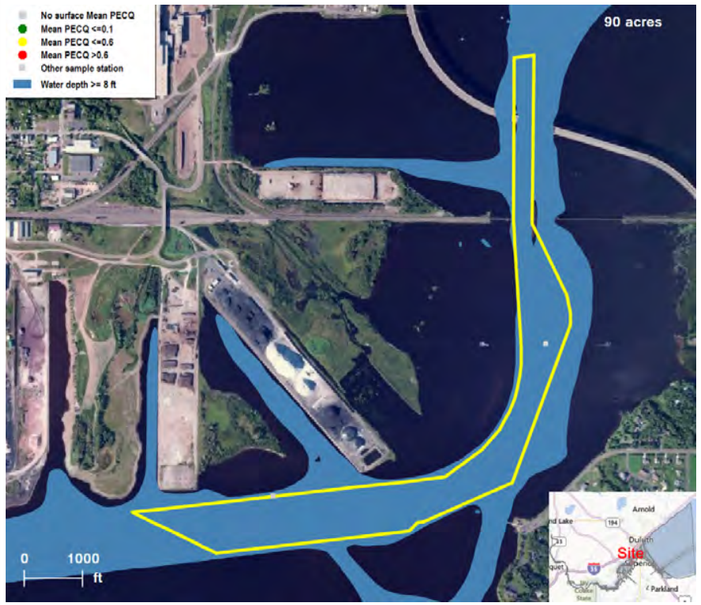
## Assessment Area # 62(Belknap Flats NC)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations);St. Louis Bay 40th Ave., 2010 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;St. Louis Bay 40th Ave., 2010.*

*Fish tissue studies:*
*Fond du Lac Fish Tissue Study 2000.*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(115) |
| Mercury | 0(0) | 0(0) | 0(6) |
| PAHs | 0(0) | 0(0) | 0(85) |
| PCBs | 0(0) | 0(0) | 0(45) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(81) |
| TOC | 0(0) | 0(0) | 0(6) |
| Grain size | 0(0) | 0(0) | 0(42) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

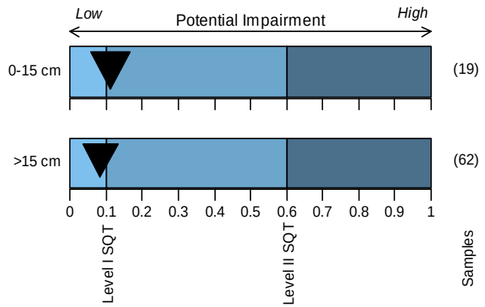
# Sediment Assessment Area Chemistry Characterization

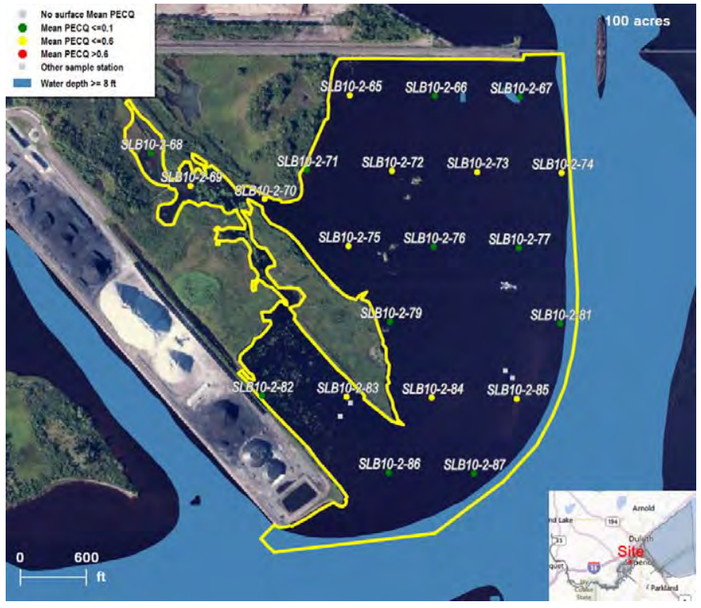
## Assessment Area # 63(Grassy Point)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

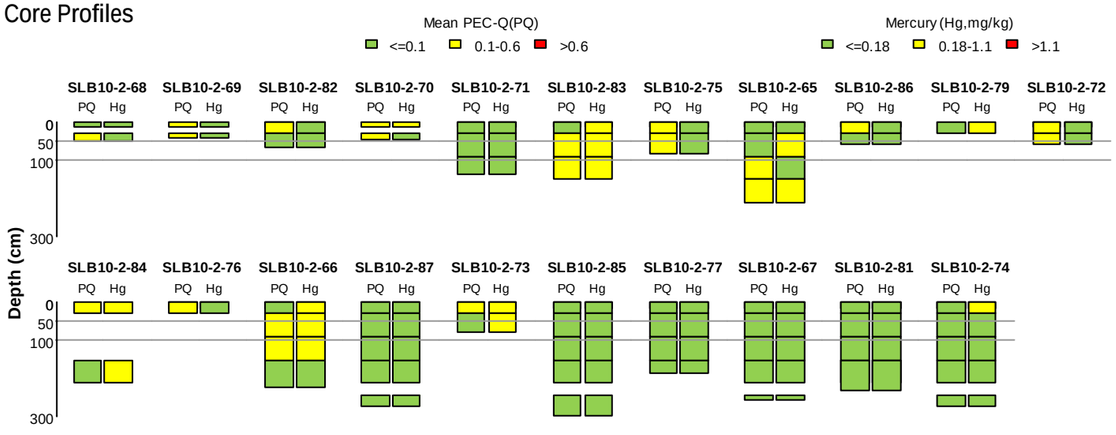
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (21 stations).*

*Other chemical studies:*
*R-EMAP Study, 1995 (2 stations);R-EMAP Study, 1996 (2).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;St. Louis Bay 40th Ave., 2010.*

*Fish tissue studies:*

## Core Profiles



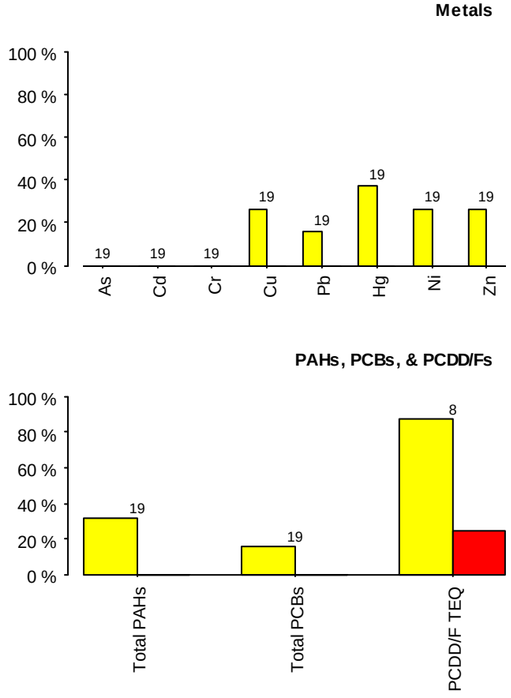

# Sediment Assessment Area Chemistry Characterization

## Data Summary

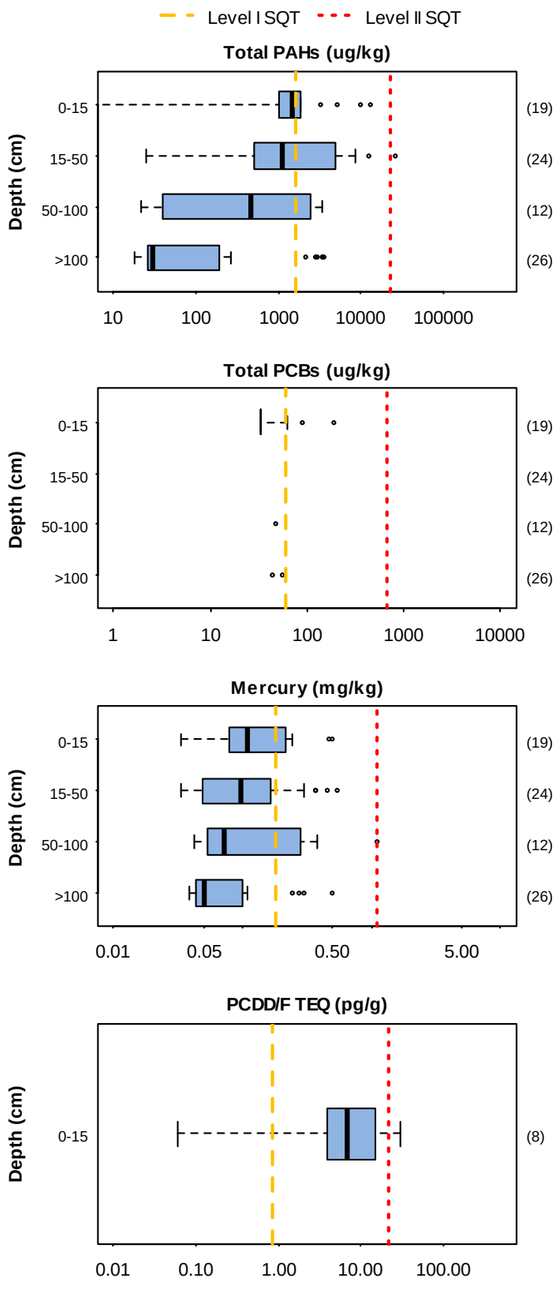
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 21(25) | 81(85) | 1782(1802) |
| Mercury | 21(25) | 81(85) | 81(85) |
| PAHs | 21(25) | 81(85) | 1553(1625) |
| PCBs | 21(21) | 81(81) | 2401(2401) |
| PCDD/Fs | 8(8) | 8(8) | 200(200) |
| Pesticides | 8(8) | 8(8) | 168(168) |
| Other parameters | 21(25) | 81(85) | 1352(1392) |
| TOC | 21(25) | 81(85) | 81(85) |
| Grain size | 21(25) | 81(85) | 567(595) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

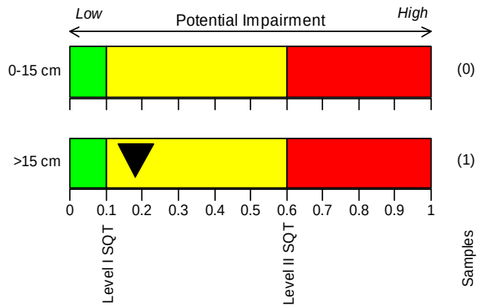
# Sediment Assessment Area Chemistry Characterization

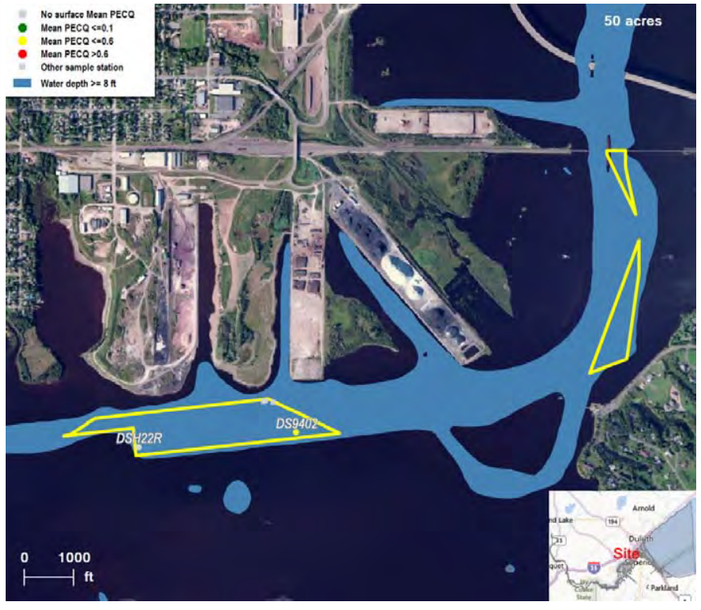
## Assessment Area # 64.1(St. Louis Bay South NC)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

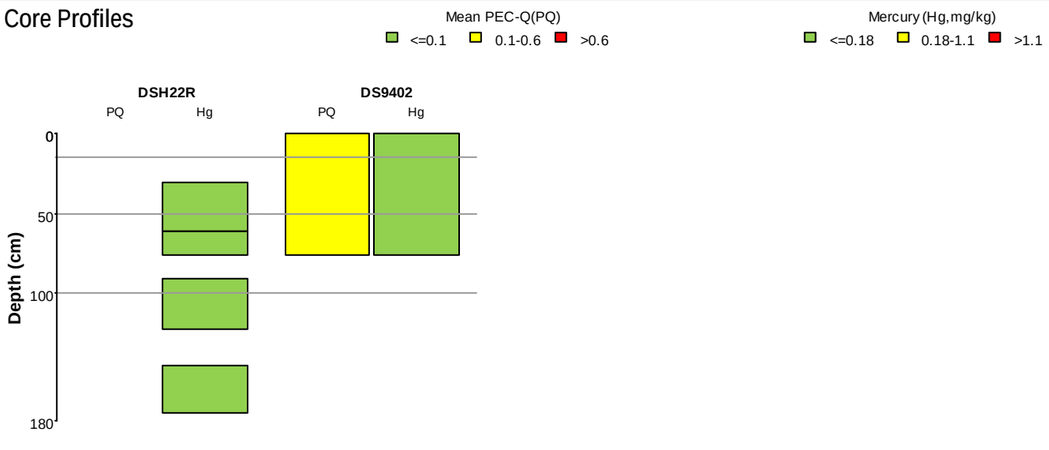
*Chemical studies used in the characterization: Duluth-Superior Harbor Study, 1993 (1 stations);USACE DACW35-93-D-0005 DELIVERY ORDER 29 (2);IT Interlake, 1999 (2).*

*Other chemical studies:*

*Macro-invertebrate studies: Duluth-Superior Harbor Study, 1993;USACE DACW35-93-D-0005 DELIVERY ORDER 29;IT Interlake, 1999.*

*Fish tissue studies: Fond du Lac Fish Tissue Study 2000.*

## Core Profiles




# Sediment Assessment Area Chemistry Characterization

## Data Summary

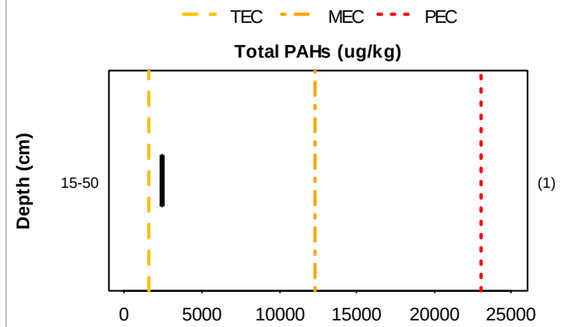
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 2(2) | 22(22) |
| Mercury | 3(3) | 6(6) | 6(6) |
| PAHs | 4(4) | 5(5) | 83(83) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 5(5) | 9(9) | 55(55) |
| TOC | 3(3) | 6(6) | 6(6) |
| Grain size | 4(4) | 5(5) | 19(19) |

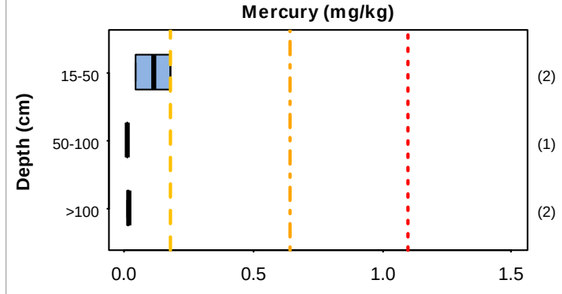
## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

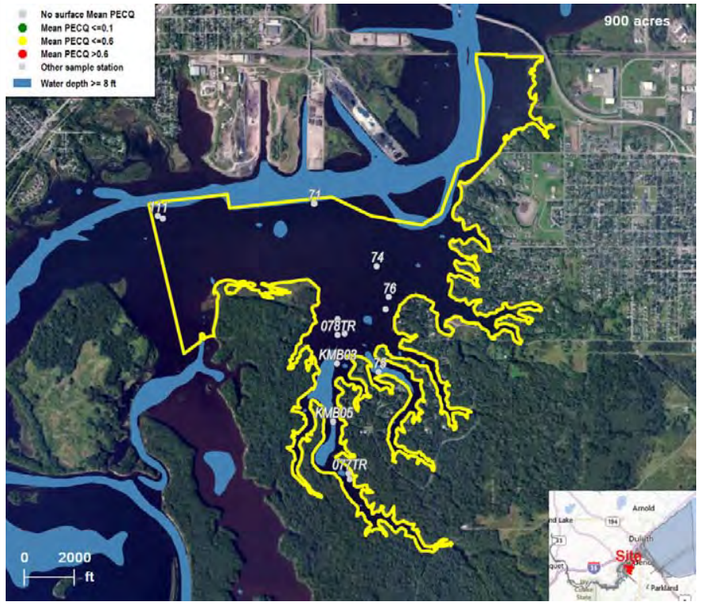
## Assessment Area # 64.2(St. Louis Bay South)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

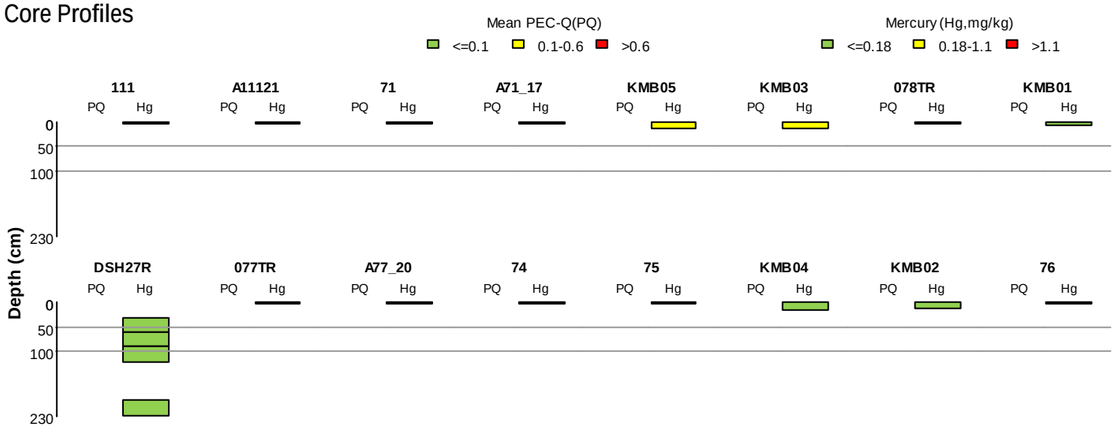
*Chemical studies used in the characterization: R-EMAP Study, 1995 (7 stations);Hotspot Study, 1994 (5);R-EMAP Study, 1996 (3);Duluth-Superior Harbor Study, 1993 (1).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;Hotspot Study, 1994;R-EMAP Study, 1996;Duluth-Superior Harbor Study, 1993;40th Ave Macroinvertebrate Survey, 2010.*

*Fish tissue studies:*

## Core Profiles



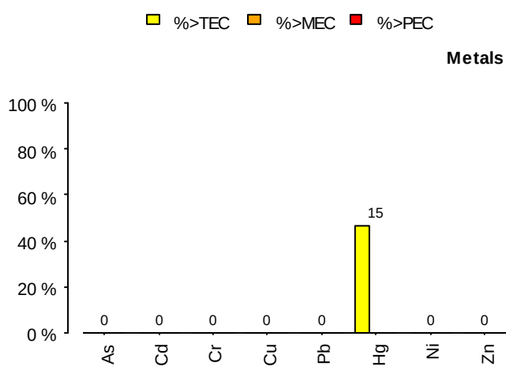

# Sediment Assessment Area Chemistry Characterization

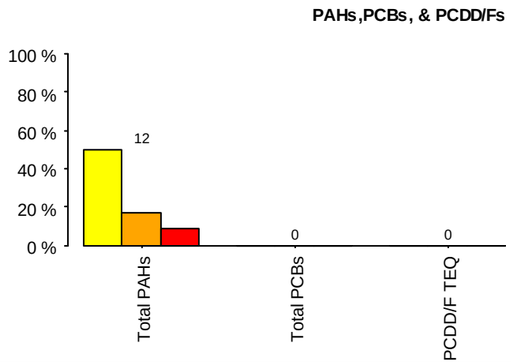
## Data Summary

**Available data in studies used for characterization (All available data)**

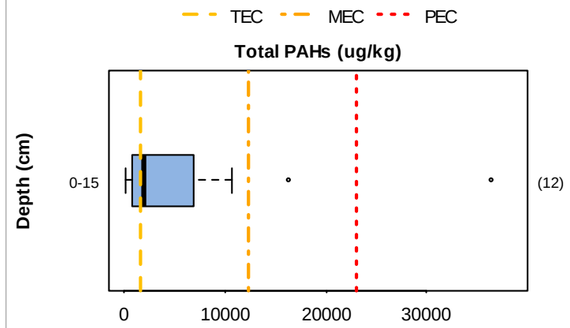
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 15(15) | 15(15) | 75(75) |
| Mercury | 16(16) | 19(19) | 19(19) |
| PAHs | 12(12) | 12(12) | 205(205) |
| PCBs | 5(5) | 5(5) | 361(361) |
| PCDD/Fs | 5(5) | 5(5) | 10(10) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 16(16) | 19(19) | 151(151) |
| TOC | 16(16) | 19(19) | 19(19) |
| Grain size | 15(15) | 15(15) | 115(115) |

## Results Exceeding Thresholds (0-15 cm samples)

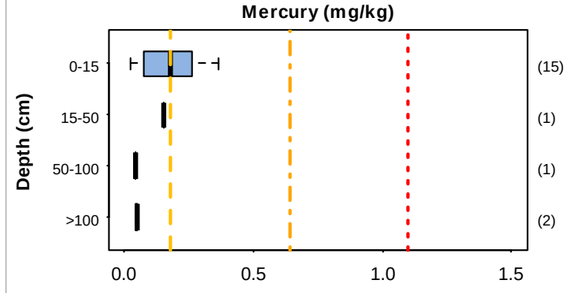



## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

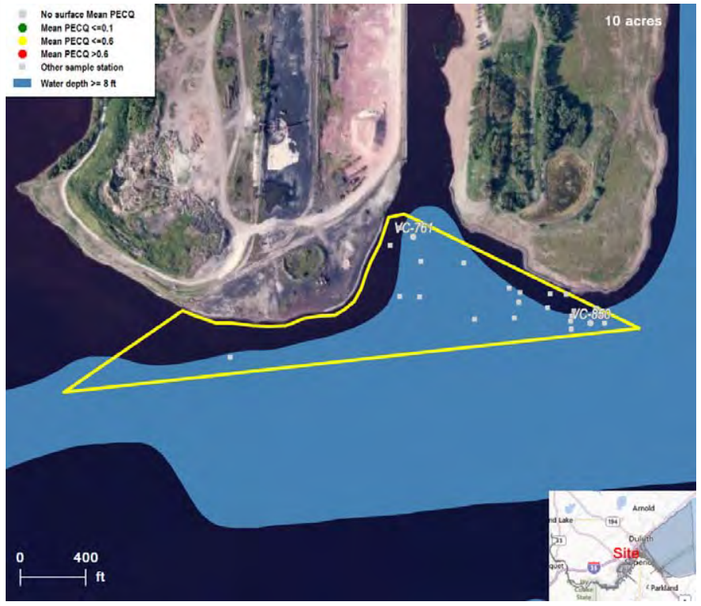
## Assessment Area # 64.3(SLRIDT - Wisconsin)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization: IT Interlake Toxicity study, 1996 (1 stations);IT Interlake, 1996 (1);IT Interlake, 1999 (14);Service Intlk WPIIIA, 2001 (4);SLRIDT Stryker Bay-Slip 7 SEG 2003-04 (5).*

*Other chemical studies:*

*Macro-invertebrate studies: IT Interlake Toxicity study, 1996;IT Interlake, 1996;IT Interlake, 1999;Service Intlk WPIIIA, 2001;SLRIDT Stryker Bay-Slip 7 SEG 2003-04.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

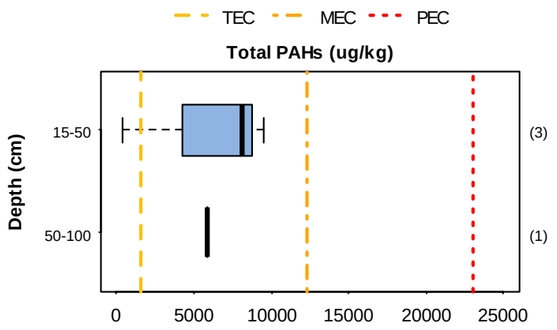
# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 13(13) | 102(102) |
| Mercury | 6(6) | 13(13) | 13(13) |
| PAHs | 25(25) | 43(43) | 730(730) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 25(25) | 43(43) | 988(988) |
| TOC | 2(2) | 3(3) | 3(3) |
| Grain size | 16(16) | 31(31) | 34(34) |

## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

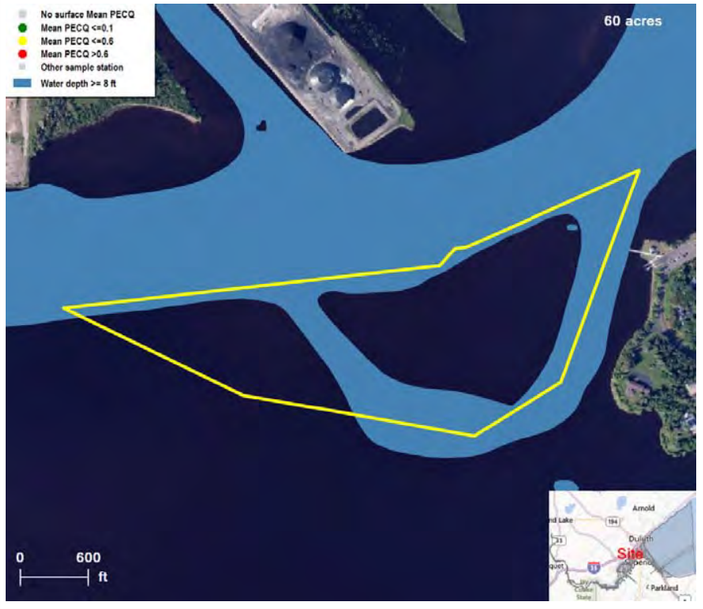
## Assessment Area # 65(Belknap Flats)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

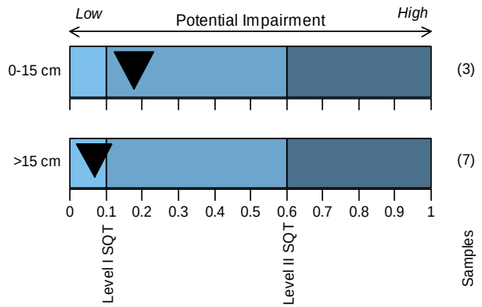
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 66(C. Reiss Coal Dock Slip)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

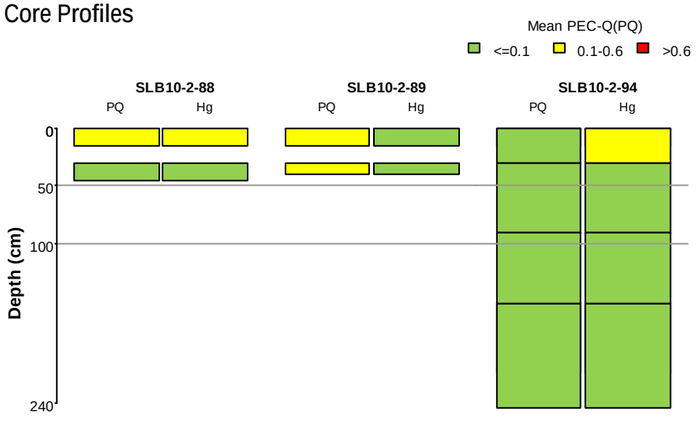
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (3 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*St. Louis Bay 40th Ave., 2010.*

*Fish tissue studies:*

## Core Profiles



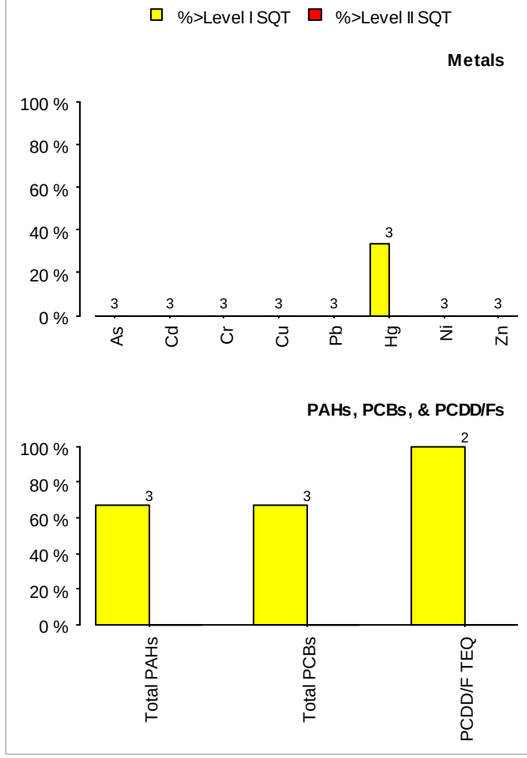

# Sediment Assessment Area Chemistry Characterization

## Data Summary

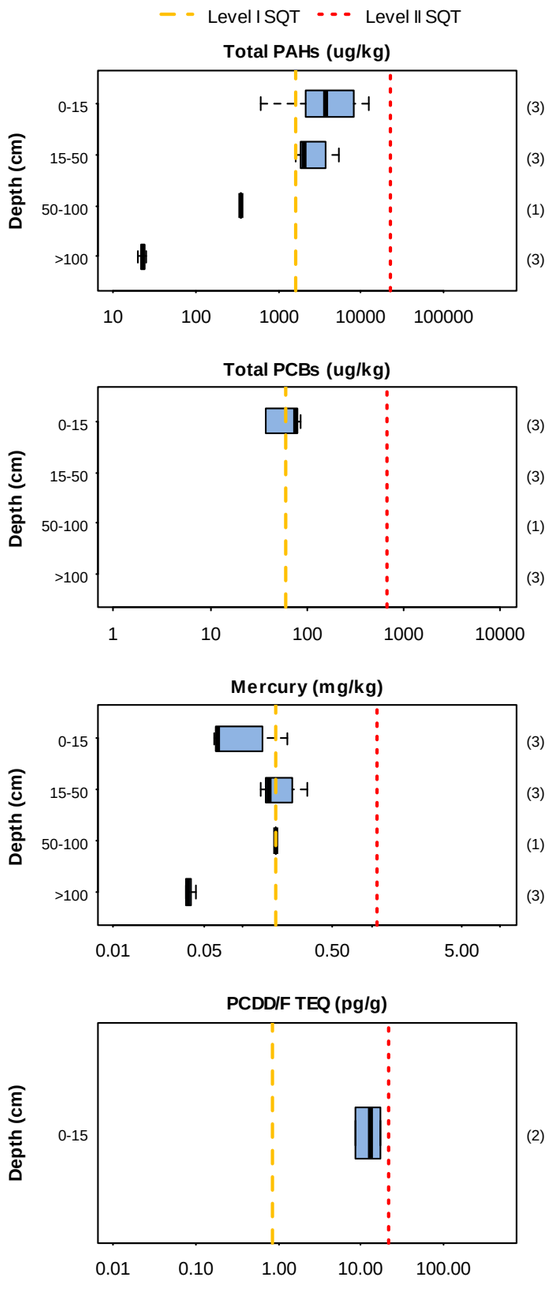
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(3) | 10(10) | 220(220) |
| Mercury | 3(3) | 10(10) | 10(10) |
| PAHs | 3(3) | 10(10) | 214(214) |
| PCBs | 3(3) | 10(10) | 508(508) |
| PCDD/Fs | 2(2) | 2(2) | 50(50) |
| Pesticides | 2(2) | 2(2) | 42(42) |
| Other parameters | 3(3) | 10(10) | 174(174) |
| TOC | 3(3) | 10(10) | 10(10) |
| Grain size | 3(3) | 10(10) | 70(70) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

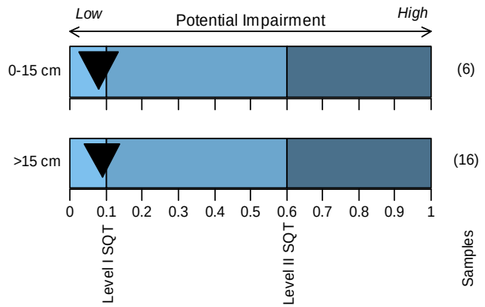
# Sediment Assessment Area Chemistry Characterization

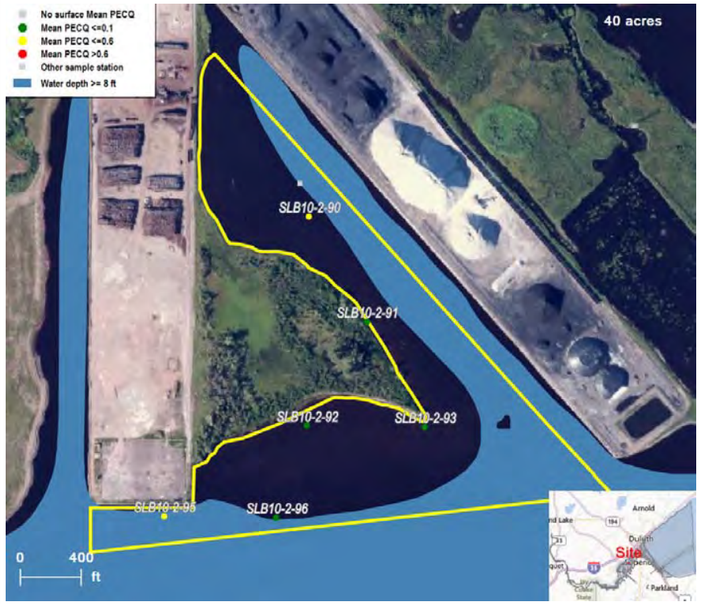
## Assessment Area # 67(Bay between C. Reiss and SLRIDT 7)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

### Studies with Samples in Sediment Assessment Area:

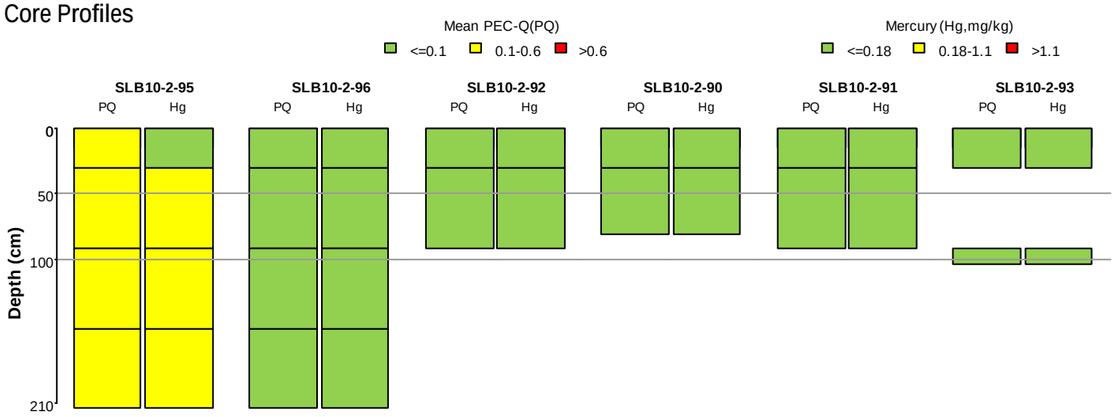
*Chemical studies used in the characterization:*
*St. Louis Bay 40th Ave., 2010 (6 stations).*

*Other chemical studies:*
*Duluth-Superior Harbor Study, 1993 (1 stations).*

*Macro-invertebrate studies:*
*Duluth-Superior Harbor Study, 1993;St. Louis Bay 40th Ave., 2010.*

*Fish tissue studies:*

## Core Profiles



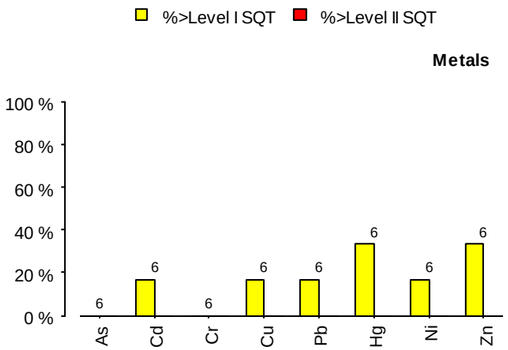

# Sediment Assessment Area Chemistry Characterization

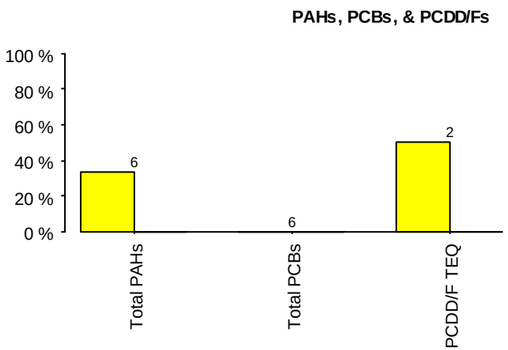
## Data Summary

**Available data in studies used for characterization (All available data)**

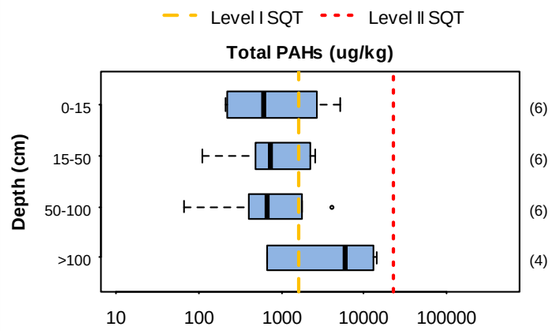
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 22(22) | 484(484) |
| Mercury | 6(7) | 22(26) | 22(26) |
| PAHs | 6(6) | 22(22) | 418(418) |
| PCBs | 6(6) | 22(22) | 616(616) |
| PCDD/Fs | 2(2) | 2(2) | 50(50) |
| Pesticides | 2(2) | 2(2) | 42(42) |
| Other parameters | 6(7) | 22(26) | 366(374) |
| TOC | 6(7) | 22(26) | 22(26) |
| Grain size | 6(6) | 22(22) | 154(154) |

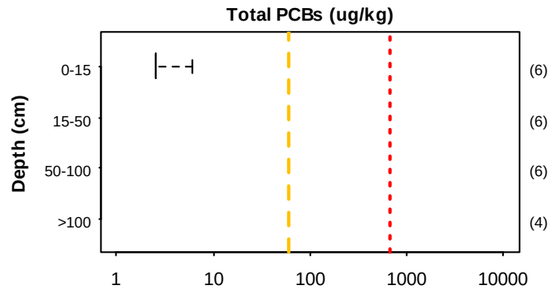
## Results Exceeding Thresholds (0-15 cm samples)

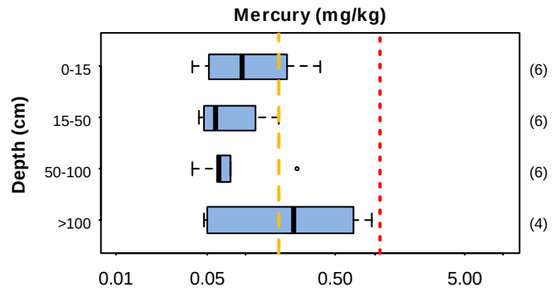


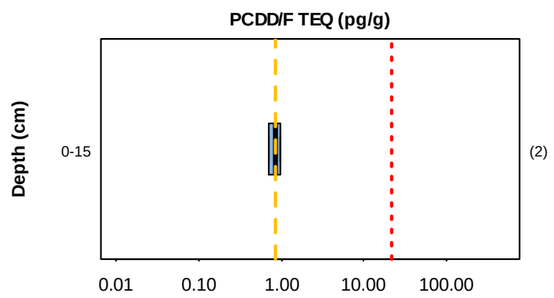




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

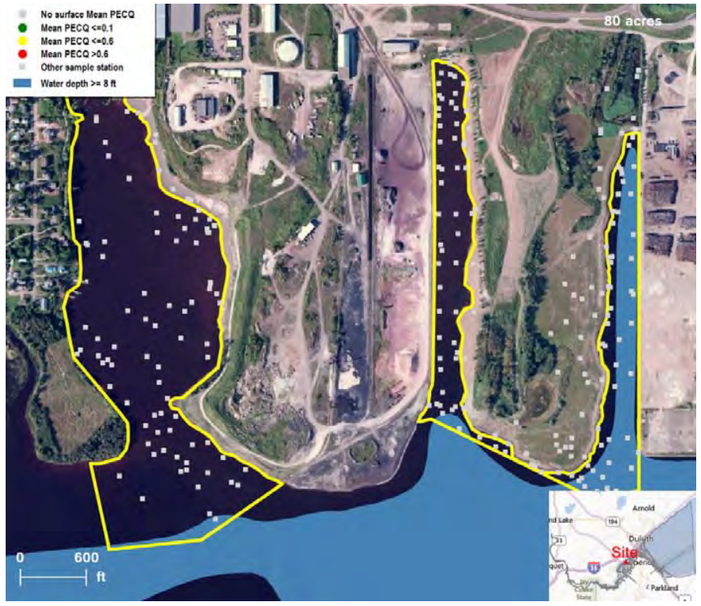
## Assessment Area # 68(SLRIDT Superfund Site)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*Duluth Superfund Sites, 1993 (3 stations);R-EMAP Study, 1995 (3);R-EMAP Study, 1996 (2);Duluth-Superior Harbor Study, 1993 (1);IT Interlake Toxicity study, 1996 (12);IT Interlake, 1993 (7);IT Interlake, 1996 (27);IT Interlake, 1997 (6);IT Interlake, 1998 (25);IT Interlake, 1999 (167);Service Intlk, 2000 (10);Service Intlk WPIIIA, 2001 (37);Service Intlk WPIII, 2001 (31);Bay West Intlk Supplemental 2001 (14);Bay West Intlk Reconnaissance 2001 (18);SLRIDT Stryker Bay-Slip 7 SEG 2003-04 (24).*

*Macro-invertebrate studies:*
*Duluth Superfund Sites, 1993;R-EMAP Study, 1995;R-EMAP Study, 1996;Duluth-Superior Harbor Study, 1993;IT Interlake Toxicity study, 1996;IT Interlake, 1993;IT Interlake, 1996;IT Interlake, 1997;IT Interlake, 1998;IT Interlake, 1999;Service Intlk, 2000;Service Intlk WPIIIA, 2001;Service Intlk WPIII, 2001;Bay West Intlk Supplemental 2001;Bay West Intlk Reconnaissance 2001;SLRIDT Stryker Bay-Slip 7 SEG 2003-04;US Steel Macroinvertebrate Survey.*

*Fish tissue studies:*
*Bay West Intlk Supplemental 2001;Fond du Lac Fish Tissue Study 2000;St. Louis River USFWS 2001-02.*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(1298) |
| Mercury | 0(0) | 0(0) | 0(173) |
| PAHs | 0(0) | 0(0) | 0(8740) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(15) |
| Pesticides | 0(0) | 0(0) | 0(24) |
| Other parameters | 0(0) | 0(0) | 0(7557) |
| TOC | 0(0) | 0(0) | 0(167) |
| Grain size | 0(0) | 0(0) | 0(1453) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

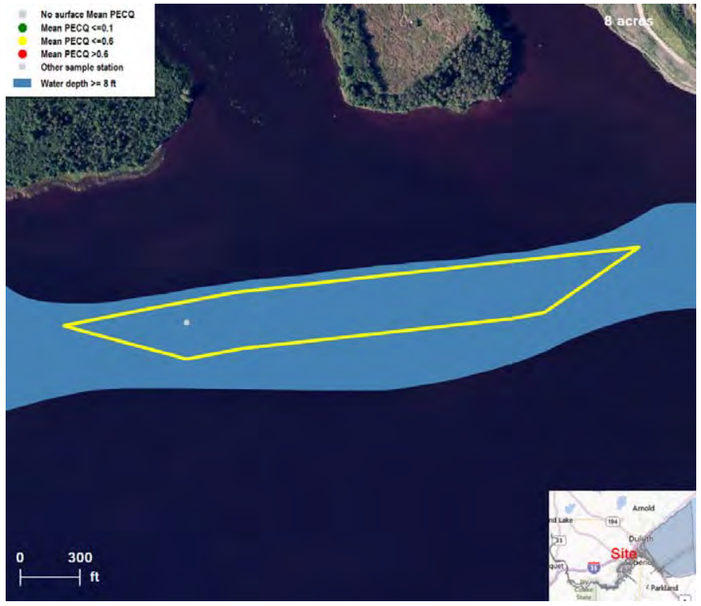
## Assessment Area # 69(Dwights Point Estuary Flats)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*
*Lower St. Louis River, 2011 (1 stations).*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(20) |
| Mercury | 0(0) | 0(0) | 0(2) |
| PAHs | 0(0) | 0(0) | 0(80) |
| PCBs | 0(0) | 0(0) | 0(14) |
| PCDD/Fs | 0(0) | 0(0) | 0(50) |
| Pesticides | 0(0) | 0(0) | 0(56) |
| Other parameters | 0(0) | 0(0) | 0(130) |
| TOC | 0(0) | 0(0) | 0(2) |
| Grain size | 0(0) | 0(0) | 0(4) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

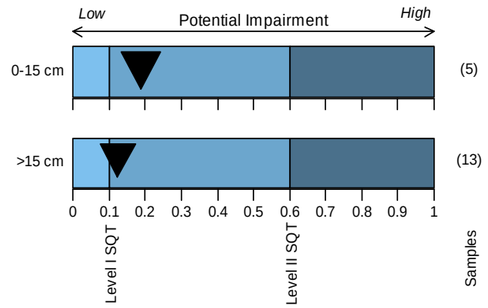
# Sediment Assessment Area Chemistry Characterization

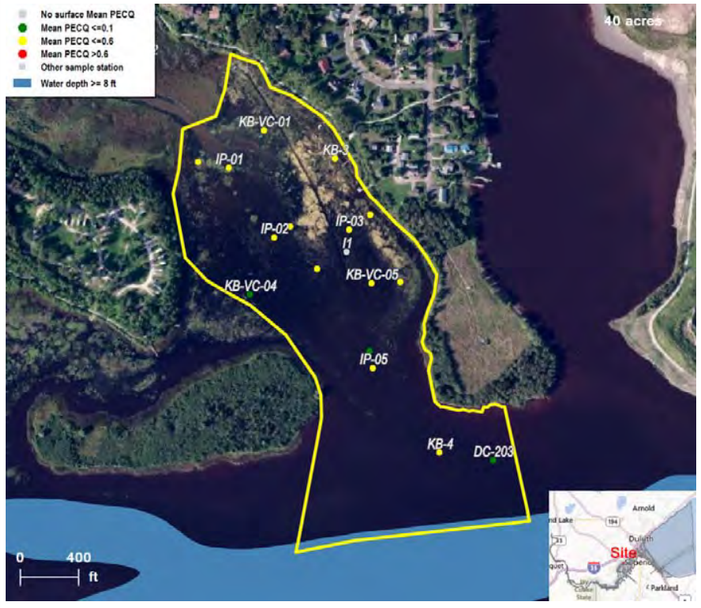
## Assessment Area # 70(Kingsbury Bay)

*Geographic zone: St. Louis Bay*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

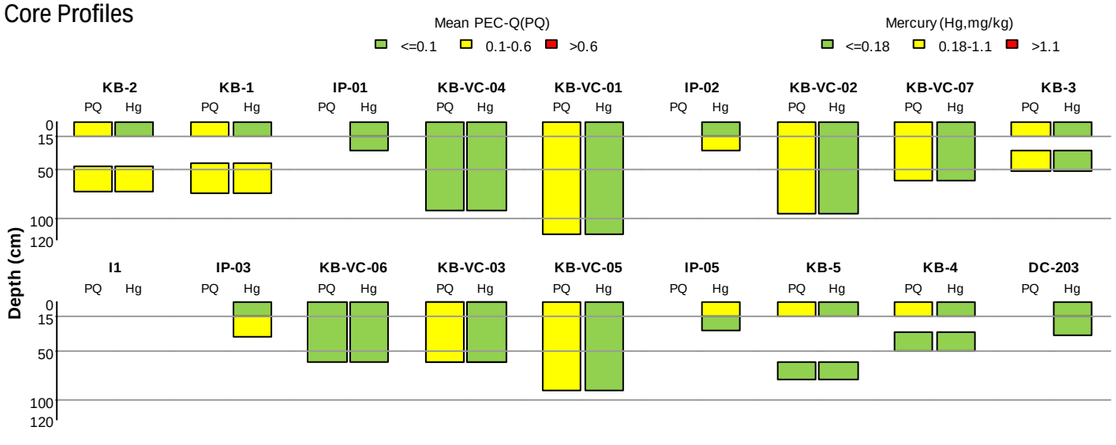
*Chemical studies used in the characterization: Service Intlk WPIIIA, 2001 (1 stations);Bay West Intlk Supplemental 2001 (5);Bay West Intlk Reconnaissance 2001 (1);Reference sites, 2001 (4);SLRIDT Reference Sites SEG 2004 (7);Lower St. Louis River, 2011 (5).*

*Other chemical studies:*

*Macro-invertebrate studies: Service Intlk WPIIIA, 2001;Bay West Intlk Supplemental 2001;Bay West Intlk Reconnaissance 2001;Reference sites, 2001;SLRIDT Reference Sites SEG 2004;Lower St. Louis River, 2011;US Steel Macroinvertebrate Survey.*

*Fish tissue studies: Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



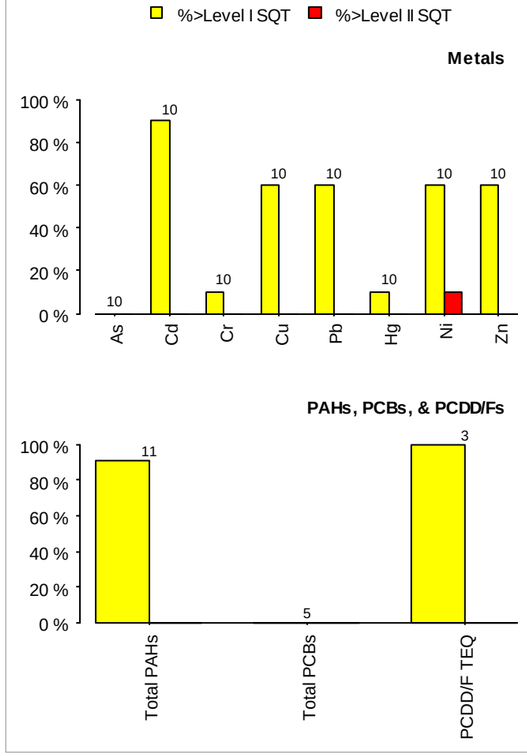

# Sediment Assessment Area Chemistry Characterization

## Data Summary

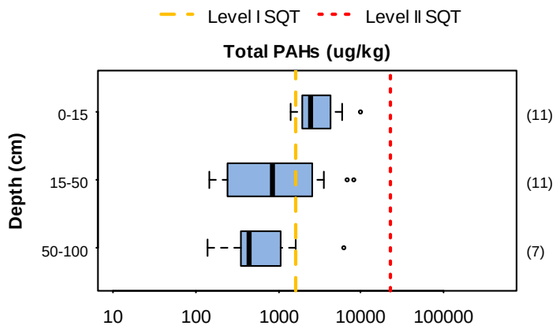
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 17(17) | 28(28) | 266(266) |
| Mercury | 17(17) | 28(28) | 28(28) |
| PAHs | 18(18) | 29(29) | 835(835) |
| PCBs | 12(12) | 18(18) | 134(134) |
| PCDD/Fs | 3(3) | 6(6) | 150(150) |
| Pesticides | 10(10) | 14(14) | 239(239) |
| Other parameters | 18(18) | 29(29) | 1331(1331) |
| TOC | 16(16) | 26(26) | 26(26) |
| Grain size | 14(14) | 23(23) | 33(33) |

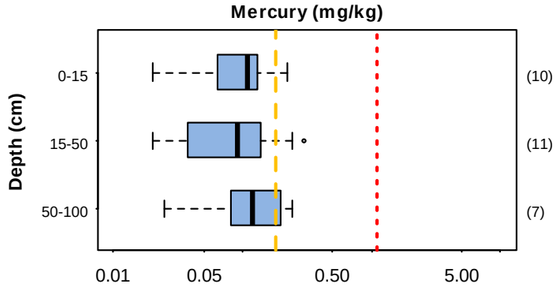
## Results Exceeding Thresholds (0-15 cm samples)

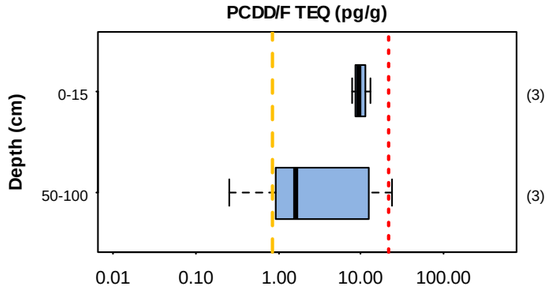



## Distributions of Constituent Concentrations




No PCBs detected in 18 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

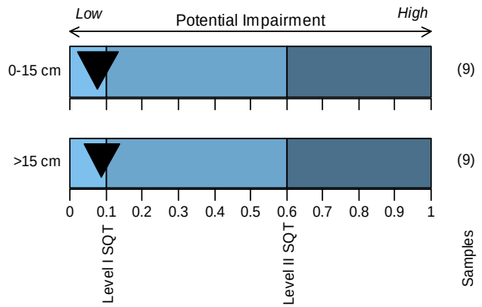
# Sediment Assessment Area Chemistry Characterization

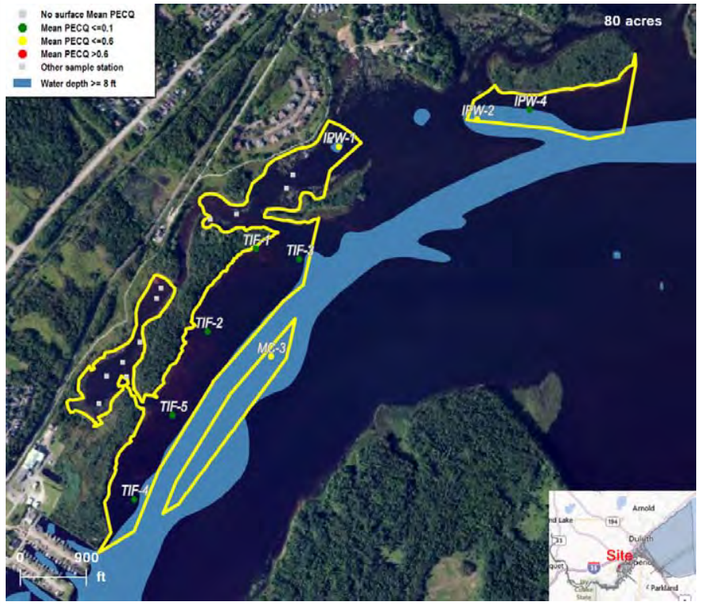
## Assessment Area # 71.1(Tallas Island)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

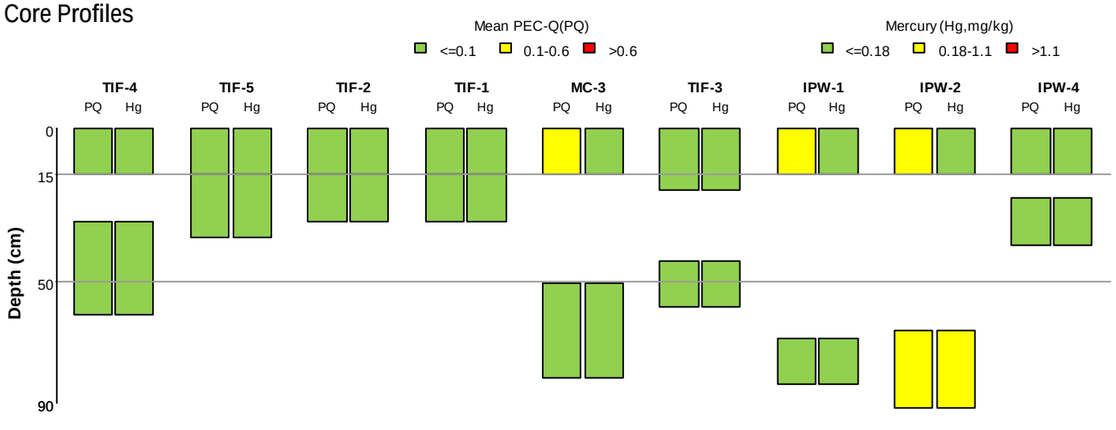
*Chemical studies used in the characterization: Lower St. Louis River, 2011 (9 stations).*

*Other chemical studies: Bay West Intlk Supplemental 2001 (2 stations);Bay West Intlk Reconnaissance 2001 (1);Reference sites, 2001 (3);SLRIDT Stryker Bay-Slip 7 SEG 2003-04 (3);SLRIDT Reference Sites SEG 2004 (8).*

*Macro-invertebrate studies: Duluth-Superior Harbor Study, 1993;Bay West Intlk Supplemental 2001;Bay West Intlk Reconnaissance 2001;Reference sites, 2001;SLRIDT Stryker Bay-Slip 7 SEG 2003-04;SLRIDT Reference Sites SEG 2004;Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



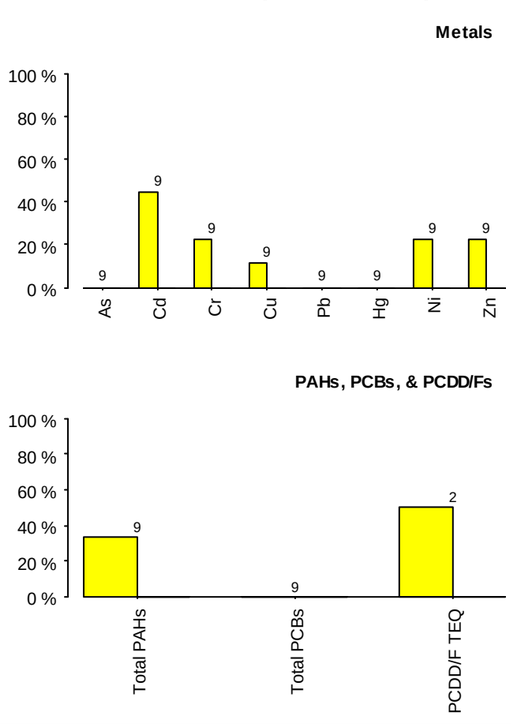

# Sediment Assessment Area Chemistry Characterization

## Data Summary

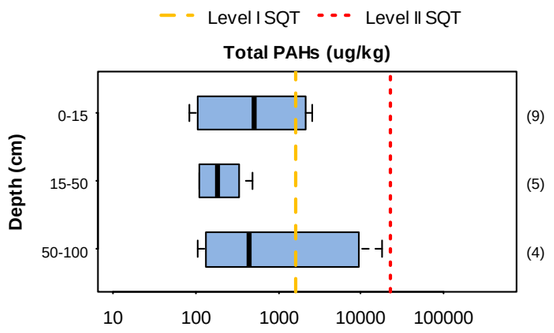
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 9(20) | 18(35) | 180(354) |
| Mercury | 9(20) | 18(35) | 18(35) |
| PAHs | 9(21) | 18(36) | 692(1088) |
| PCBs | 9(17) | 18(29) | 126(214) |
| PCDD/Fs | 2(2) | 4(4) | 100(100) |
| Pesticides | 2(7) | 4(9) | 112(157) |
| Other parameters | 9(21) | 18(36) | 498(1088) |
| TOC | 9(17) | 18(29) | 18(29) |
| Grain size | 9(14) | 18(26) | 36(44) |

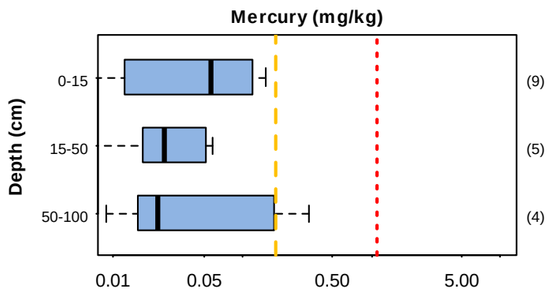
## Results Exceeding Thresholds (0-15 cm samples)

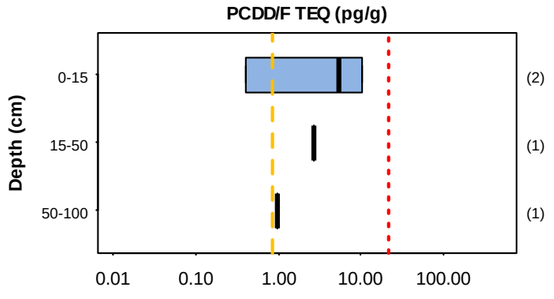



## Distributions of Constituent Concentrations




No PCBs detected in 18 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

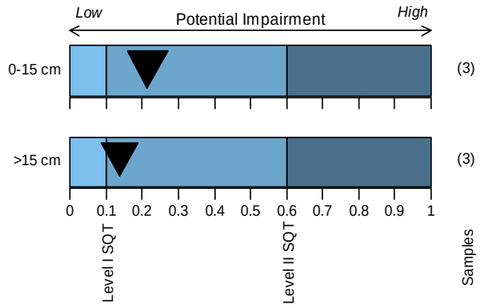
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 71.2(Kingsbury Bay Complex)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

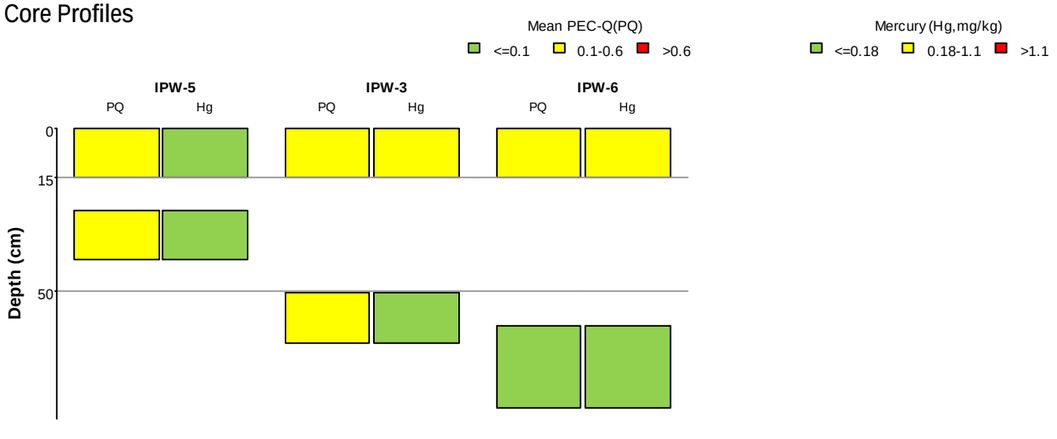
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (3 stations).*

*Other chemical studies:*
*Bay West Intlk Supplemental 2001 (7 stations);Reference sites, 2001 (2).*

*Macro-invertebrate studies:*
*Bay West Intlk Supplemental 2001;Reference sites, 2001;Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



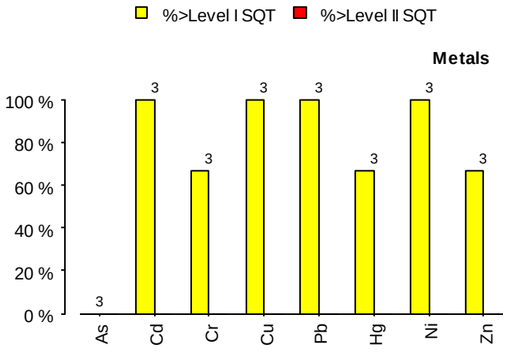

# Sediment Assessment Area Chemistry Characterization

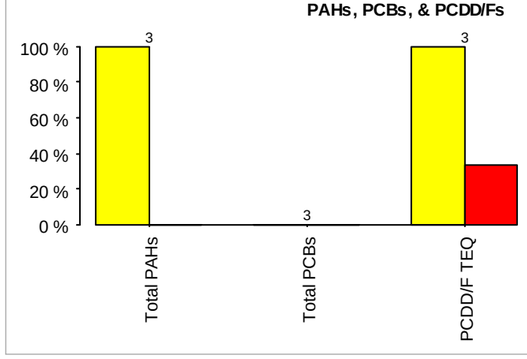
## Data Summary

**Available data in studies used for characterization (All available data)**

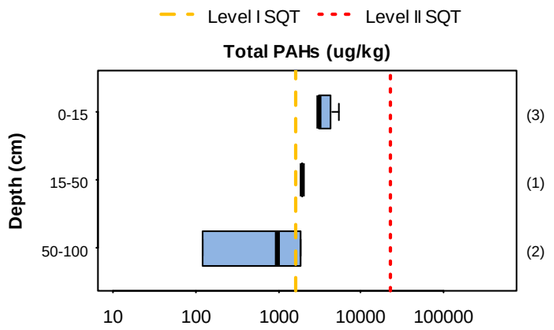
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(5) | 6(10) | 60(88) |
| Mercury | 3(5) | 6(10) | 6(10) |
| PAHs | 3(5) | 6(10) | 240(368) |
| PCBs | 3(3) | 6(6) | 42(42) |
| PCDD/Fs | 3(3) | 6(6) | 150(150) |
| Pesticides | 3(3) | 6(6) | 168(168) |
| Other parameters | 3(5) | 6(10) | 390(694) |
| TOC | 3(5) | 6(10) | 6(10) |
| Grain size | 3(12) | 6(17) | 12(23) |

## Results Exceeding Thresholds (0-15 cm samples)

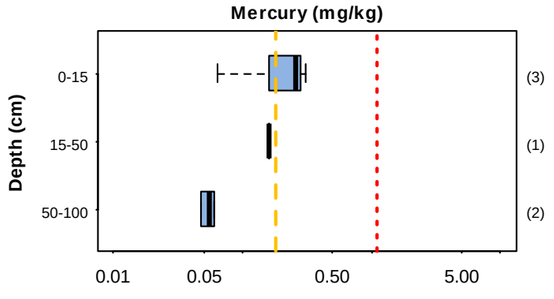


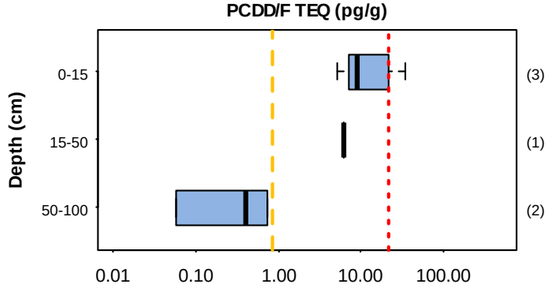




## Distributions of Constituent Concentrations




No PCBs detected in 6 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

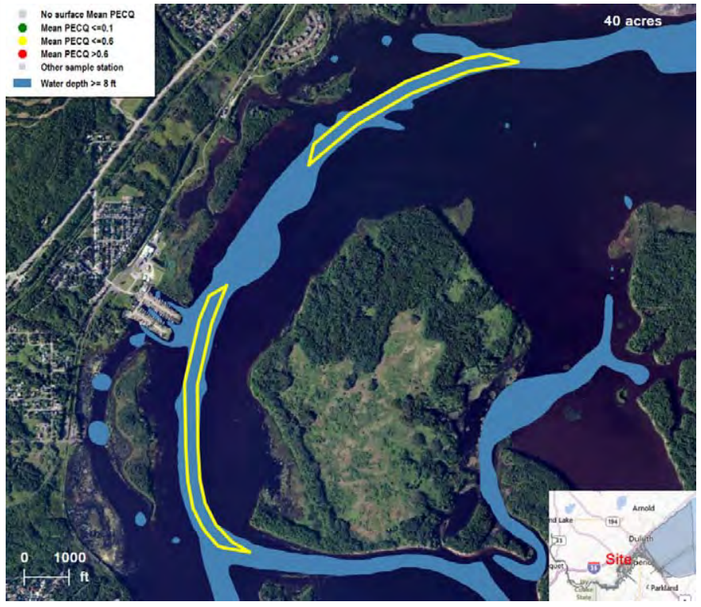
## Assessment Area # 72.1(Clough Island NC)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

TEC MEC PEC

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

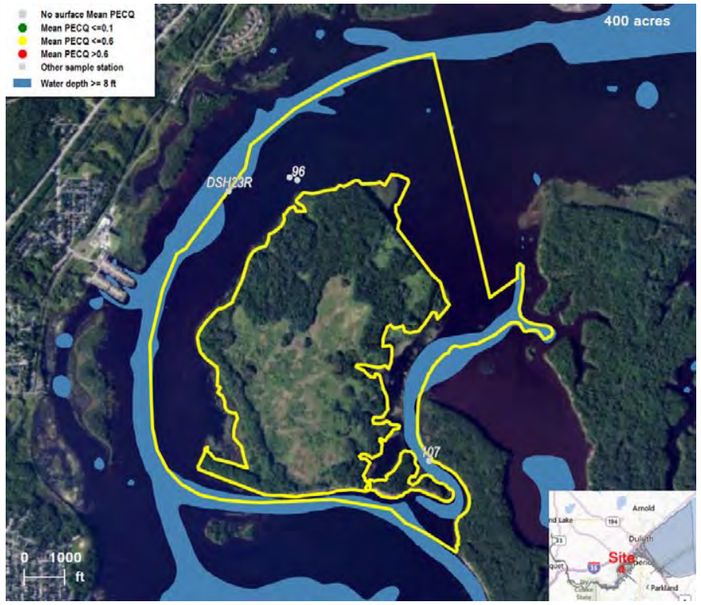
## Assessment Area # 72.2(Clough Island)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

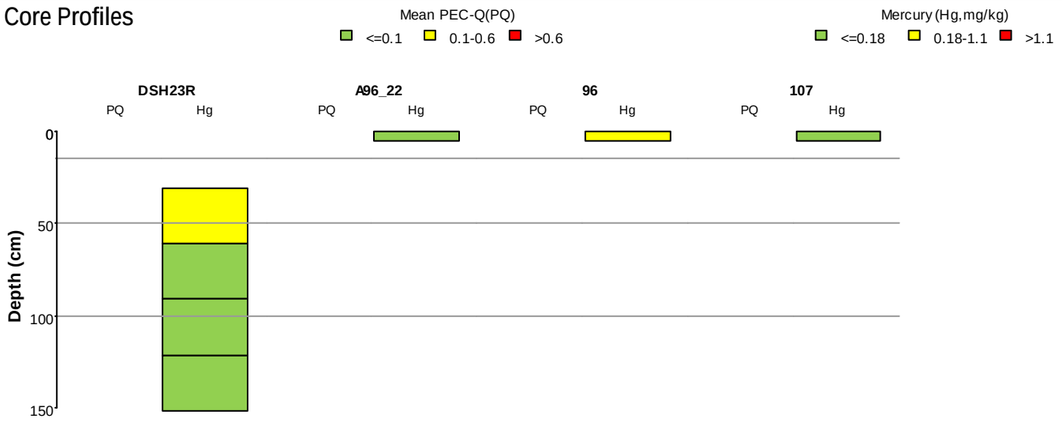
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (2 stations);R-EMAP Study, 1996 (1);Duluth-Superior Harbor Study, 1993 (1).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;Duluth-Superior Harbor Study, 1993;40th Ave Macroinvertebrate Survey, 2010.*

*Fish tissue studies:*

## Core Profiles



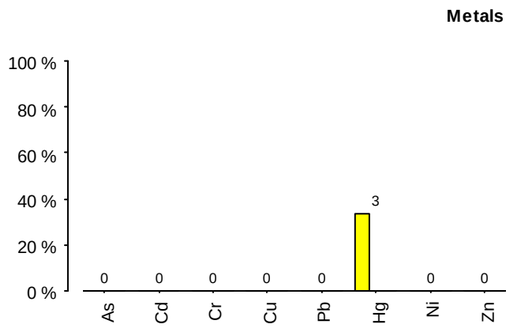

# Sediment Assessment Area Chemistry Characterization

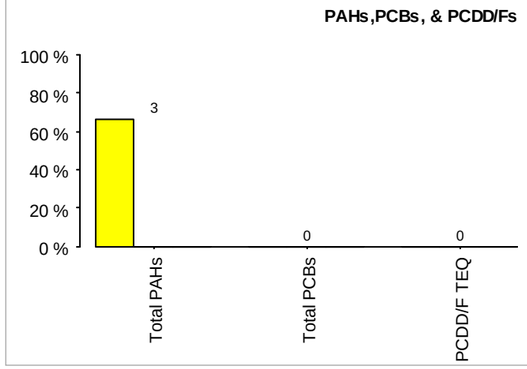
## Data Summary

**Available data in studies used for characterization (All available data)**

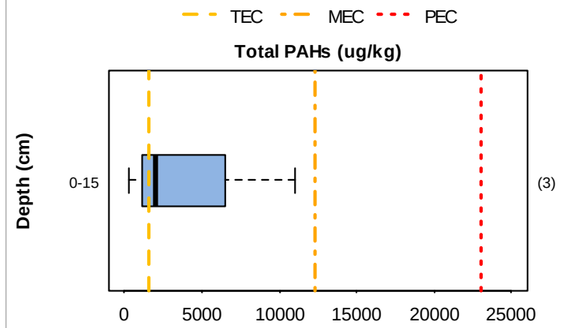
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(3) | 3(3) | 15(15) |
| Mercury | 4(4) | 7(7) | 7(7) |
| PAHs | 3(3) | 3(3) | 53(53) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 4(4) | 7(7) | 38(38) |
| TOC | 4(4) | 7(7) | 7(7) |
| Grain size | 3(3) | 3(3) | 21(21) |

## Results Exceeding Thresholds (0-15 cm samples)

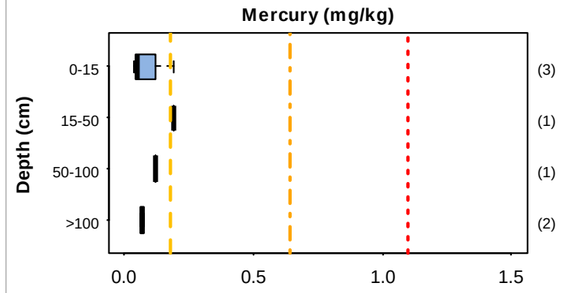



## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

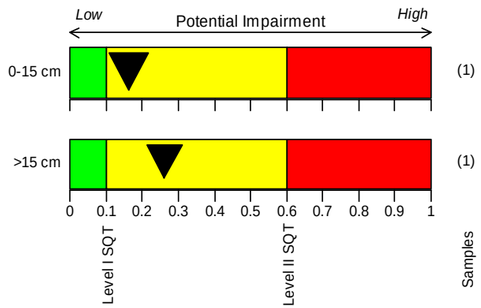
# Sediment Assessment Area Chemistry Characterization

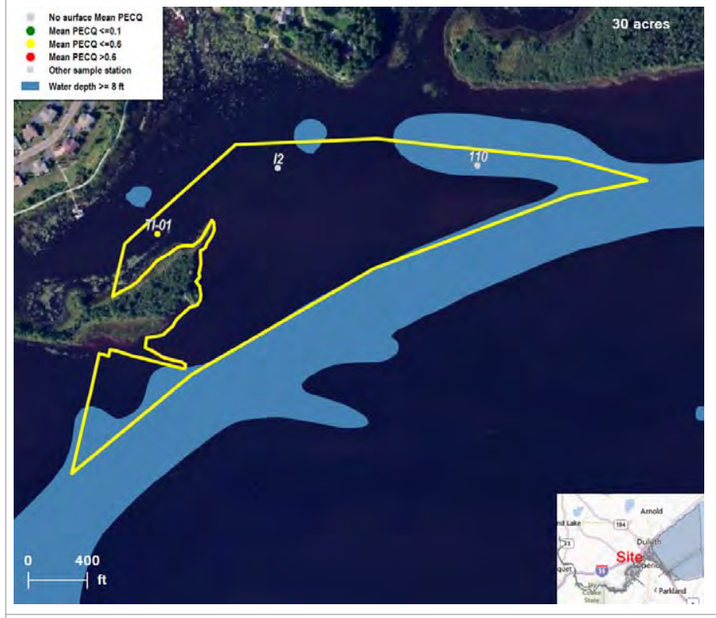
## Assessment Area # 72.3(Tallas Island Flats)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

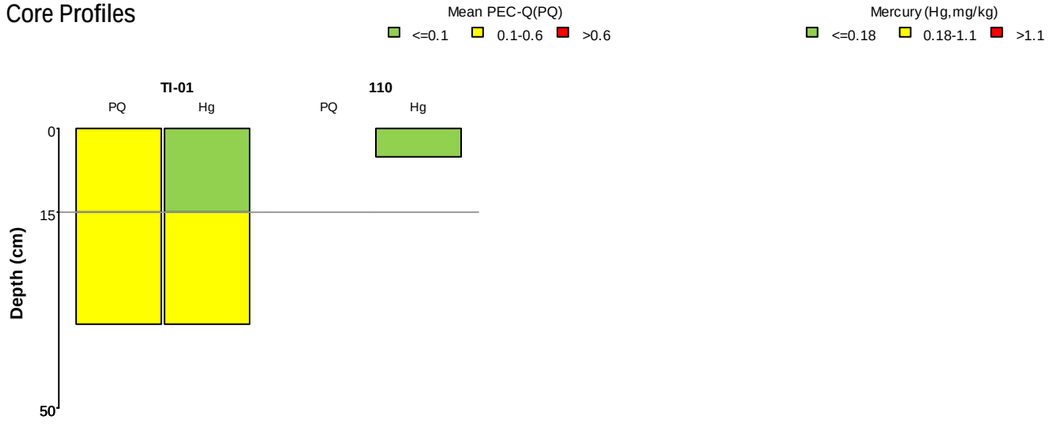
*Chemical studies used in the characterization: R-EMAP Study, 1995 (1 stations);Bay West Intlk Supplemental 2001 (3);Bay West Intlk Reconnaissance 2001 (1);Reference sites, 2001 (1).*

*Other chemical studies:*

*Macro-invertebrate studies: R-EMAP Study, 1995;Bay West Intlk Supplemental 2001;Bay West Intlk Reconnaissance 2001;Reference sites, 2001.*

*Fish tissue studies:*

## Core Profiles



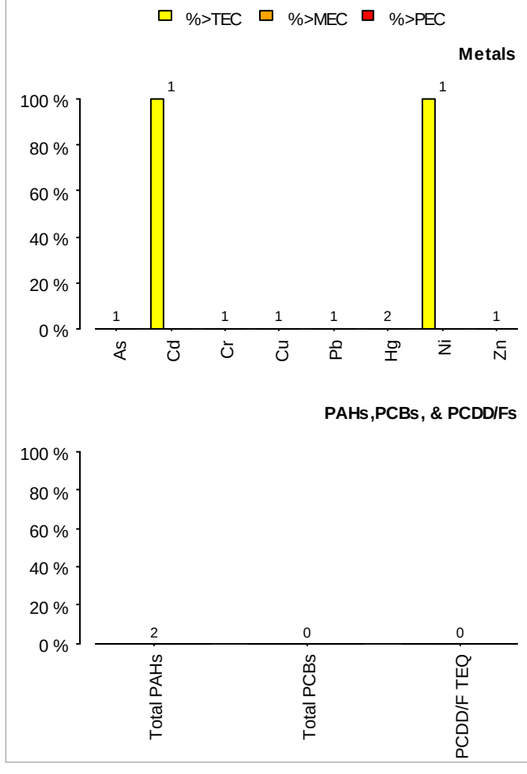

# Sediment Assessment Area Chemistry Characterization

## Data Summary

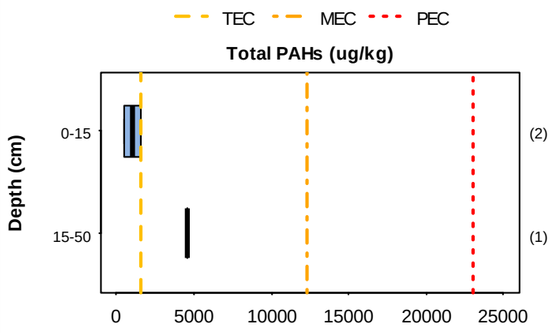
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 3(3) | 19(19) |
| Mercury | 2(2) | 3(3) | 3(3) |
| PAHs | 2(2) | 3(3) | 81(81) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 3(3) | 4(4) | 162(162) |
| TOC | 2(2) | 3(3) | 3(3) |
| Grain size | 5(5) | 6(6) | 12(12) |

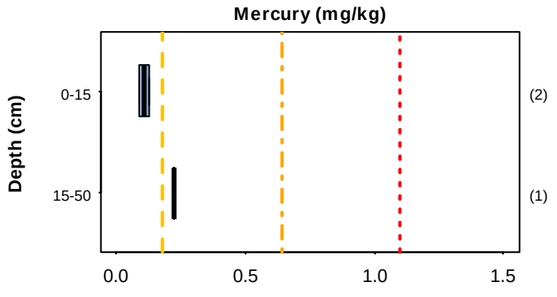
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

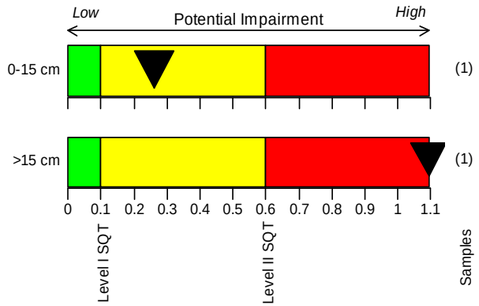
# Sediment Assessment Area Chemistry Characterization

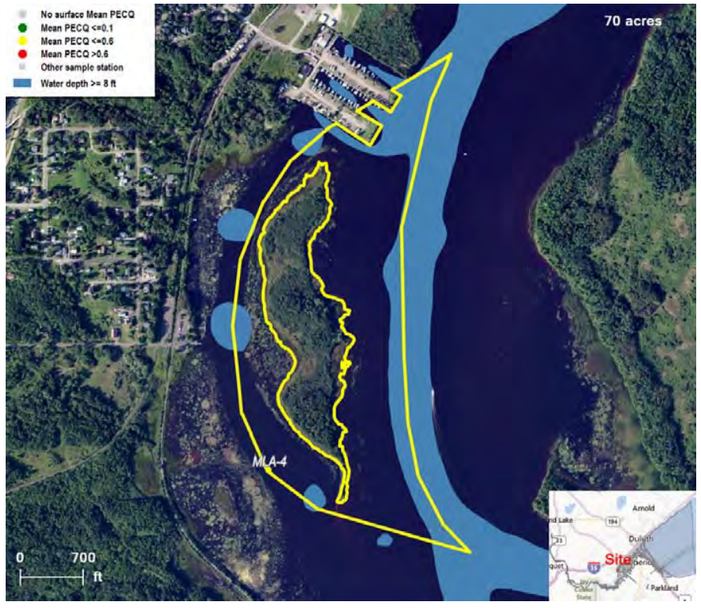
## Assessment Area # 72.4(Alder Island)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (1 stations).*

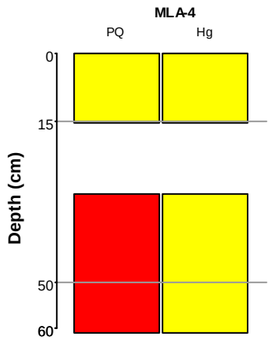
*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles

Mean PEC-Q(PQ): <=0.1 | 0.1-0.6 | >0.6
Mercury (Hg,mg/kg): <=0.18 | 0.18-1.1 | >1.1



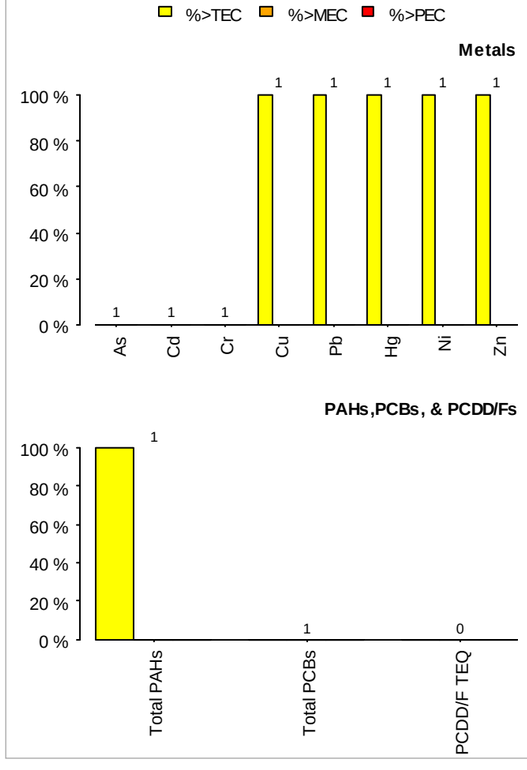

# Sediment Assessment Area Chemistry Characterization

## Data Summary

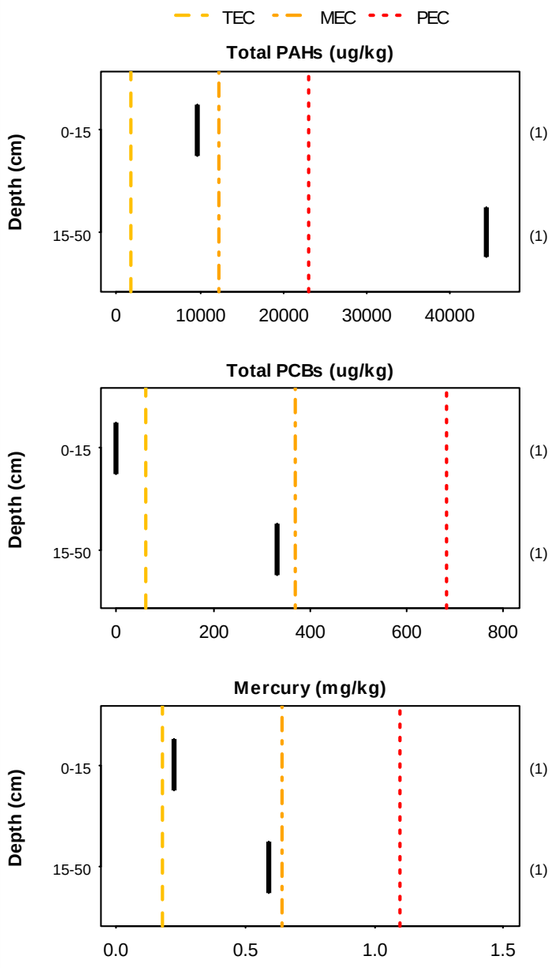
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 1(1) | 2(2) | 20(20) |
| Mercury | 1(1) | 2(2) | 2(2) |
| PAHs | 1(1) | 2(2) | 76(76) |
| PCBs | 1(1) | 2(2) | 14(14) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 1(1) | 2(2) | 34(34) |
| TOC | 1(1) | 2(2) | 2(2) |
| Grain size | 1(1) | 2(2) | 4(4) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

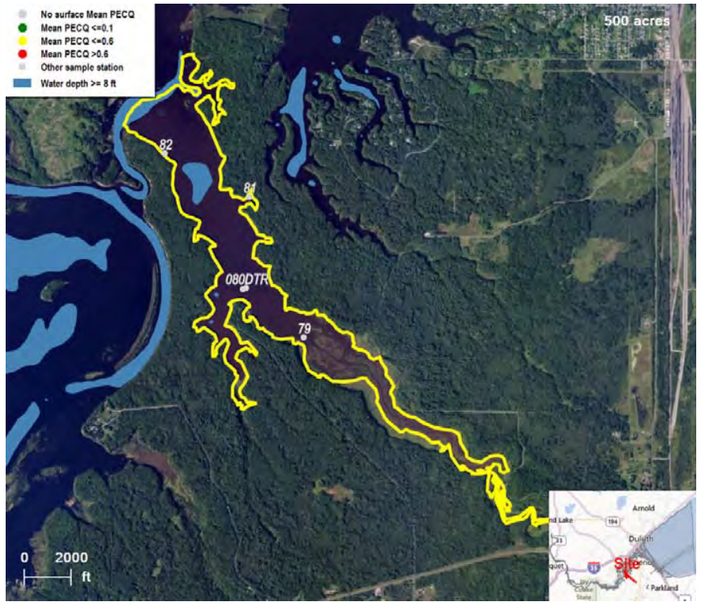
## Assessment Area # 73(Pokegama Bay)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

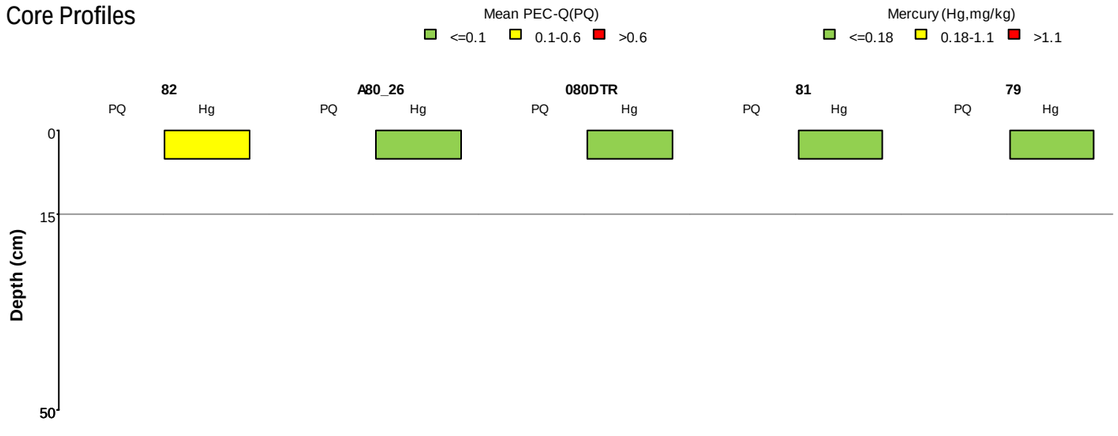
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (4 stations);R-EMAP Study, 1996 (1).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;40th Ave Macroinvertebrate Survey, 2010.*

*Fish tissue studies:*

## Core Profiles





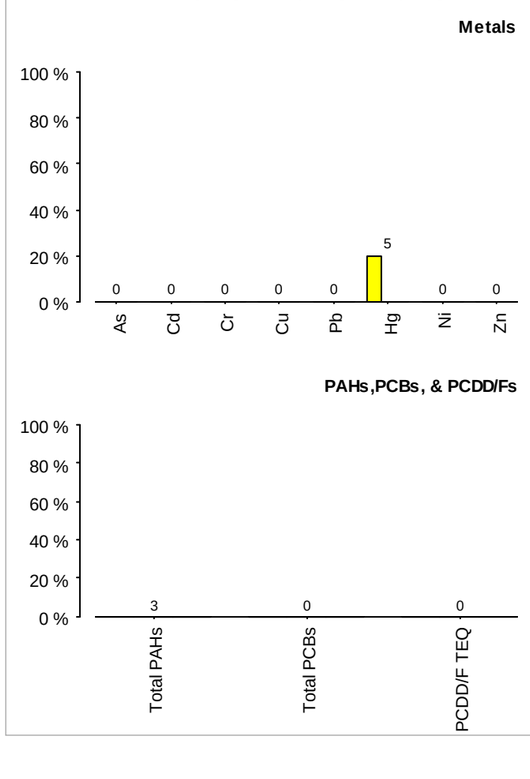
# Sediment Assessment Area Chemistry Characterization


## Data Summary

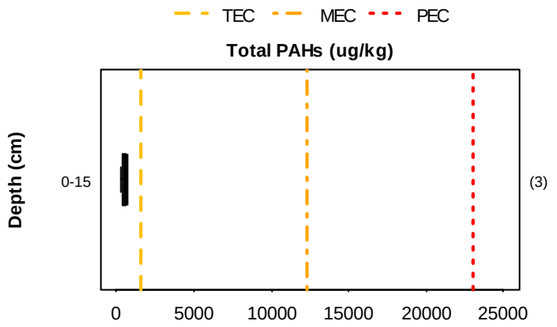
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 5(5) | 5(5) | 25(25) |
| Mercury | 5(5) | 5(5) | 5(5) |
| PAHs | 3(3) | 3(3) | 53(53) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 5(5) | 5(5) | 32(32) |
| TOC | 5(5) | 5(5) | 5(5) |
| Grain size | 5(5) | 5(5) | 35(35) |

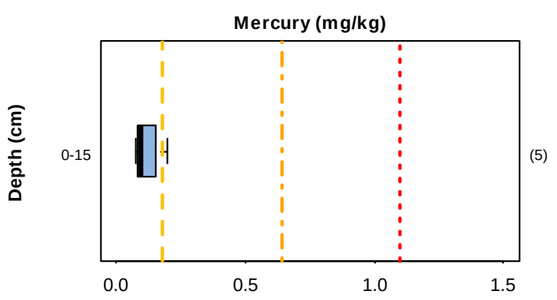
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

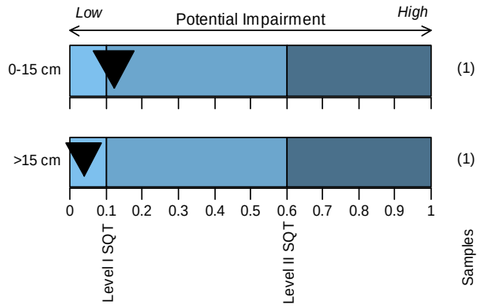
# Sediment Assessment Area Chemistry Characterization

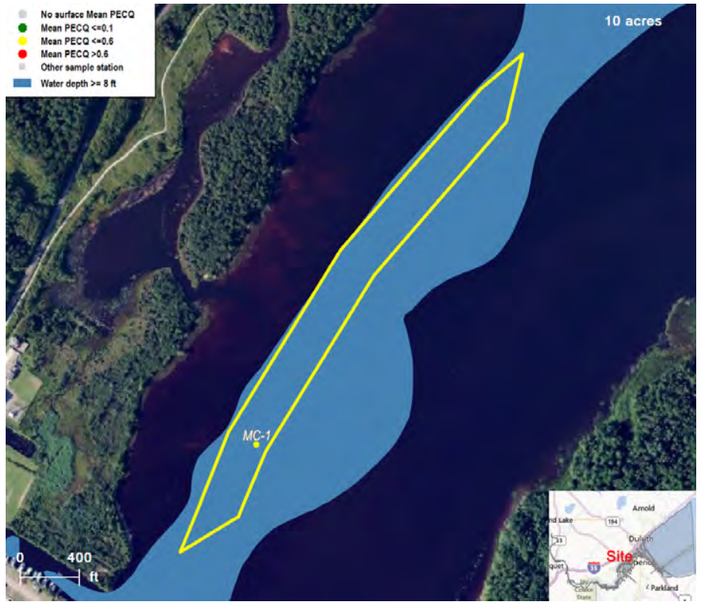
## Assessment Area # 74(Tallas Island NC)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

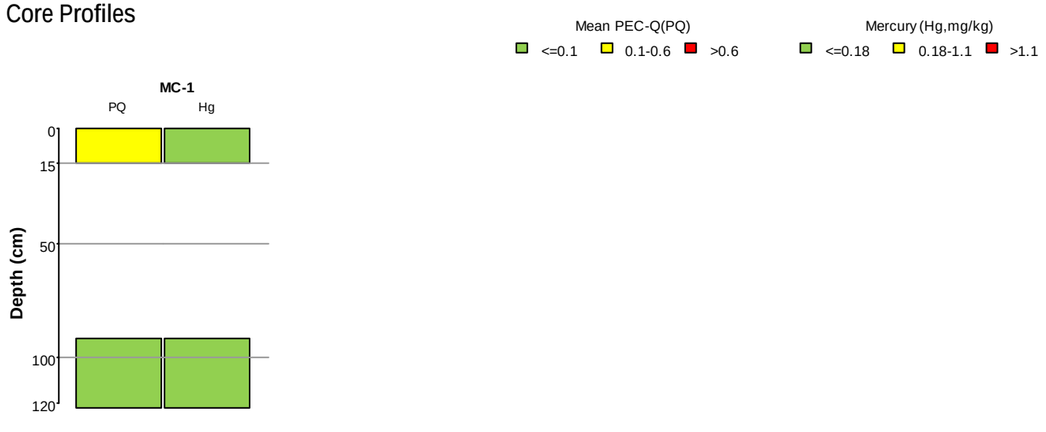
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (1 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



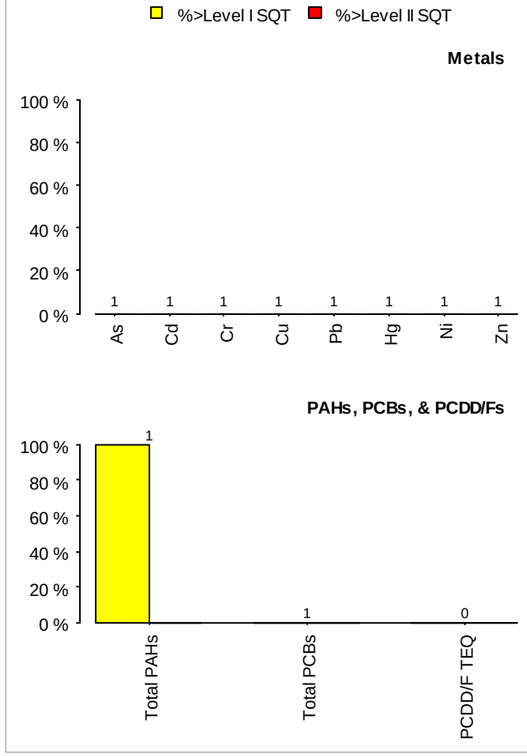

# Sediment Assessment Area Chemistry Characterization

## Data Summary

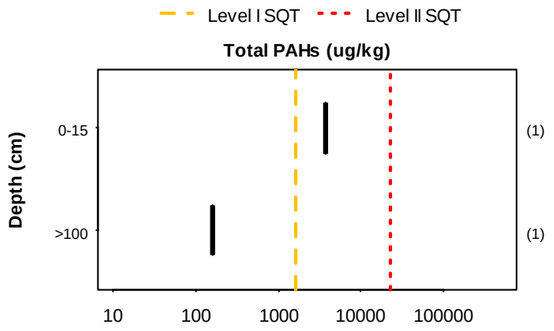
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 1(1) | 2(2) | 20(20) |
| Mercury | 1(1) | 2(2) | 2(2) |
| PAHs | 1(1) | 2(2) | 76(76) |
| PCBs | 1(1) | 2(2) | 14(14) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 1(1) | 2(2) | 34(34) |
| TOC | 1(1) | 2(2) | 2(2) |
| Grain size | 1(1) | 2(2) | 4(4) |

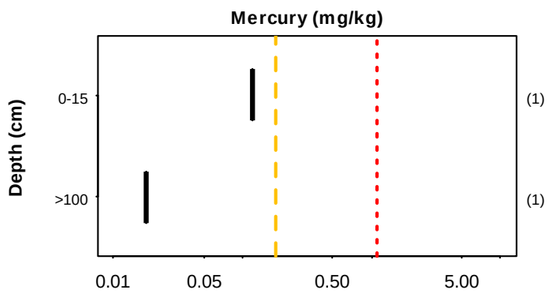
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 2 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

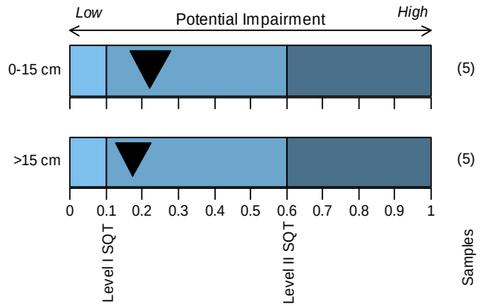
# Sediment Assessment Area Chemistry Characterization

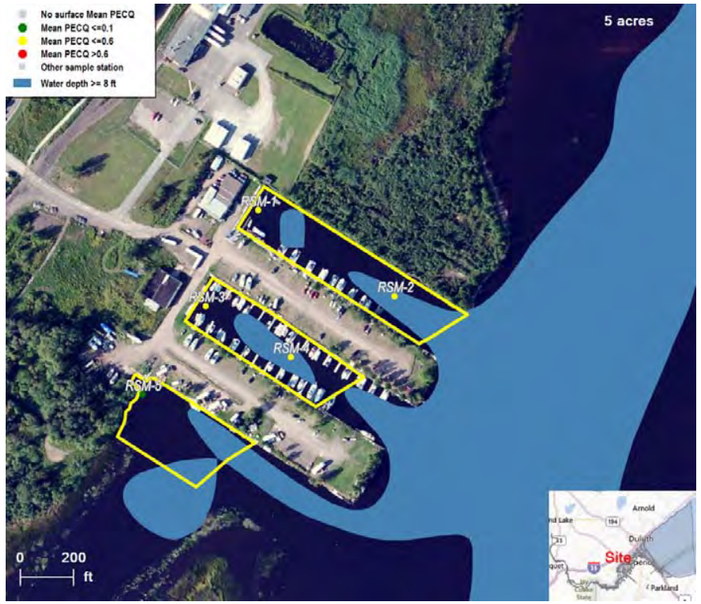
## Assessment Area # 75.1(Riverside Marina)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

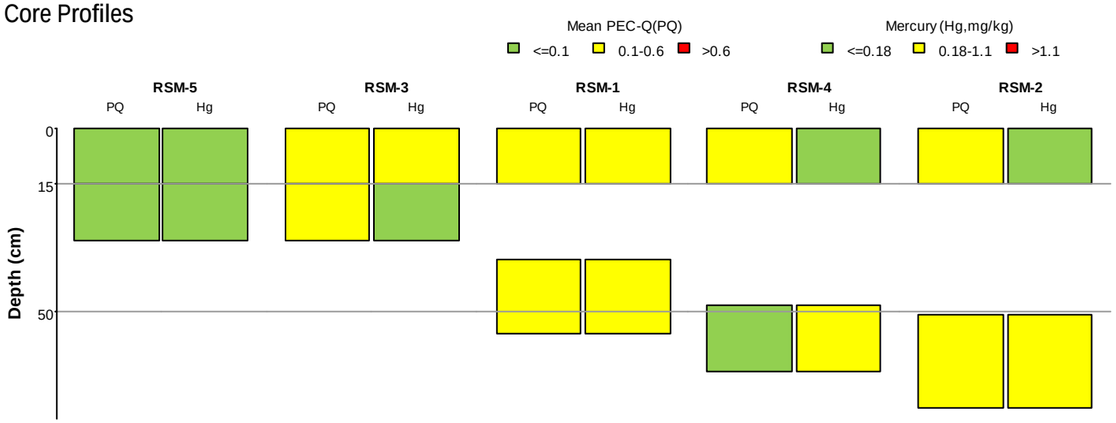
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (5 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



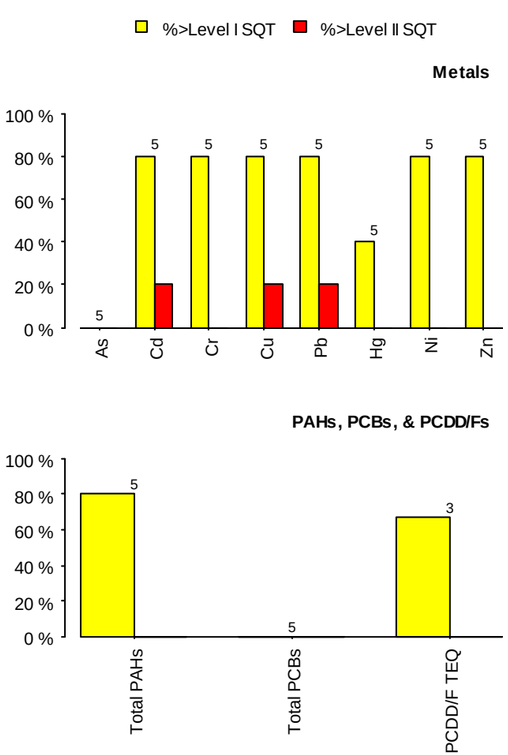

# Sediment Assessment Area Chemistry Characterization

## Data Summary

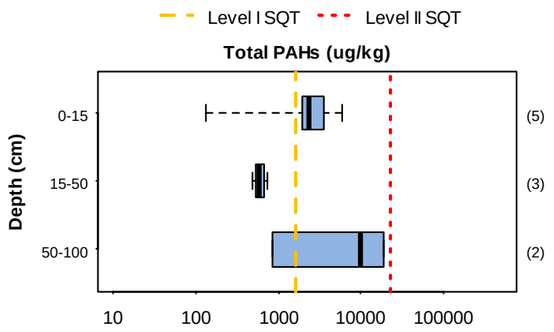
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 5(5) | 10(10) | 100(100) |
| Mercury | 5(5) | 10(10) | 10(10) |
| PAHs | 5(5) | 10(10) | 392(392) |
| PCBs | 5(5) | 10(10) | 70(70) |
| PCDD/Fs | 3(3) | 6(6) | 150(150) |
| Pesticides | 3(3) | 6(6) | 168(168) |
| Other parameters | 5(5) | 10(10) | 454(454) |
| TOC | 5(5) | 10(10) | 10(10) |
| Grain size | 5(5) | 10(10) | 20(20) |

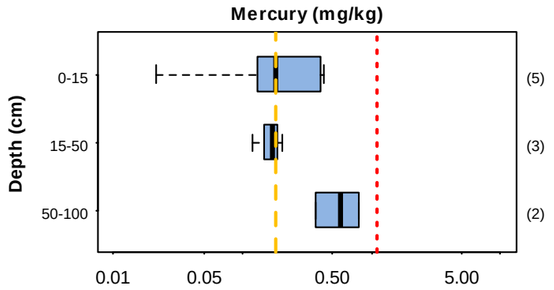
## Results Exceeding Thresholds (0-15 cm samples)

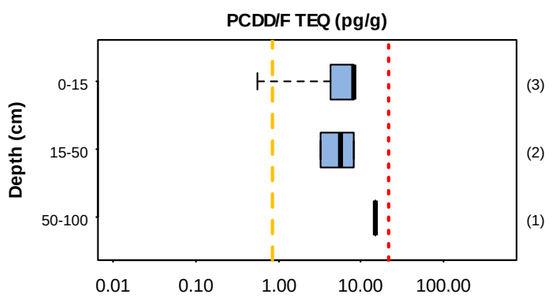



## Distributions of Constituent Concentrations




No PCBs detected in 10 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

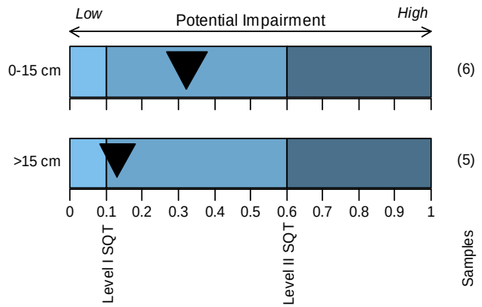
# Sediment Assessment Area Chemistry Characterization

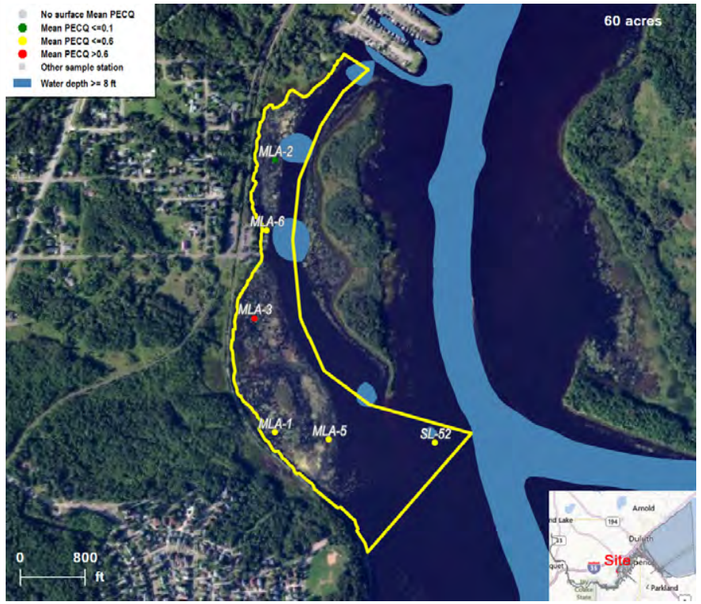
## Assessment Area # 75.2(Munger Landing)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

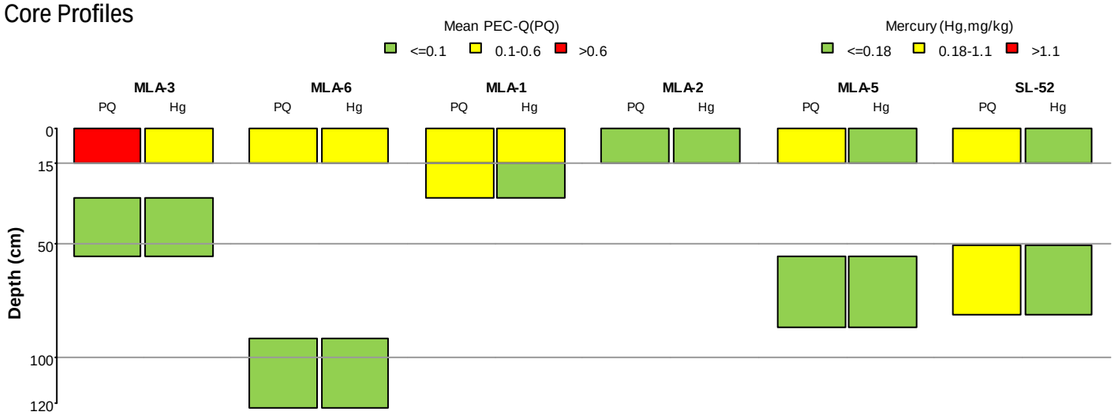
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (6 stations).*

*Other chemical studies:*
*Spirit Lake, 2011 (1 stations).*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011;Spirit Lake, 2011;US Steel Macroinvertebrate Survey.*

*Fish tissue studies:*

## Core Profiles



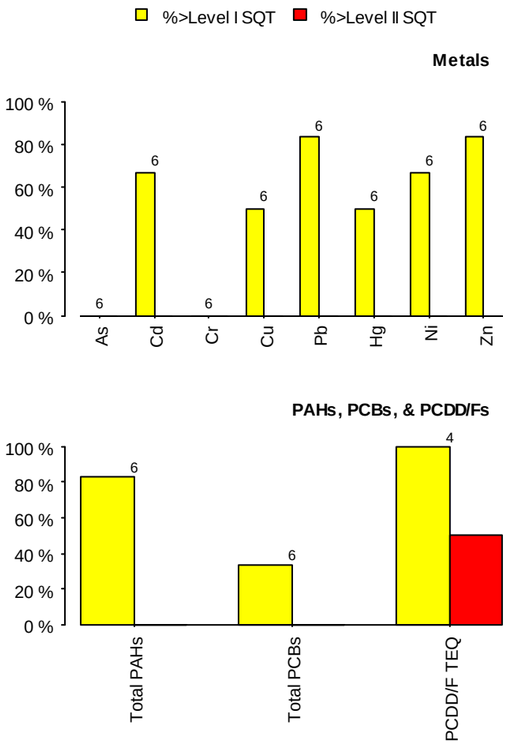

# Sediment Assessment Area Chemistry Characterization

## Data Summary

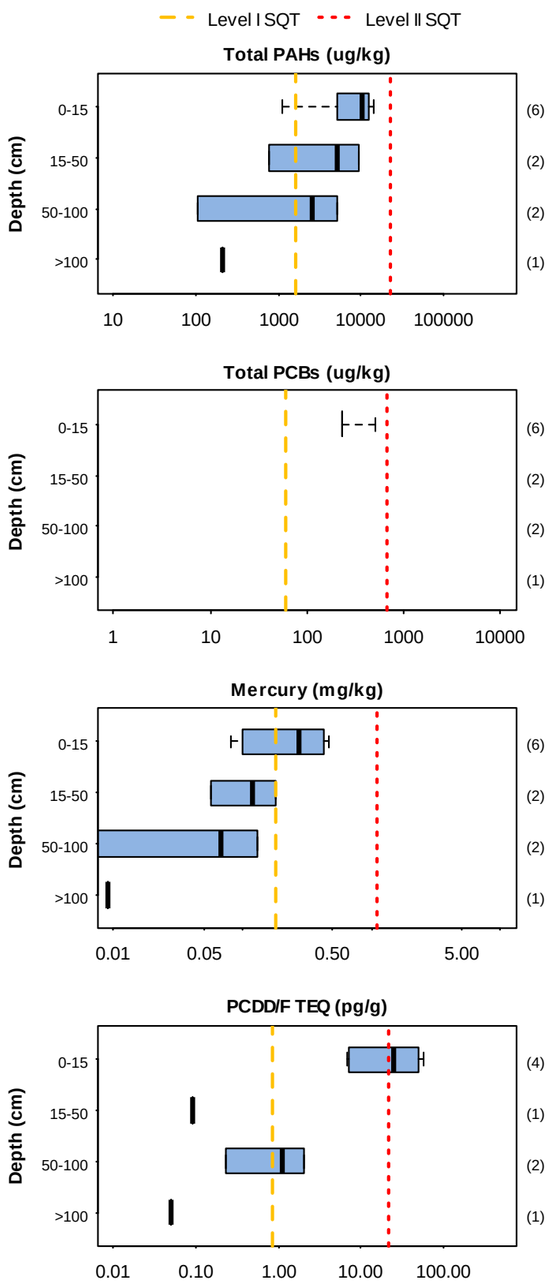
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 12(12) | 120(120) |
| Mercury | 6(6) | 12(12) | 12(12) |
| PAHs | 6(6) | 12(12) | 472(472) |
| PCBs | 6(6) | 12(12) | 84(84) |
| PCDD/Fs | 4(4) | 8(8) | 200(200) |
| Pesticides | 4(4) | 8(8) | 224(224) |
| Other parameters | 6(6) | 12(12) | 588(588) |
| TOC | 6(7) | 12(16) | 12(16) |
| Grain size | 6(6) | 12(12) | 24(24) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

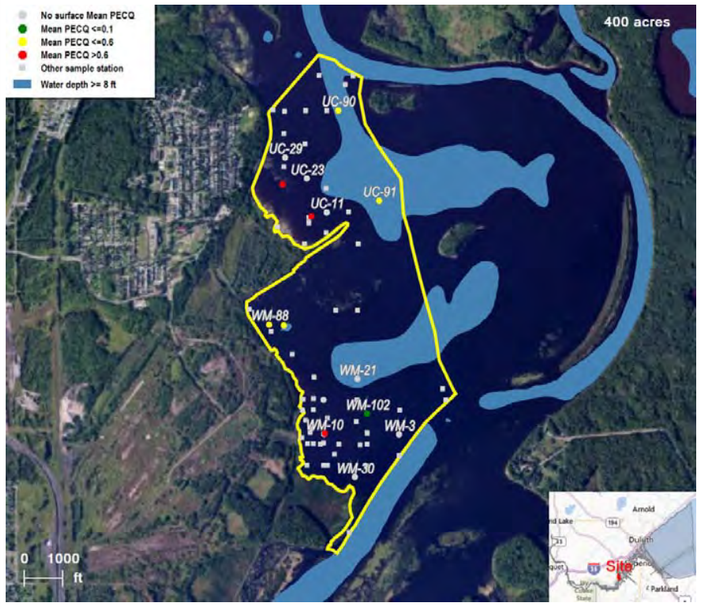
## Assessment Area # 76(U.S. Steel Superfund Site)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

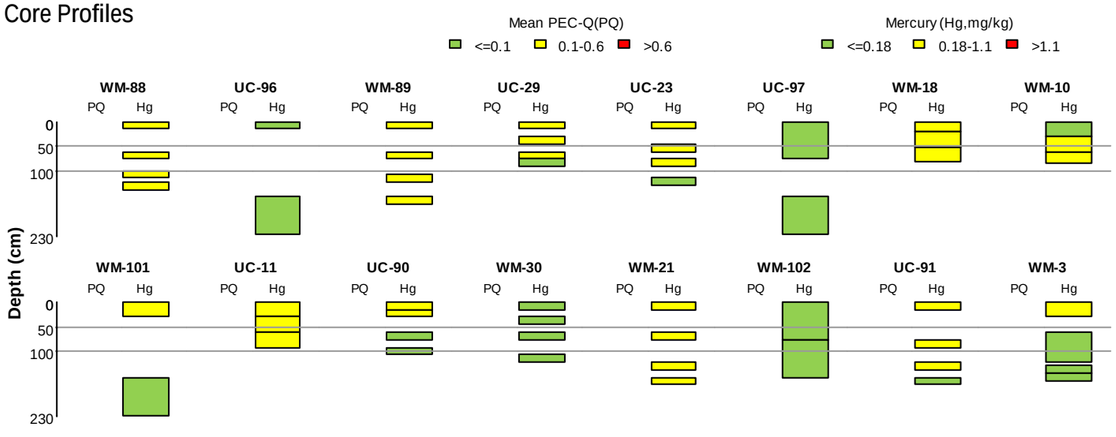
*Chemical studies used in the characterization:*
*Spirit Lake, 2011 (89 stations).*

*Other chemical studies:*
*Duluth Superfund Sites, 1993 (8 stations);R-EMAP Study, 1995 (3);R-EMAP Study, 1996 (2);LIF Study at USS Duluth Works, 2002 (13);Duluth-Superior Harbor Study, 1993 (2);USS Superfund Site URS 2003 (23);USS Superfund Site MPCA 2003 (6);Lower St. Louis River, 2011 (4).*

*Macro-invertebrate studies:*
*Duluth Superfund Sites, 1993;R-EMAP Study, 1995;R-EMAP Study, 1996;LIF Study at USS Duluth Works, 2002;Duluth-Superior Harbor Study, 1993;USS Superfund Site URS 2003;USS Superfund Site MPCA 2003;Lower St. Louis River, 2011;Spirit Lake, 2011;US Steel Macroinvertebrate Survey.*

*Fish tissue studies:*
*Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



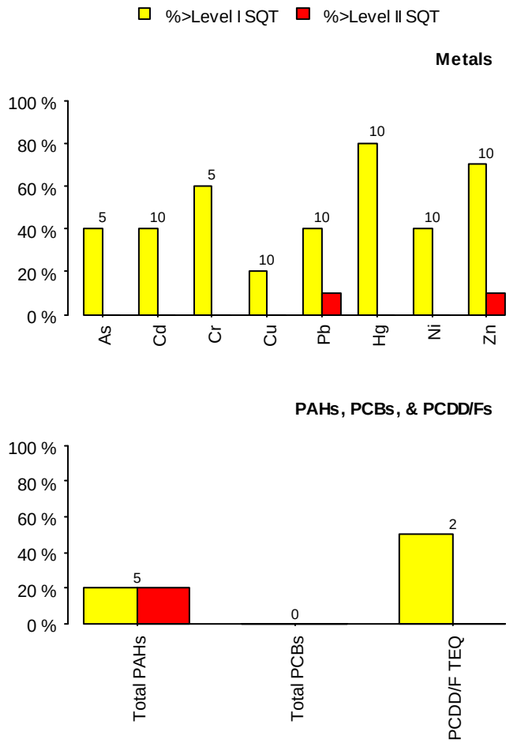

# Sediment Assessment Area Chemistry Characterization

## Data Summary

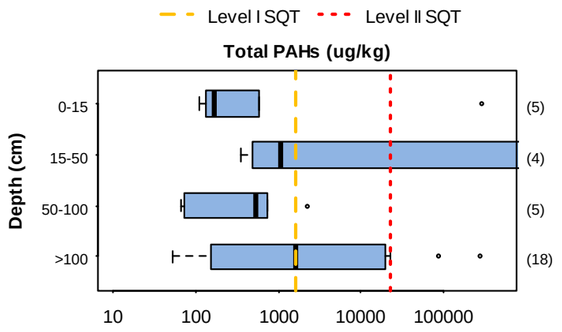
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 16(69) | 61(153) | 398(1161) |
| Mercury | 16(71) | 61(159) | 61(159) |
| PAHs | 8(46) | 32(118) | 964(3778) |
| PCBs | 0(27) | 0(48) | 0(456) |
| PCDD/Fs | 2(28) | 2(48) | 50(1240) |
| Pesticides | 0(26) | 0(46) | 0(208) |
| Other parameters | 16(71) | 63(177) | 589(4611) |
| TOC | 89(131) | 329(407) | 329(407) |
| Grain size | 12(52) | 38(109) | 38(427) |

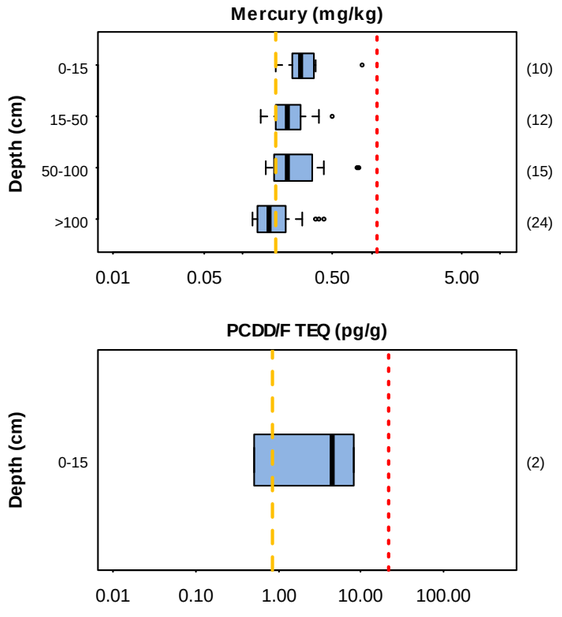
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

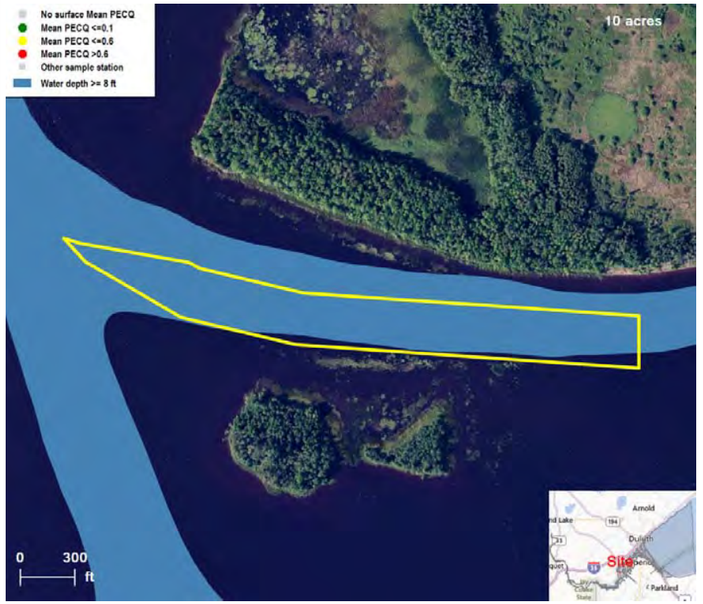
## Assessment Area # 77(Spirit Lake / Devils Elbow NC)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

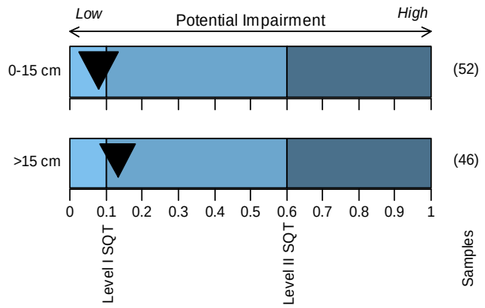
# Sediment Assessment Area Chemistry Characterization

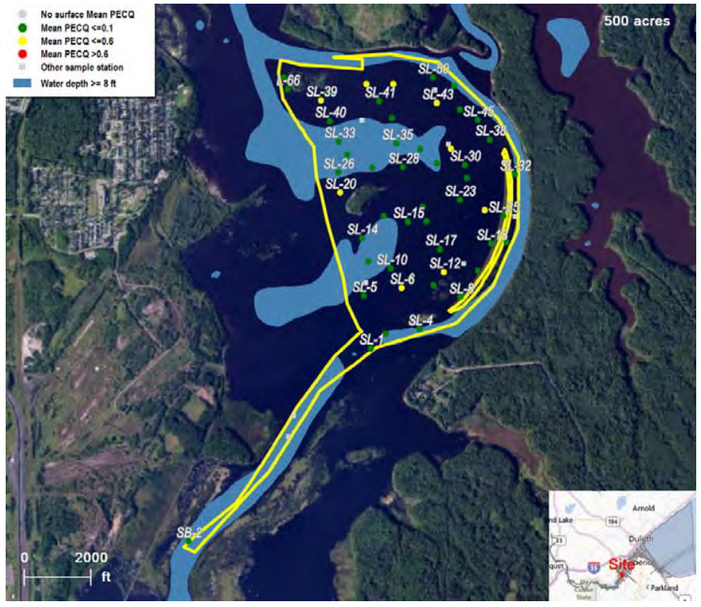
## Assessment Area # 78(Spirit Lake / Devils Elbow)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

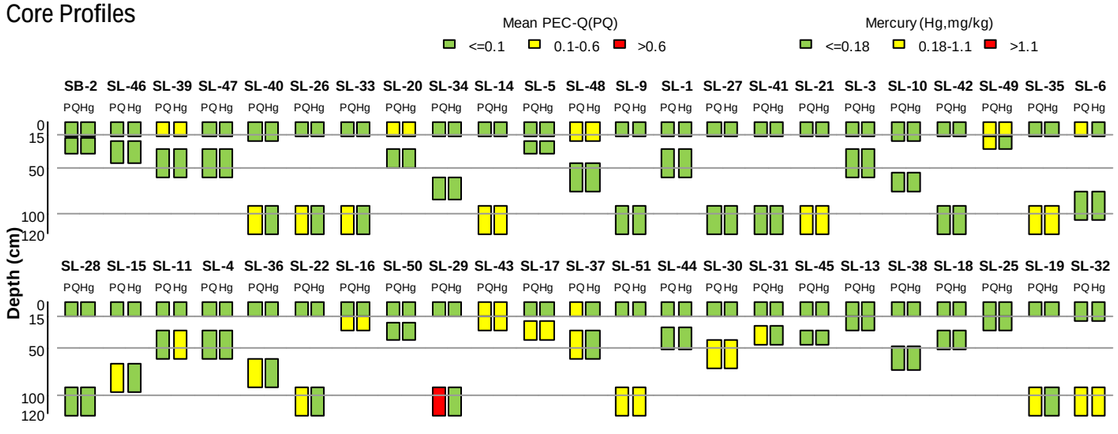
*Chemical studies used in the characterization:*
*USS Superfund Site URS 2003 (1 stations);Lower St. Louis River, 2011 (51).*

*Other chemical studies:*
*R-EMAP Study, 1995 (7 stations);Spirit Lake, 2011 (5).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;USS Superfund Site URS 2003;Lower St. Louis River, 2011;Spirit Lake, 2011;40th Ave Macroinvertebrate Survey, 2010.*

*Fish tissue studies:*

## Core Profiles



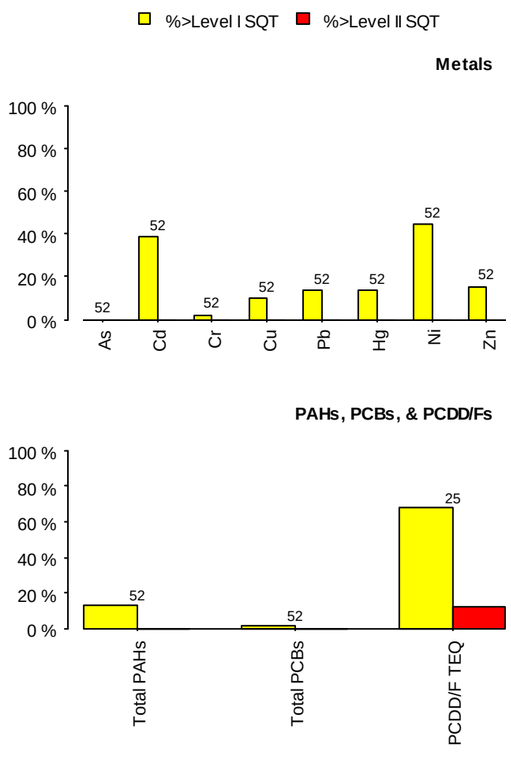

# Sediment Assessment Area Chemistry Characterization

## Data Summary

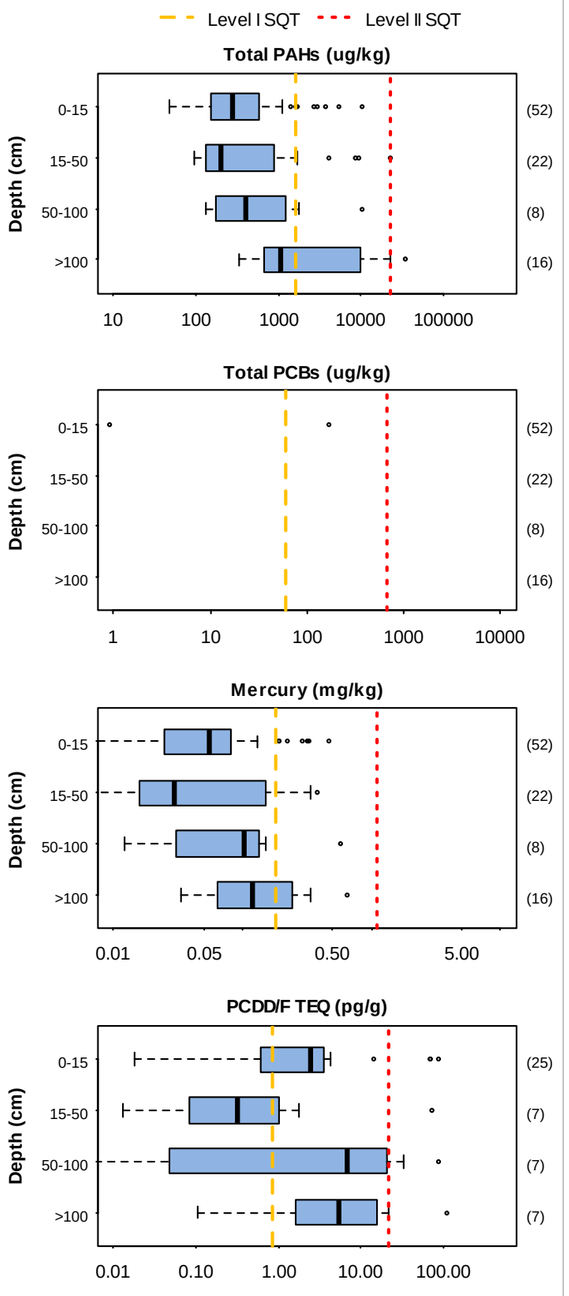
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 52(60) | 98(109) | 982(1041) |
| Mercury | 52(60) | 98(109) | 98(109) |
| PAHs | 52(54) | 98(100) | 3813(3847) |
| PCBs | 52(52) | 98(98) | 689(689) |
| PCDD/Fs | 25(25) | 46(46) | 1151(1151) |
| Pesticides | 25(25) | 46(46) | 1261(1261) |
| Other parameters | 52(60) | 98(109) | 3887(3940) |
| TOC | 52(64) | 98(126) | 98(126) |
| Grain size | 52(60) | 98(109) | 202(255) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

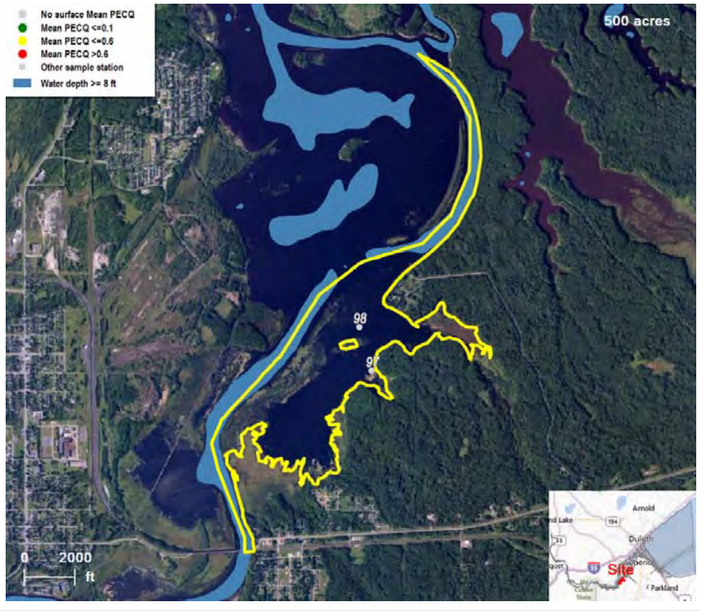
## Assessment Area # 79(Little Pokegama River/Bay)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (2 stations).*

*Other chemical studies:*

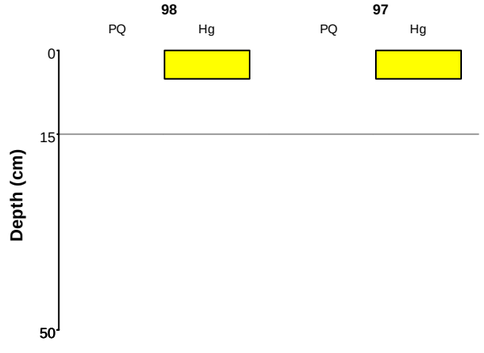
*Macro-invertebrate studies:*
*R-EMAP Study, 1995;US Steel Macroinvertebrate Survey.*

*Fish tissue studies:*
*Fond du Lac Fish Tissue Study 2000.*

## Core Profiles

Mean PEC-Q(PQ) <=0.1 0.1-0.6 >0.6

Mercury (Hg,mg/kg) <=0.18 0.18-1.1 >1.1





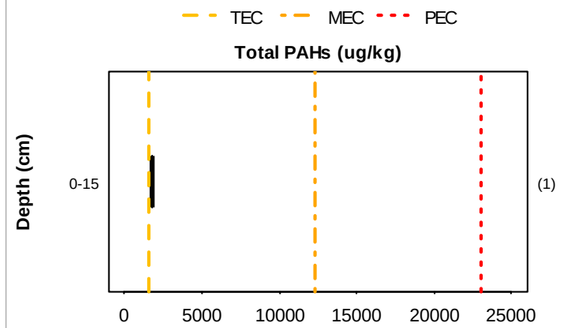
# Sediment Assessment Area Chemistry Characterization


## Data Summary

**Available data in studies used for characterization (All available data)**

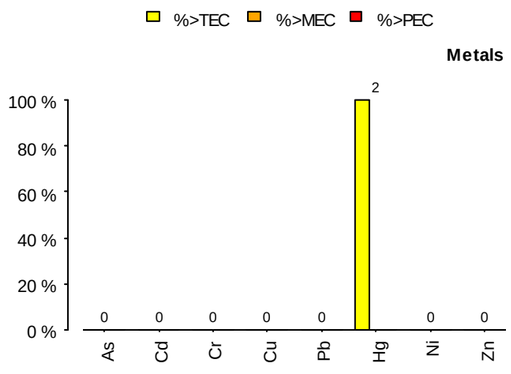
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 2(2) | 10(10) |
| Mercury | 2(2) | 2(2) | 2(2) |
| PAHs | 1(1) | 1(1) | 17(17) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 2(2) | 2(2) | 11(11) |
| TOC | 2(2) | 2(2) | 2(2) |
| Grain size | 2(2) | 2(2) | 14(14) |

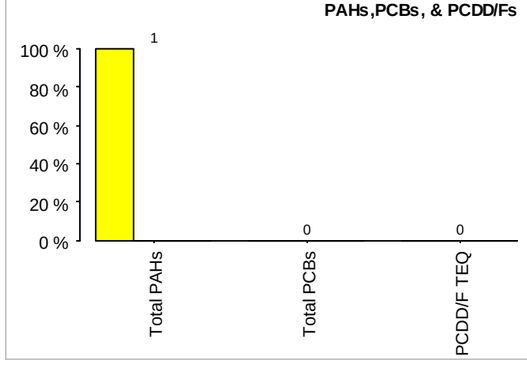
## Distributions of Constituent Concentrations

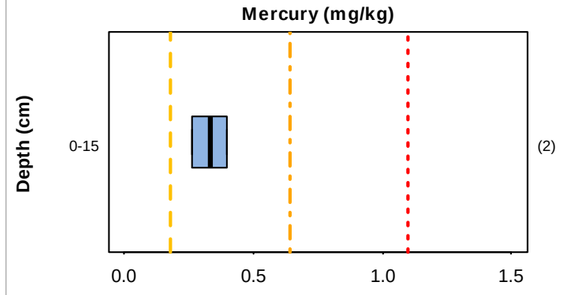



No PCBs detected in 0 analyzed samples

## Results Exceeding Thresholds (0-15 cm samples)




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

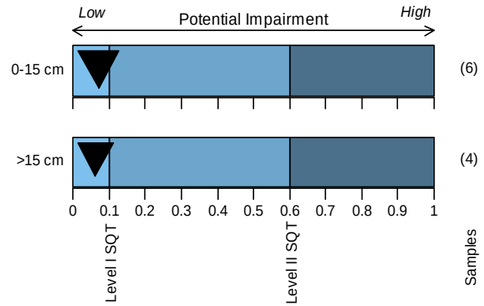
# Sediment Assessment Area Chemistry Characterization

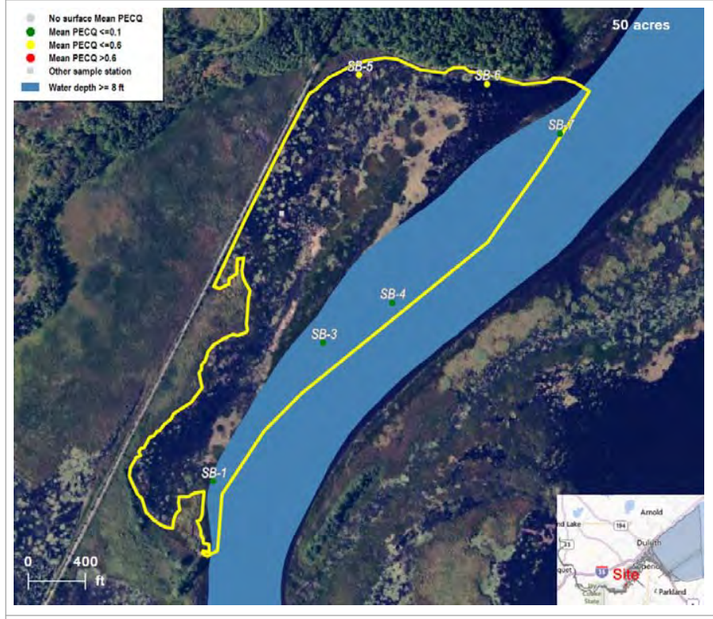
## Assessment Area # 80(Steelton Bay)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

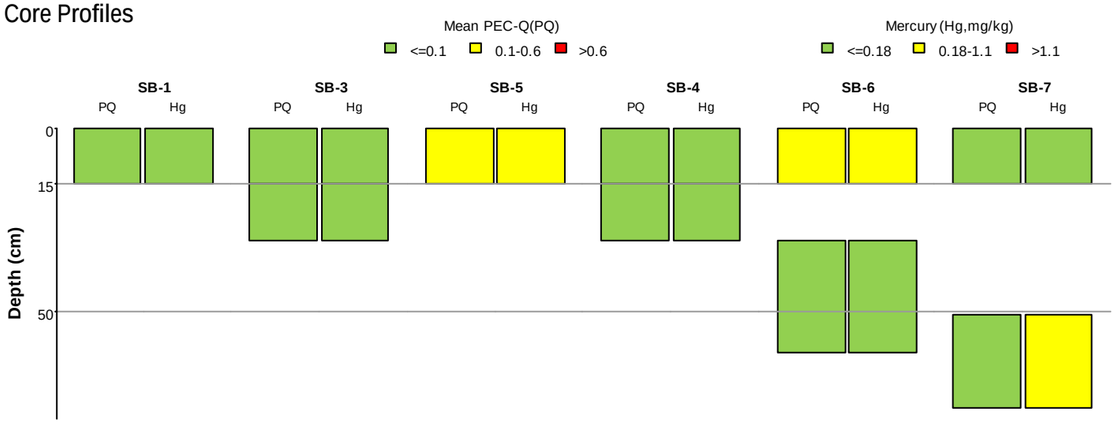
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (6 stations).*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



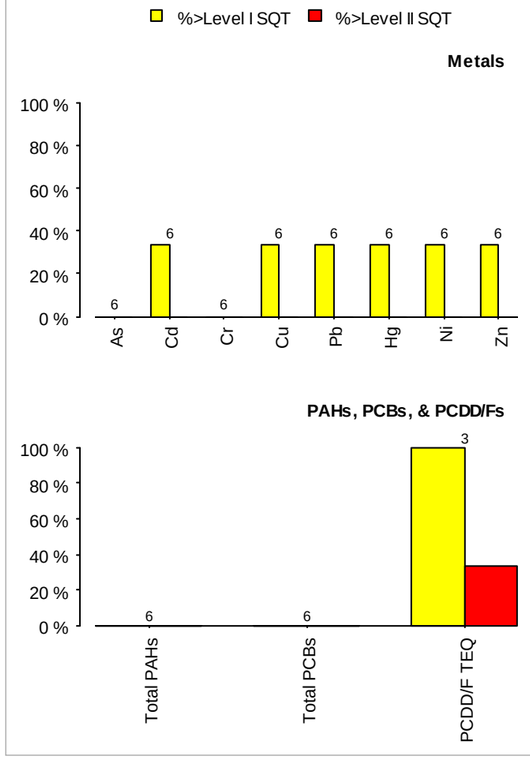

# Sediment Assessment Area Chemistry Characterization

## Data Summary

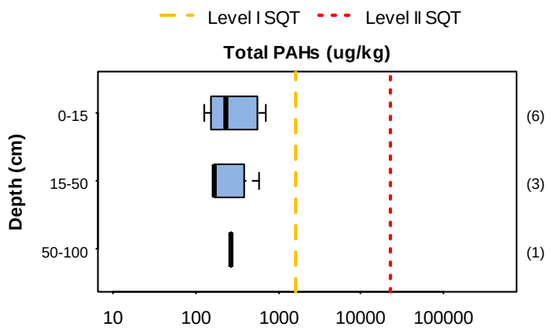
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(7) | 10(11) | 100(105) |
| Mercury | 6(7) | 10(11) | 10(11) |
| PAHs | 6(6) | 10(10) | 388(388) |
| PCBs | 6(6) | 10(10) | 70(70) |
| PCDD/Fs | 3(3) | 4(4) | 100(100) |
| Pesticides | 3(3) | 4(4) | 112(112) |
| Other parameters | 6(7) | 10(11) | 362(363) |
| TOC | 6(7) | 10(11) | 10(11) |
| Grain size | 6(7) | 10(11) | 20(27) |

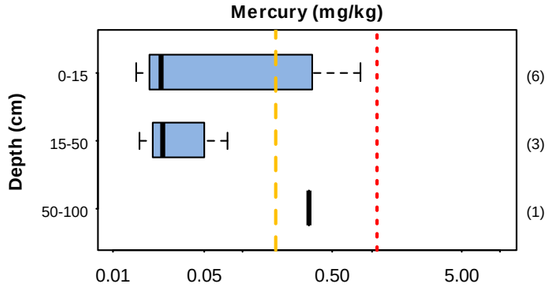
## Results Exceeding Thresholds (0-15 cm samples)

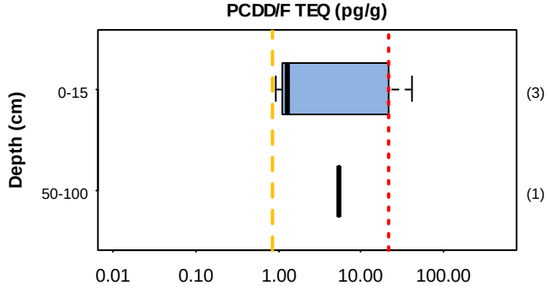



## Distributions of Constituent Concentrations




No PCBs detected in 10 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

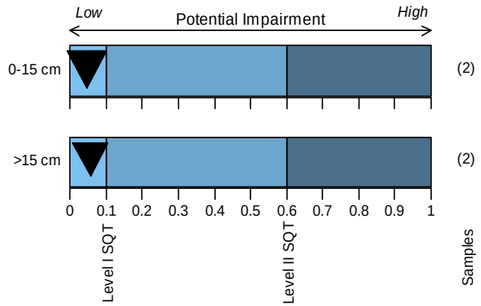
# Sediment Assessment Area Chemistry Characterization

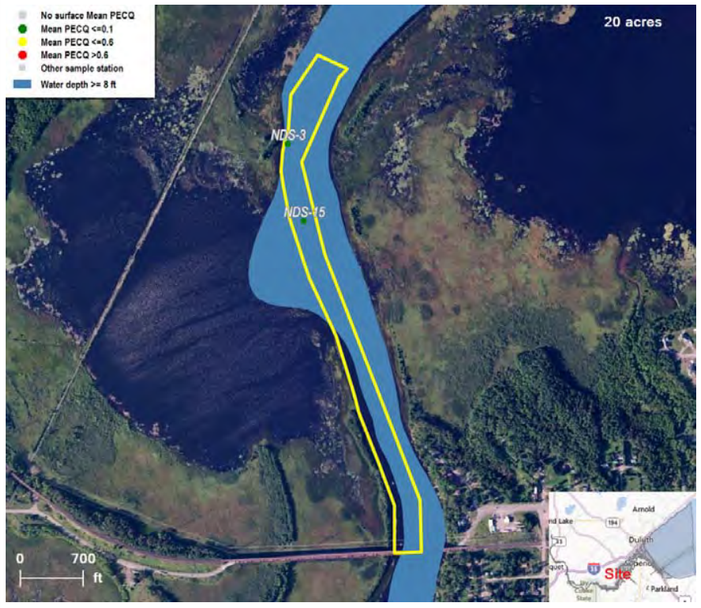
## Assessment Area # 81(New Duluth Stretch)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

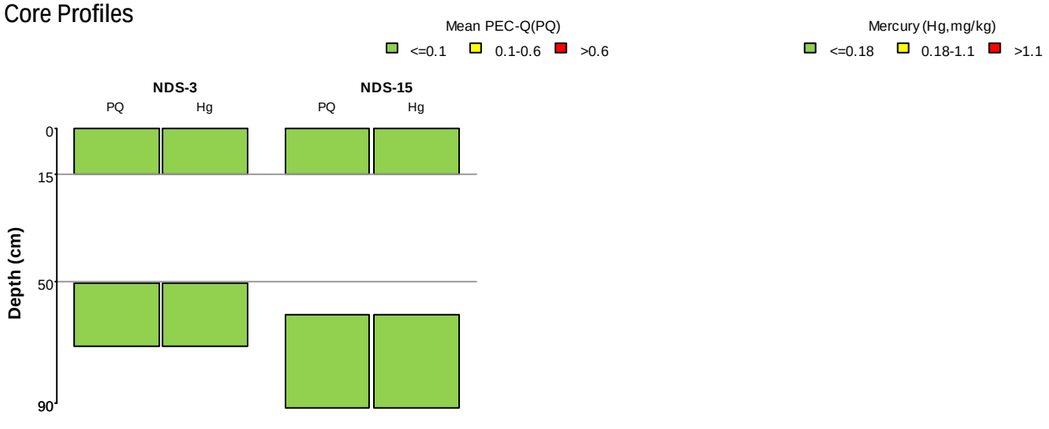
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (2 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



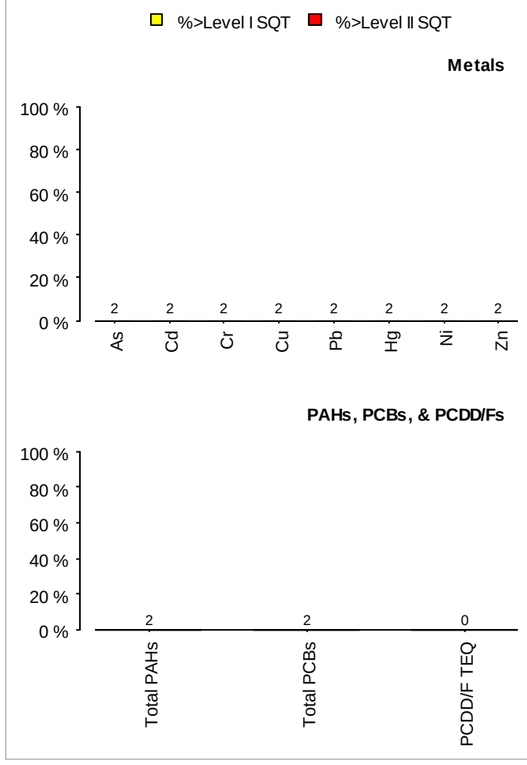

# Sediment Assessment Area Chemistry Characterization

## Data Summary

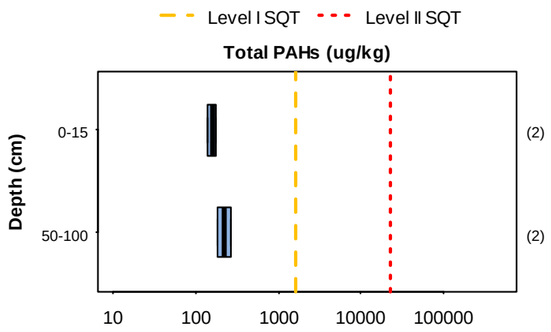
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 4(4) | 40(40) |
| Mercury | 2(2) | 4(4) | 4(4) |
| PAHs | 2(2) | 4(4) | 152(152) |
| PCBs | 2(2) | 4(4) | 28(28) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 2(2) | 4(4) | 68(68) |
| TOC | 2(2) | 4(4) | 4(4) |
| Grain size | 2(2) | 4(4) | 8(8) |

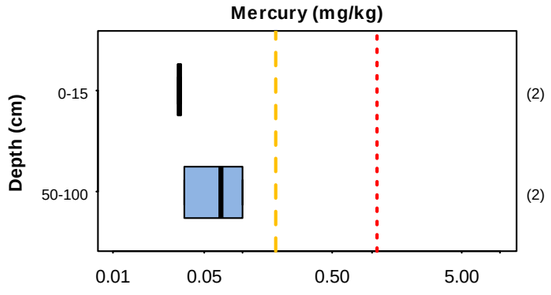
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 4 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

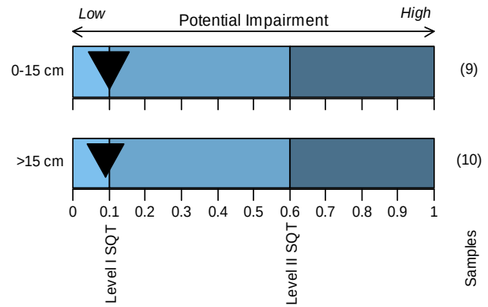
# Sediment Assessment Area Chemistry Characterization

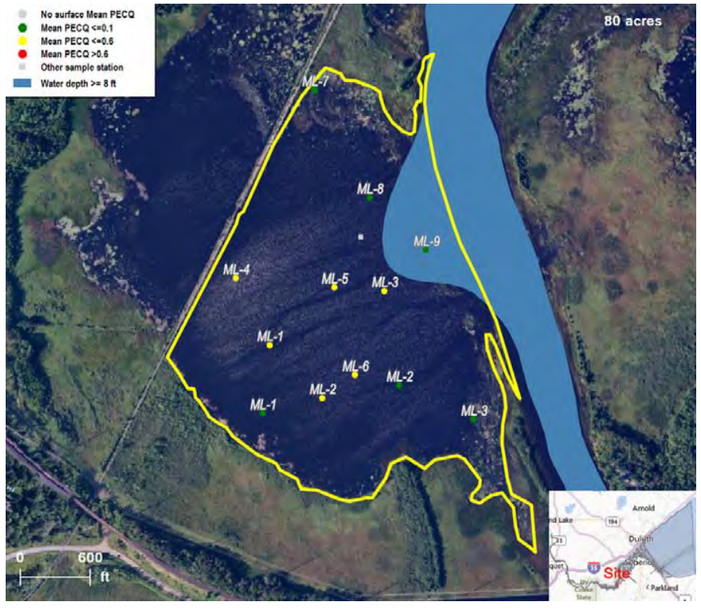
## Assessment Area # 82(Mud Lake East)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

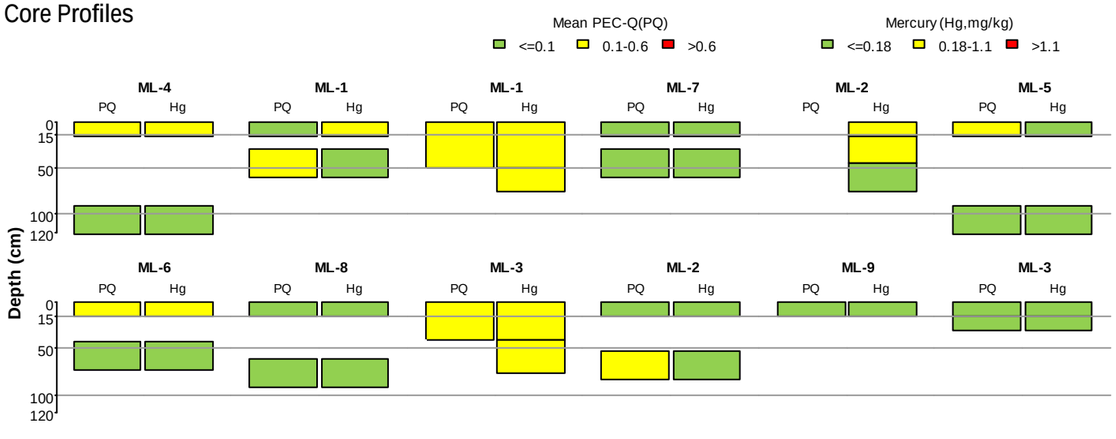
*Chemical studies used in the characterization: Lower St. Louis River, 2011 (9 stations);SL Mud Lake/Radio Tower Bay MPCA 2008 Sed Chem (3).*

*Other chemical studies: Duluth-Superior Harbor Study, 1993 (1 stations).*

*Macro-invertebrate studies: Duluth-Superior Harbor Study, 1993;Lower St. Louis River, 2011;SL Mud Lake/Radio Tower Bay MPCA 2008 Sed Chem.*

*Fish tissue studies: Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



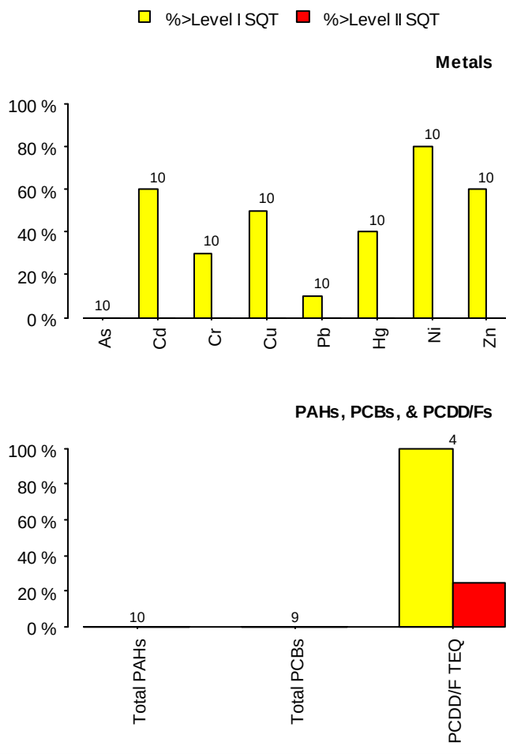

# Sediment Assessment Area Chemistry Characterization

## Data Summary

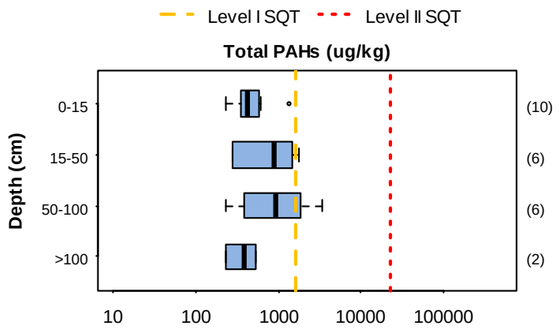
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 12(12) | 25(25) | 306(306) |
| Mercury | 12(13) | 25(27) | 25(27) |
| PAHs | 12(12) | 25(25) | 1008(1008) |
| PCBs | 11(11) | 20(20) | 144(144) |
| PCDD/Fs | 4(4) | 8(8) | 200(200) |
| Pesticides | 6(6) | 10(10) | 228(228) |
| Other parameters | 12(13) | 25(27) | 871(875) |
| TOC | 12(13) | 25(27) | 25(27) |
| Grain size | 12(12) | 25(25) | 70(70) |

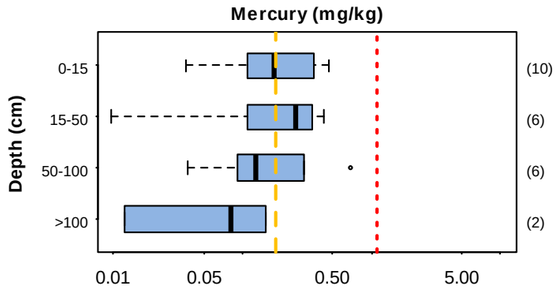
## Results Exceeding Thresholds (0-15 cm samples)

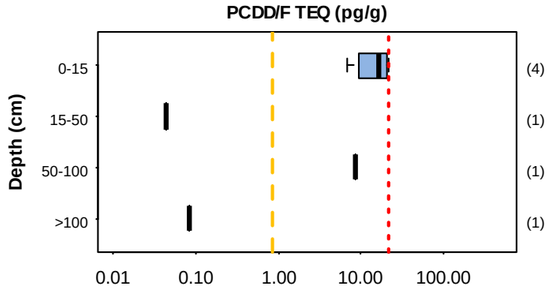



## Distributions of Constituent Concentrations




No PCBs detected in 19 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

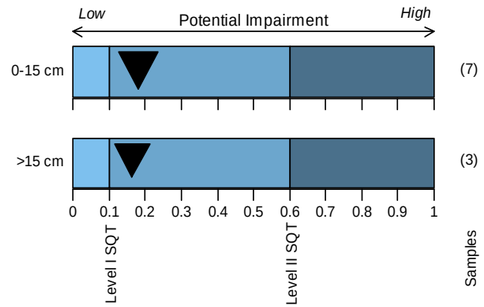
# Sediment Assessment Area Chemistry Characterization

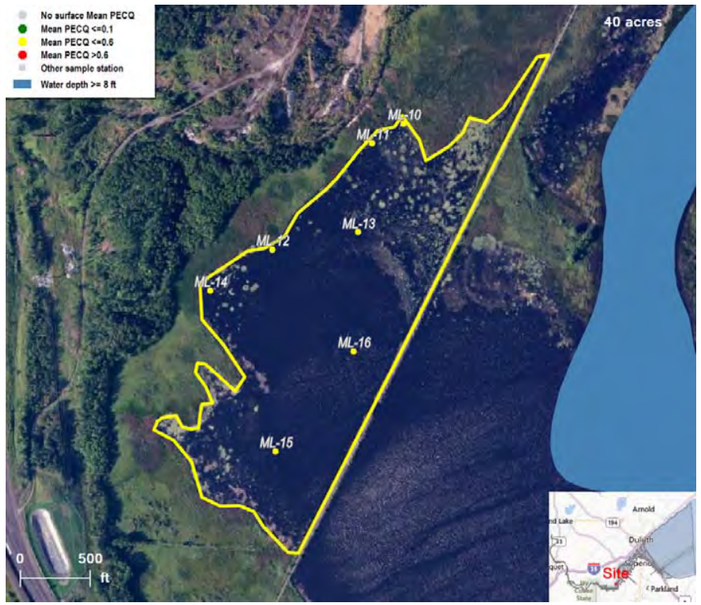
## Assessment Area # 83(Mud Lake West)

*Geographic zone: Lower St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

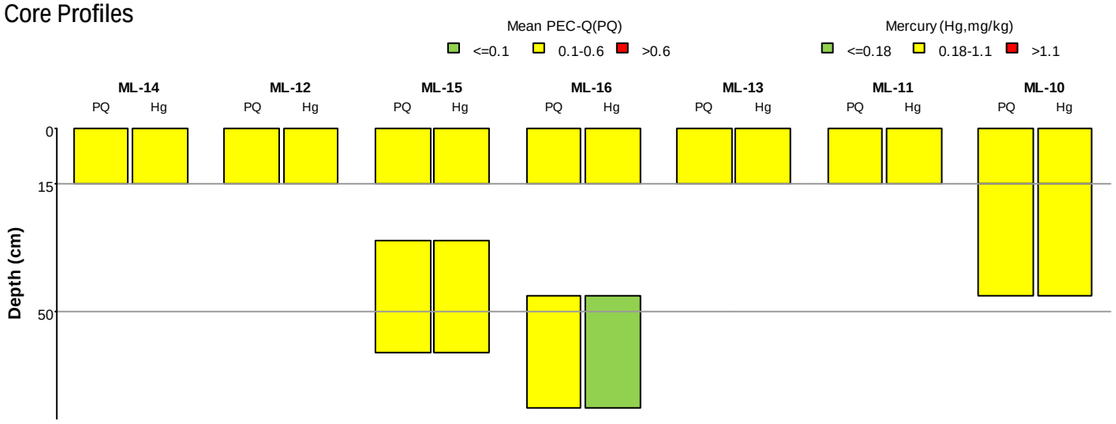
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (7 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



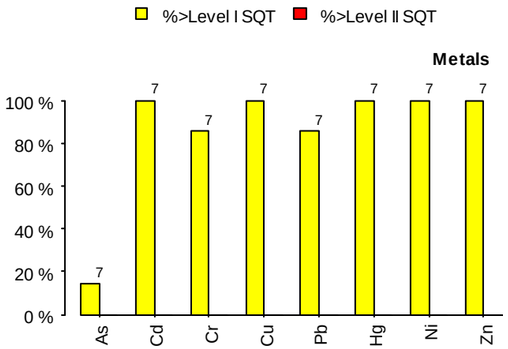

# Sediment Assessment Area Chemistry Characterization

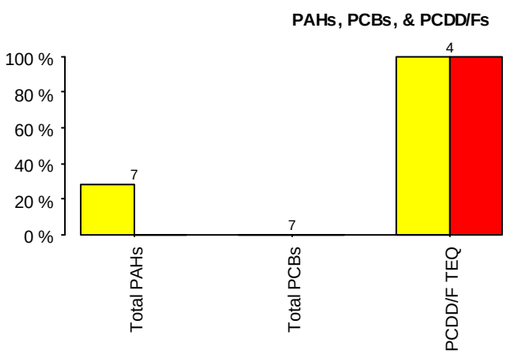
## Data Summary

**Available data in studies used for characterization (All available data)**

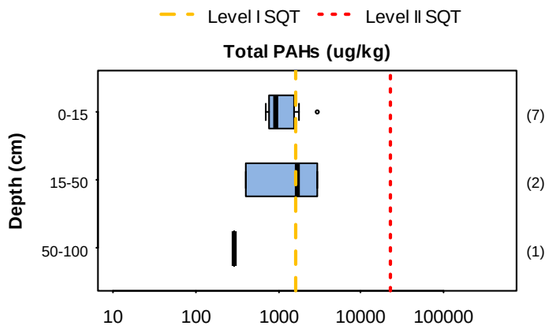
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 7(7) | 10(10) | 100(100) |
| Mercury | 7(7) | 10(10) | 10(10) |
| PAHs | 7(7) | 10(10) | 394(394) |
| PCBs | 7(7) | 10(10) | 70(70) |
| PCDD/Fs | 4(4) | 7(7) | 175(175) |
| Pesticides | 4(4) | 7(7) | 196(196) |
| Other parameters | 7(7) | 10(10) | 506(506) |
| TOC | 7(7) | 10(10) | 10(10) |
| Grain size | 7(7) | 10(10) | 20(20) |

## Results Exceeding Thresholds (0-15 cm samples)

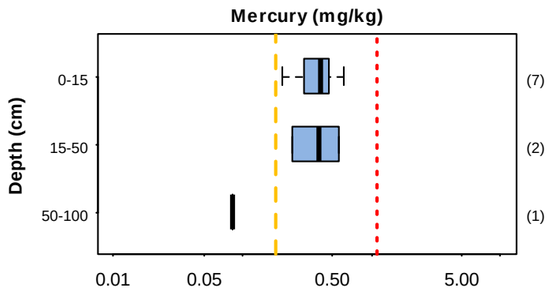


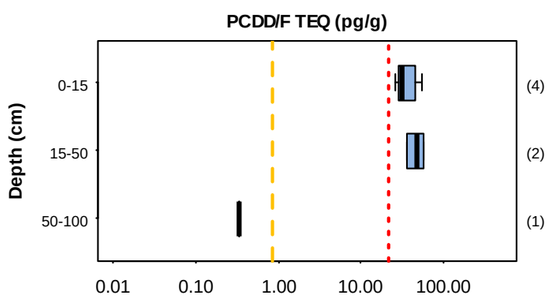




## Distributions of Constituent Concentrations




No PCBs detected in 10 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

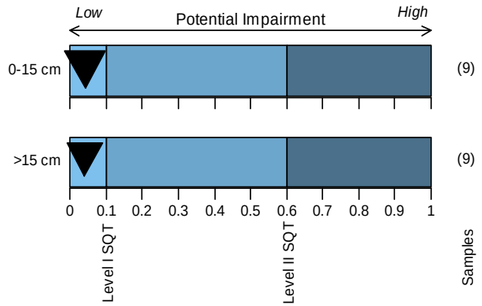
# Sediment Assessment Area Chemistry Characterization

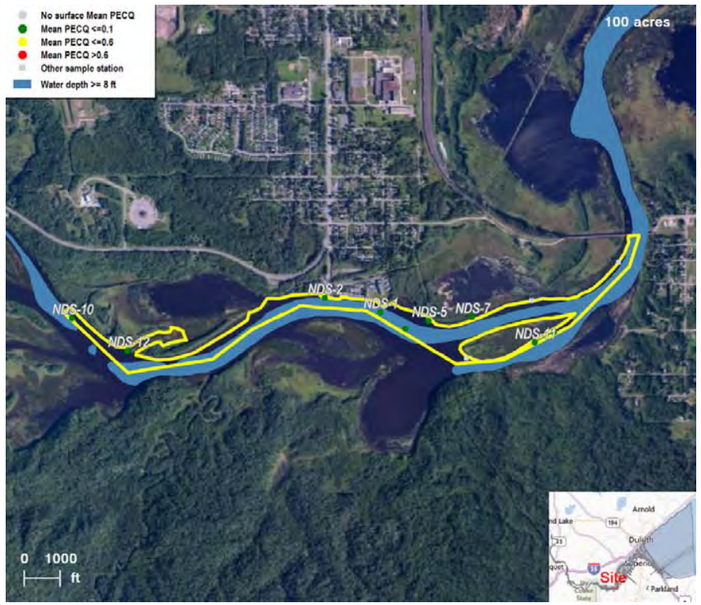
## Assessment Area # 84(Lower St. Louis River)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

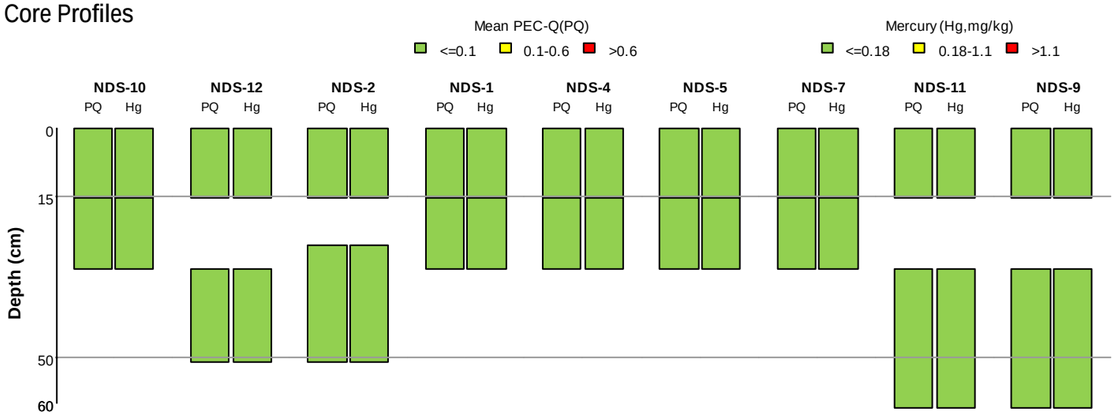
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (9 stations).*

*Other chemical studies:*
*R-EMAP Study, 1995 (2 stations);Bioaccumulation Study, 1999 (1).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Bioaccumulation Study, 1999;Lower St. Louis River, 2011.*

*Fish tissue studies:*
*Bioaccumulation Study, 1999.*

## Core Profiles



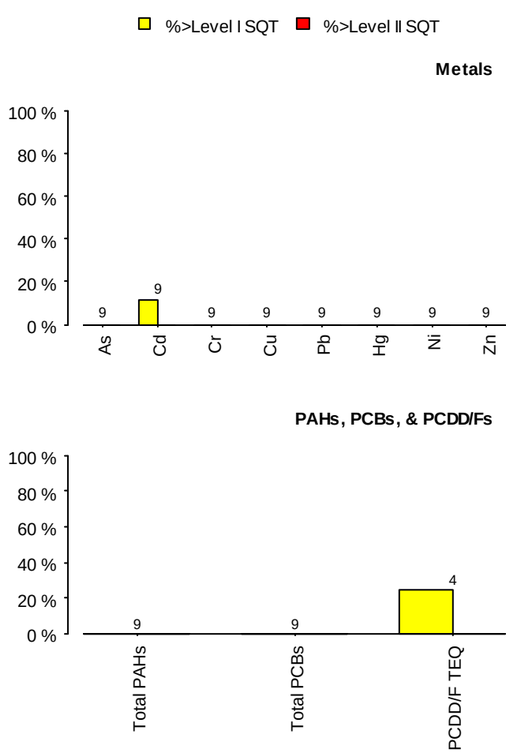

# Sediment Assessment Area Chemistry Characterization

## Data Summary

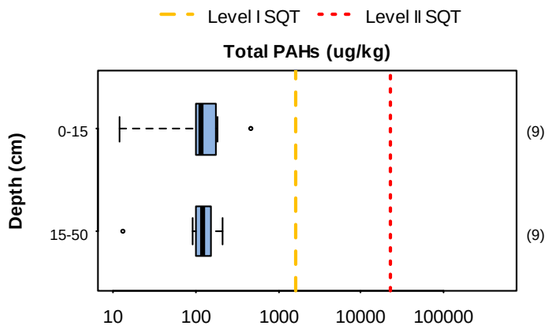
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 9(11) | 18(20) | 180(190) |
| Mercury | 9(12) | 18(21) | 18(21) |
| PAHs | 9(11) | 18(20) | 700(735) |
| PCBs | 9(10) | 18(19) | 126(147) |
| PCDD/Fs | 4(4) | 8(8) | 200(200) |
| Pesticides | 4(4) | 8(8) | 224(224) |
| Other parameters | 9(12) | 18(21) | 688(709) |
| TOC | 9(12) | 17(20) | 17(20) |
| Grain size | 9(11) | 18(20) | 36(50) |

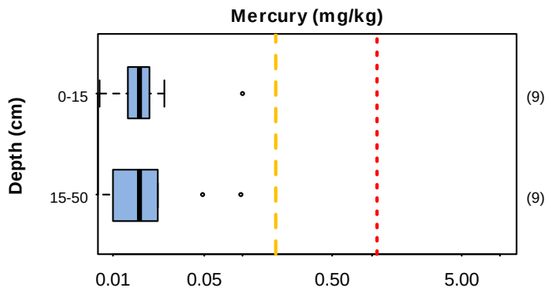
## Results Exceeding Thresholds (0-15 cm samples)

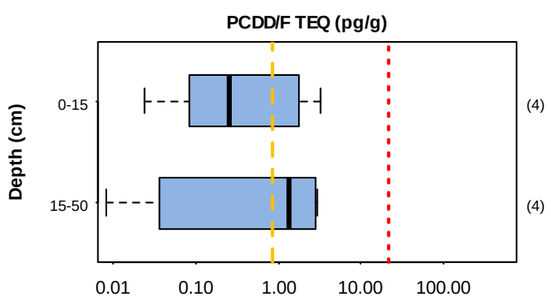



## Distributions of Constituent Concentrations




No PCBs detected in 18 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

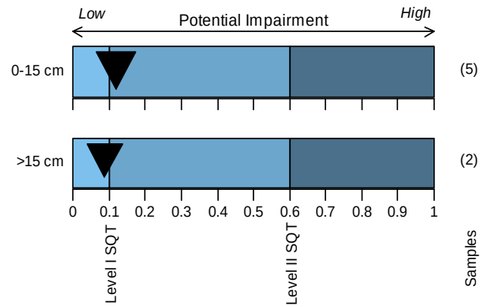
# Sediment Assessment Area Chemistry Characterization

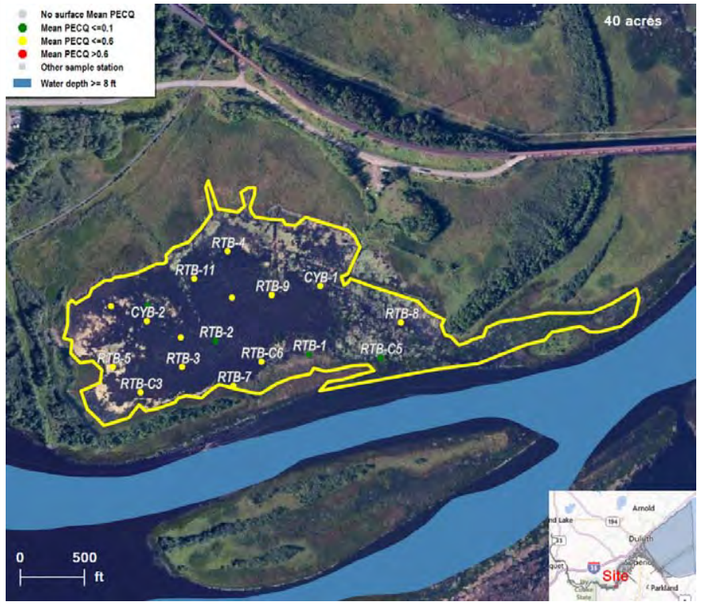
## Assessment Area # 85(Cedar Yard Bay (Radio Tower Bay))

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

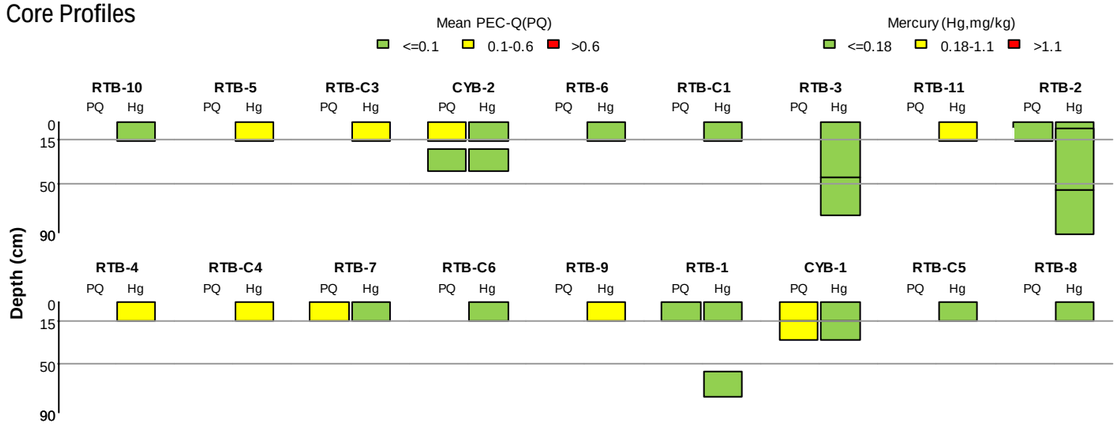
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (2 stations);SL Mud Lake/Radio Tower Bay MPCA 2008 Sed Chem (16).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011;SL Mud Lake/Radio Tower Bay MPCA 2008 Sed Chem;Radio Tower Bay Macroinvertebrate Survey, 2011.*

*Fish tissue studies:*

## Core Profiles



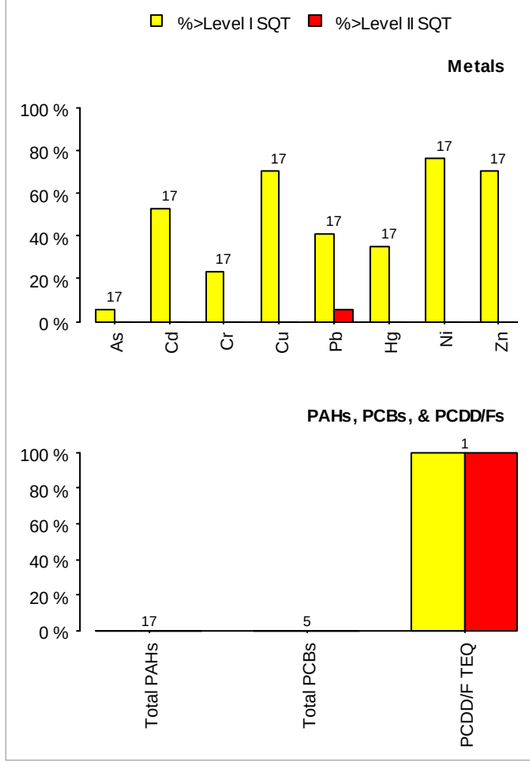

# Sediment Assessment Area Chemistry Characterization

## Data Summary

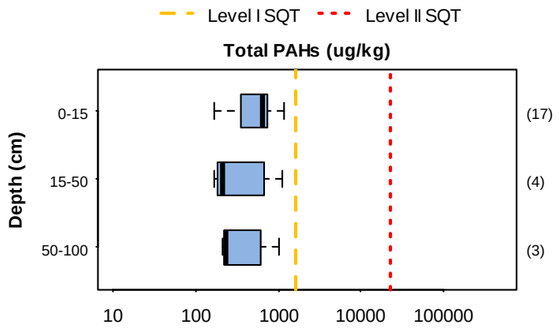
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 18(18) | 24(24) | 400(400) |
| Mercury | 18(18) | 24(24) | 24(24) |
| PAHs | 18(18) | 24(24) | 1029(1029) |
| PCBs | 5(5) | 7(7) | 57(57) |
| PCDD/Fs | 1(1) | 2(2) | 50(50) |
| Pesticides | 4(4) | 5(5) | 65(65) |
| Other parameters | 18(18) | 24(24) | 561(561) |
| TOC | 18(18) | 23(23) | 23(23) |
| Grain size | 18(18) | 23(23) | 86(86) |

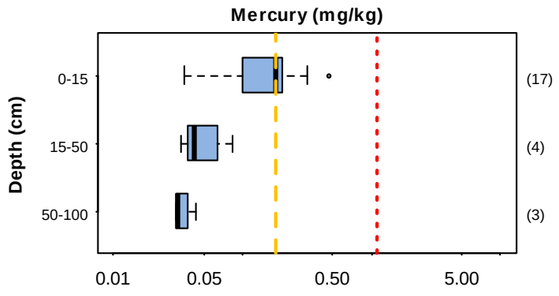
## Results Exceeding Thresholds (0-15 cm samples)

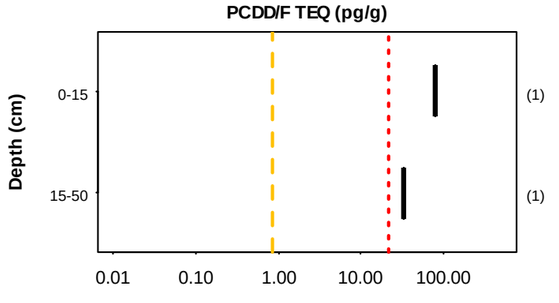



## Distributions of Constituent Concentrations




No PCBs detected in 7 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

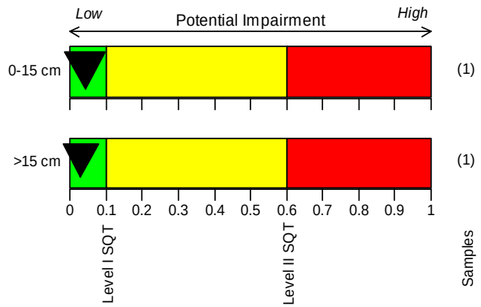
# Sediment Assessment Area Chemistry Characterization

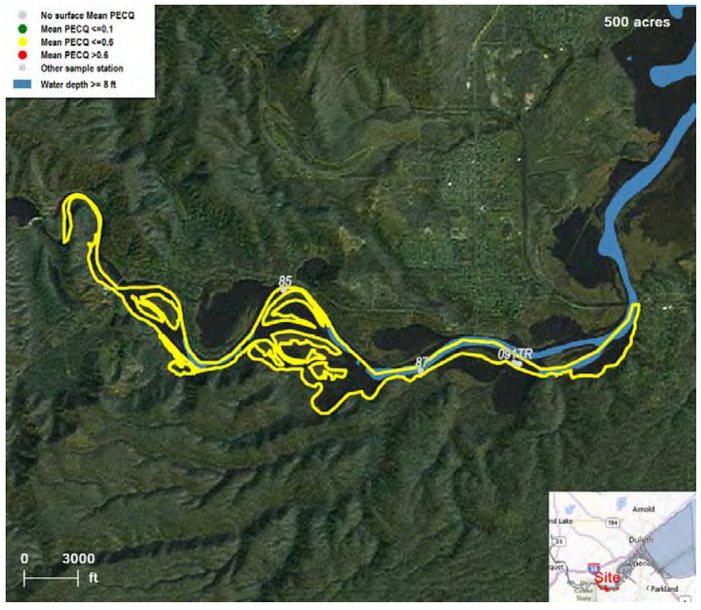
## Assessment Area # 86(SLR Upstream of Oliver Bridge)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

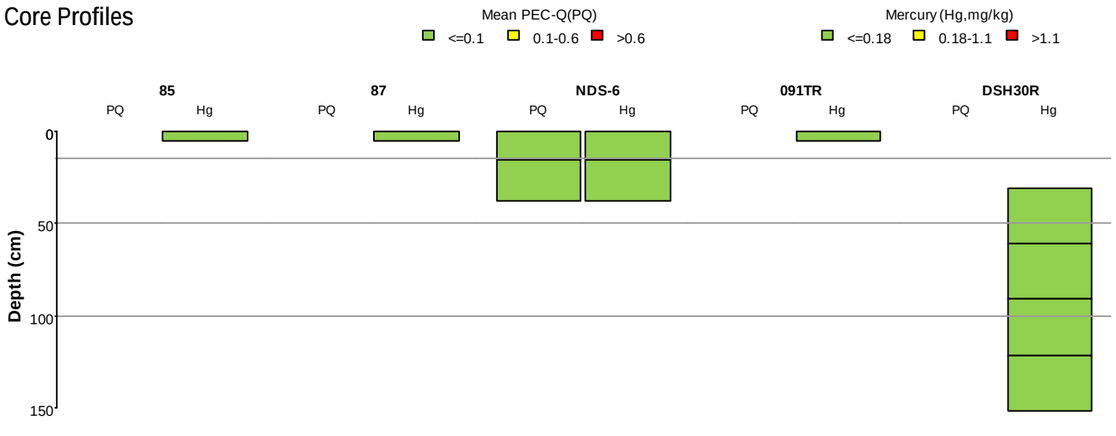
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (3 stations);Duluth-Superior Harbor Study, 1993 (1);Lower St. Louis River, 2011 (1).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Duluth-Superior Harbor Study, 1993;Lower St. Louis River, 2011.*

*Fish tissue studies:*
*Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



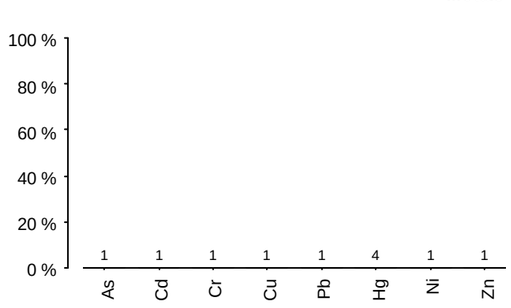

# Sediment Assessment Area Chemistry Characterization

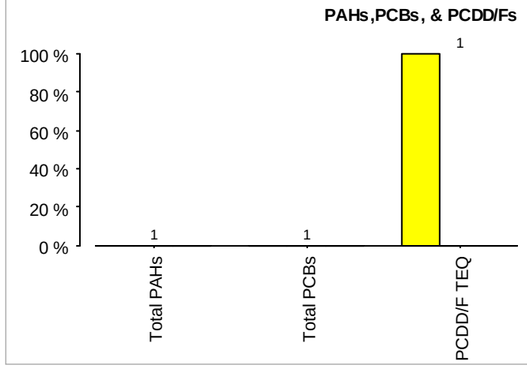
## Data Summary

**Available data in studies used for characterization (All available data)**

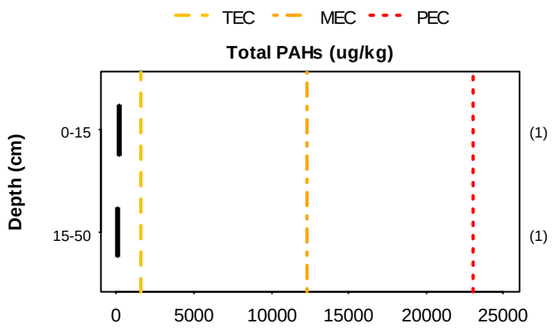
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(4) | 5(5) | 35(35) |
| Mercury | 5(5) | 9(9) | 9(9) |
| PAHs | 1(1) | 2(2) | 80(80) |
| PCBs | 1(1) | 2(2) | 14(14) |
| PCDD/Fs | 1(1) | 2(2) | 50(50) |
| Pesticides | 1(1) | 2(2) | 56(56) |
| Other parameters | 5(5) | 9(9) | 141(141) |
| TOC | 5(5) | 9(9) | 9(9) |
| Grain size | 4(4) | 5(5) | 25(25) |

## Results Exceeding Thresholds (0-15 cm samples)

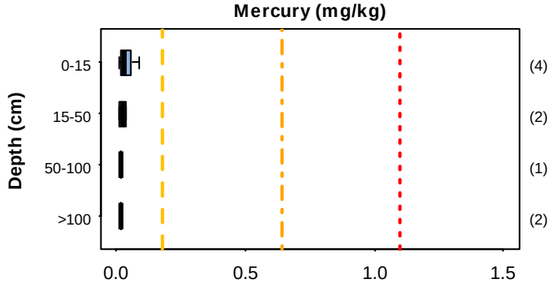


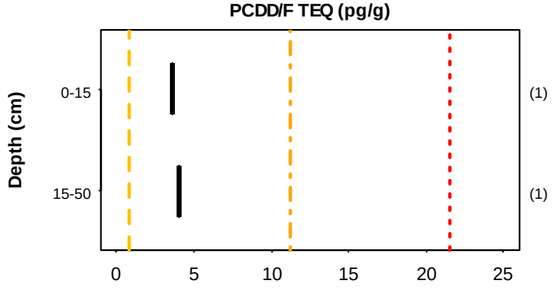




## Distributions of Constituent Concentrations




No PCBs detected in 2 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

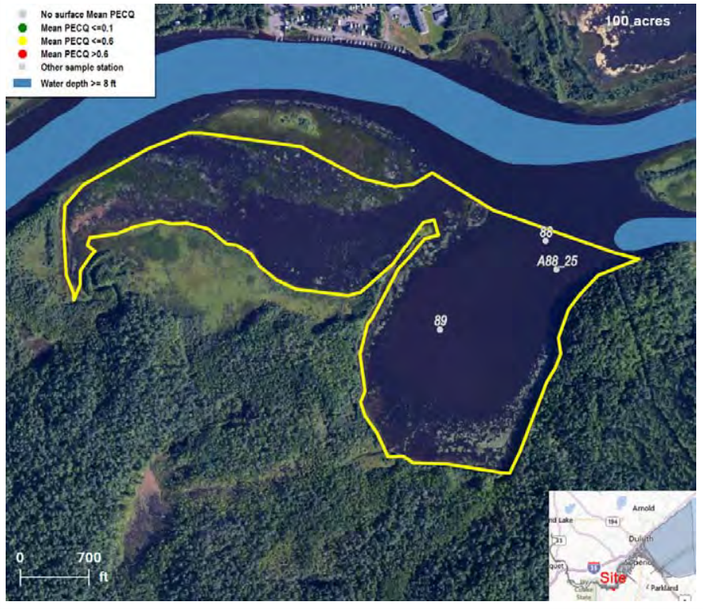
## Assessment Area # 87(Red River Bay)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (2 stations);R-EMAP Study, 1996 (1).*

*Other chemical studies:*

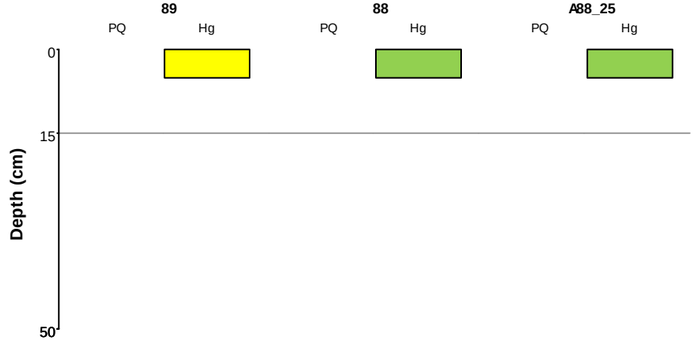
*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996.*

*Fish tissue studies:*

## Core Profiles

Mean PEC-Q(PQ) <=0.1 0.1-0.6 >0.6

Mercury (Hg,mg/kg) <=0.18 0.18-1.1 >1.1





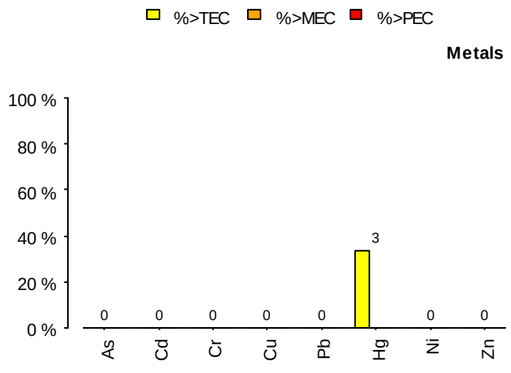
# Sediment Assessment Area Chemistry Characterization

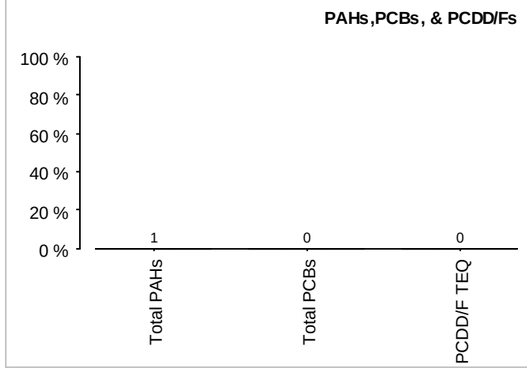

## Data Summary

**Available data in studies used for characterization (All available data)**

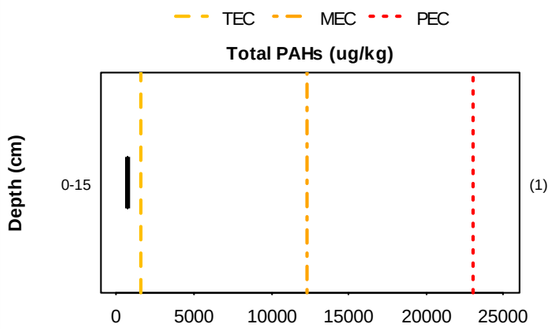
| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(3) | 3(3) | 15(15) |
| Mercury | 3(3) | 3(3) | 3(3) |
| PAHs | 1(1) | 1(1) | 19(19) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 3(3) | 3(3) | 12(12) |
| TOC | 3(3) | 3(3) | 3(3) |
| Grain size | 3(3) | 3(3) | 21(21) |

## Results Exceeding Thresholds (0-15 cm samples)

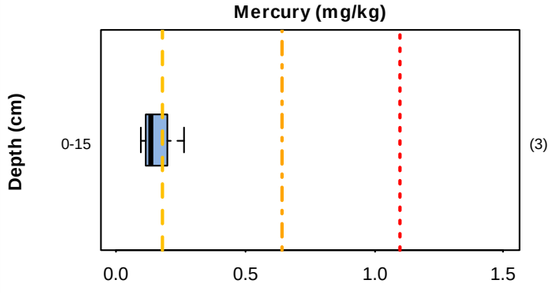



## Distributions of Constituent Concentrations




No PCBs detected in 0 analyzed samples




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

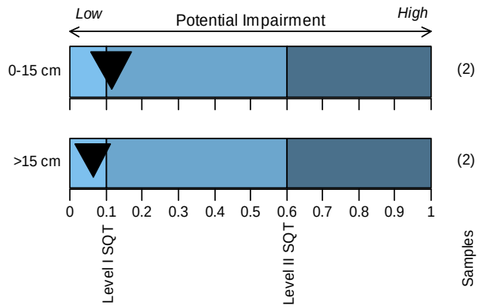
# Sediment Assessment Area Chemistry Characterization

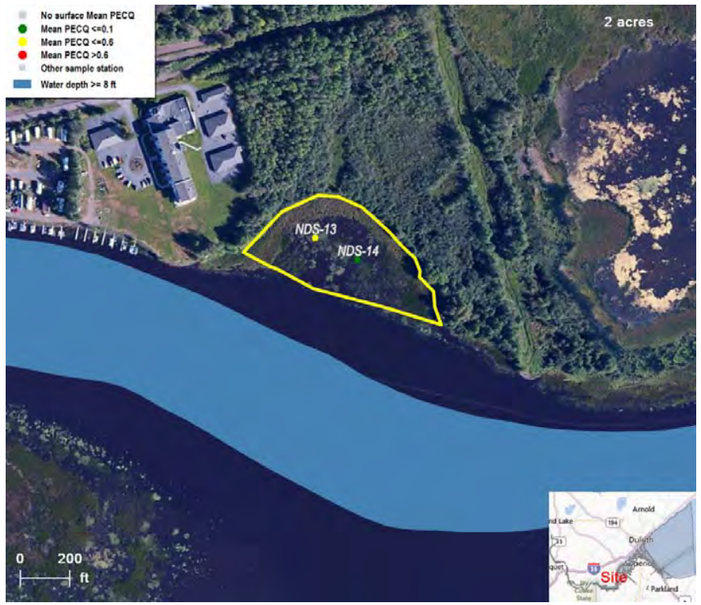
## Assessment Area # 88(New Duluth Bay)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

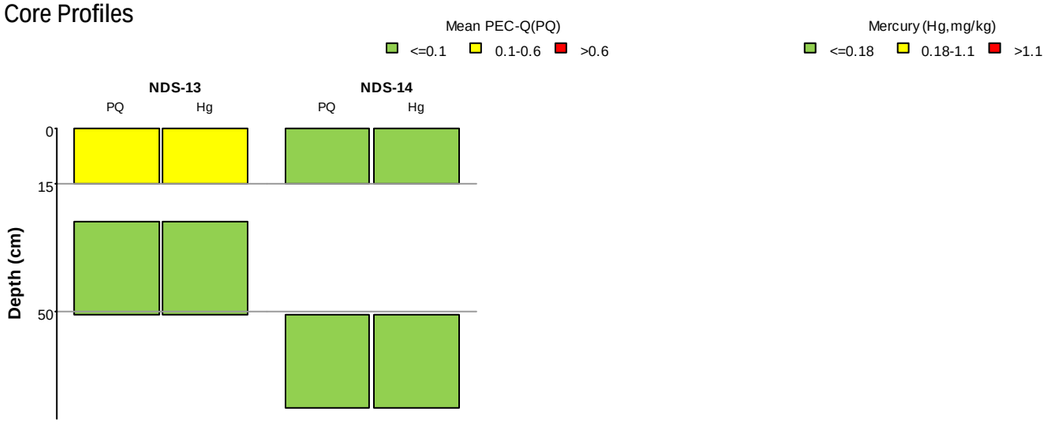
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (2 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



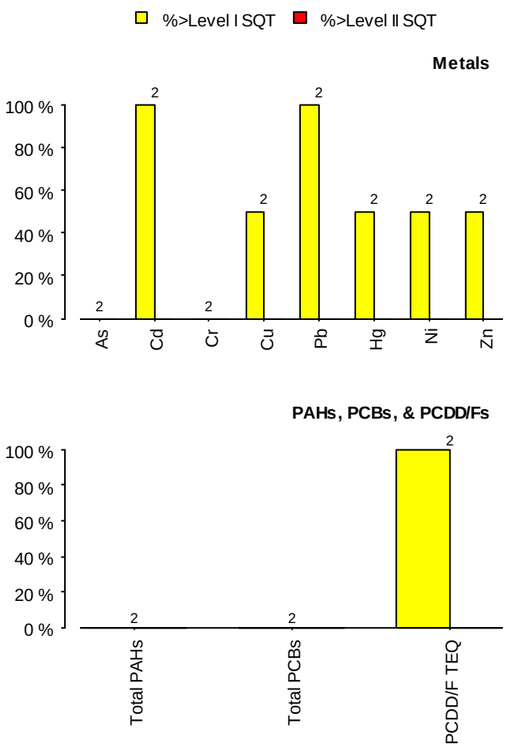

# Sediment Assessment Area Chemistry Characterization

## Data Summary

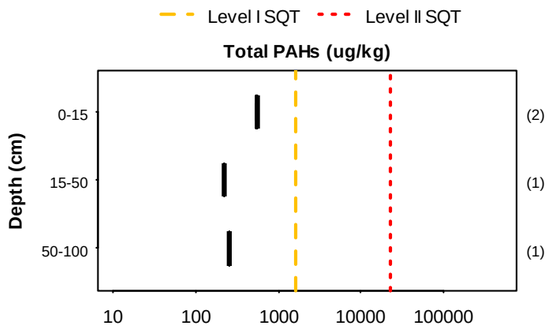
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 4(4) | 40(40) |
| Mercury | 2(2) | 4(4) | 4(4) |
| PAHs | 2(2) | 4(4) | 160(160) |
| PCBs | 2(2) | 4(4) | 28(28) |
| PCDD/Fs | 2(2) | 4(4) | 100(100) |
| Pesticides | 2(2) | 4(4) | 112(112) |
| Other parameters | 2(2) | 4(4) | 260(260) |
| TOC | 2(2) | 4(4) | 4(4) |
| Grain size | 2(2) | 4(4) | 8(8) |

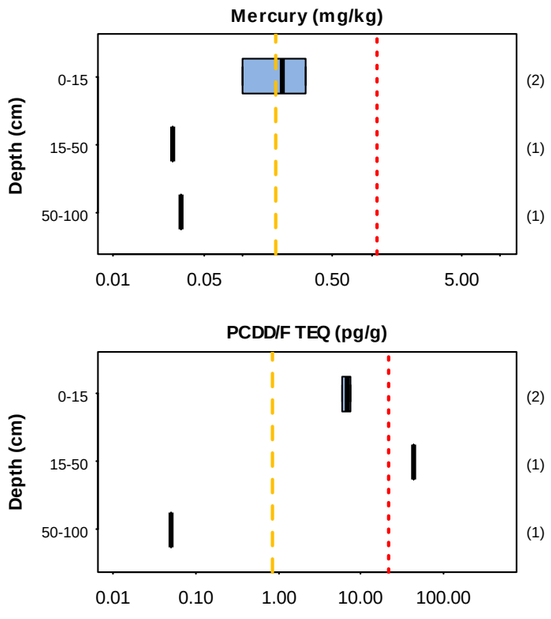
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 4 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

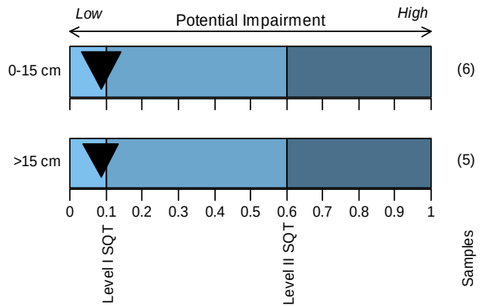
# Sediment Assessment Area Chemistry Characterization

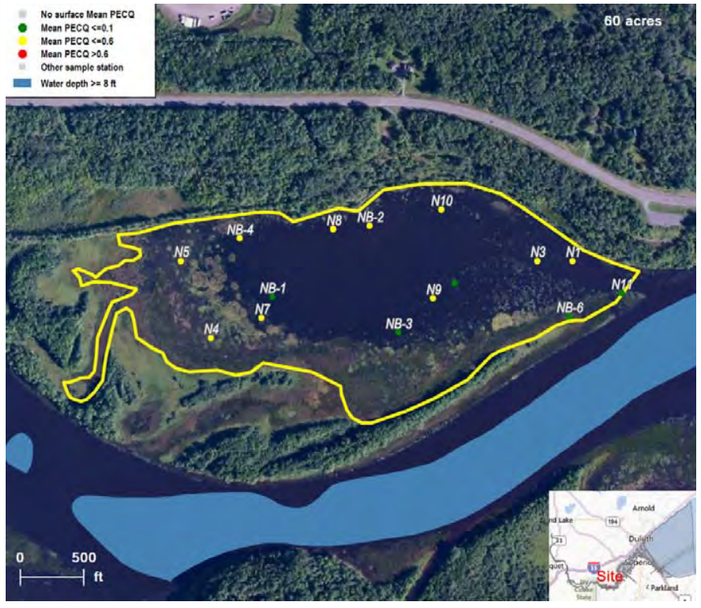
## Assessment Area # 89(North Bay)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

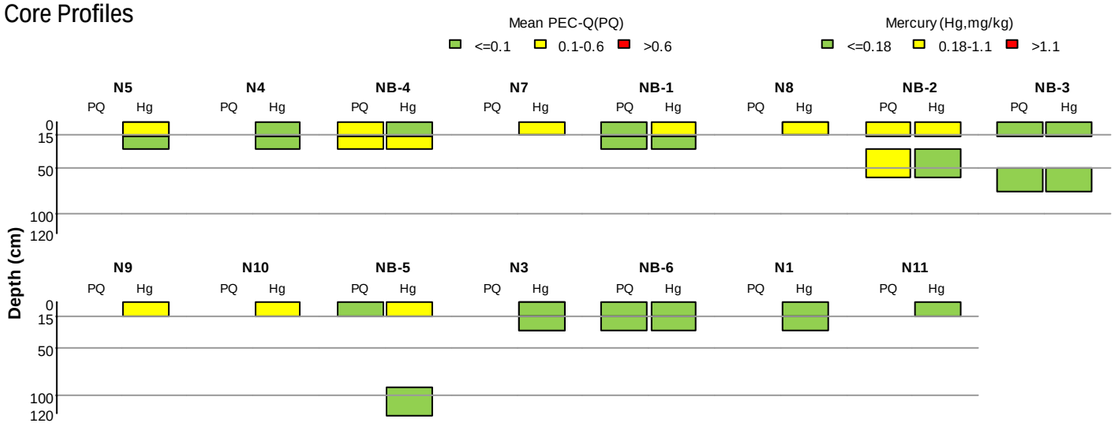
*Chemical studies used in the characterization: Bay West Intlk Supplemental 2001 (5 stations);Bay West Intlk Reconnaissance 2001 (4);Lower St. Louis River, 2011 (6).*

*Other chemical studies: Chlorinated Bornane/Bornene Study, 1999 (2 stations).*

*Macro-invertebrate studies: Chlorinated Bornane/Bornene Study, 1999;Bay West Intlk Supplemental 2001;Bay West Intlk Reconnaissance 2001;Lower St. Louis River, 2011;Radio Tower Bay Macroinvertebrate Survey, 2011.*

*Fish tissue studies: Bay West Intlk Supplemental 2001;St. Louis River USFWS 2001-02.*

## Core Profiles



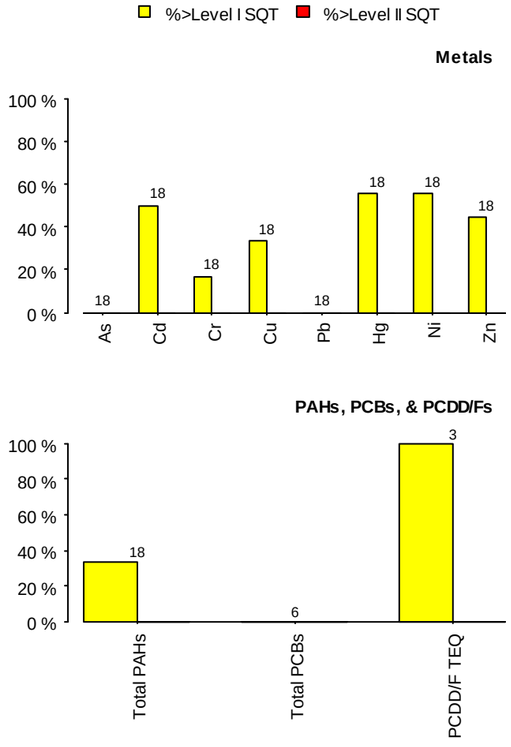

# Sediment Assessment Area Chemistry Characterization

## Data Summary

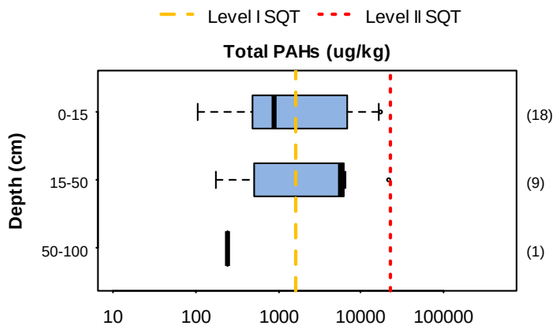
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 15(15) | 29(29) | 273(273) |
| Mercury | 15(15) | 29(29) | 29(29) |
| PAHs | 15(15) | 28(28) | 839(839) |
| PCBs | 6(6) | 12(12) | 84(84) |
| PCDD/Fs | 8(8) | 12(12) | 156(156) |
| Pesticides | 8(10) | 12(27) | 174(235) |
| Other parameters | 15(17) | 29(51) | 1750(1786) |
| TOC | 15(15) | 28(28) | 28(28) |
| Grain size | 15(15) | 29(29) | 41(41) |

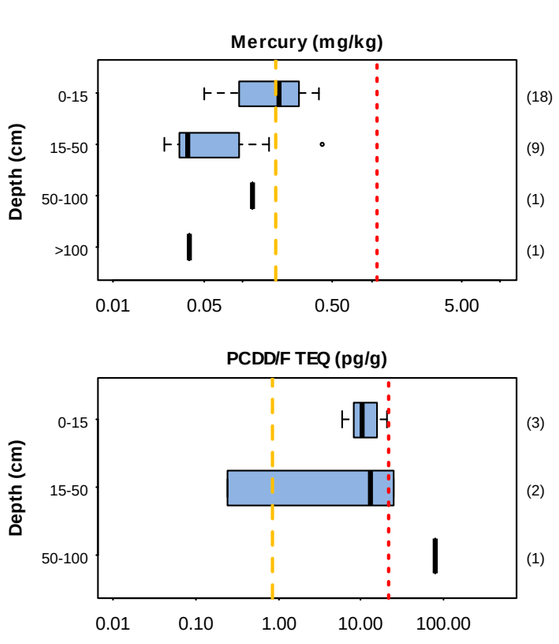
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 12 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

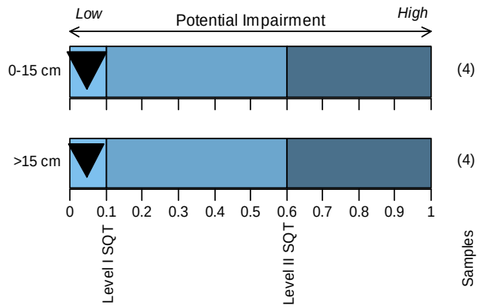
# Sediment Assessment Area Chemistry Characterization

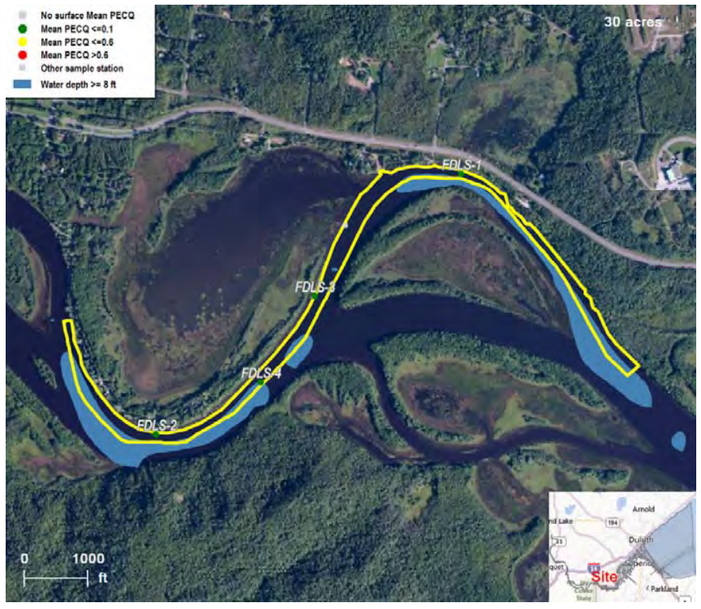
## Assessment Area # 90(Fond du Lac Stretch)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

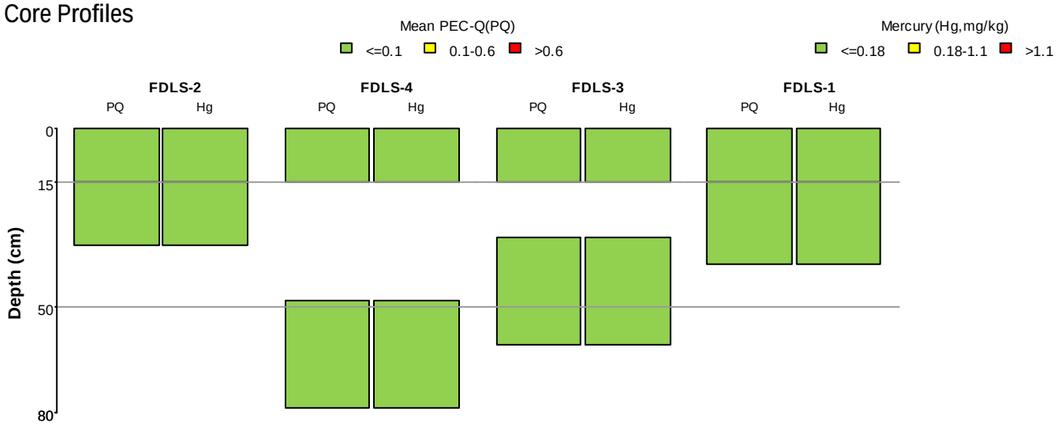
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (4 stations).*

*Other chemical studies:*
*R-EMAP Study, 1995 (1 stations).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



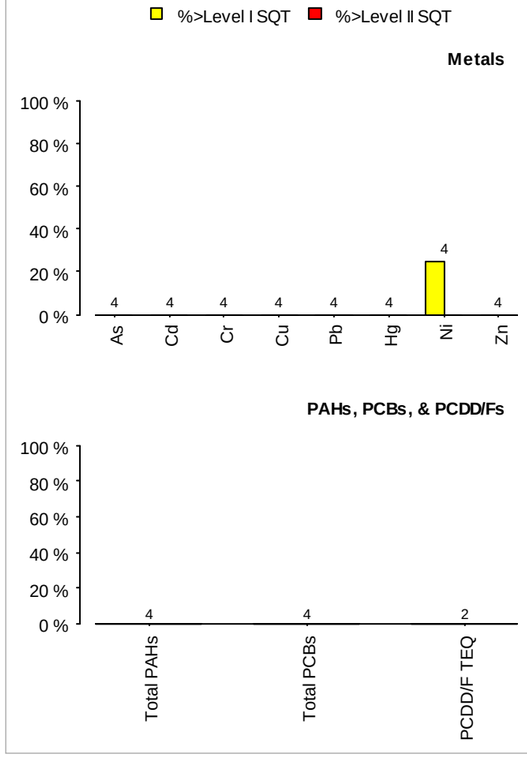

# Sediment Assessment Area Chemistry Characterization

## Data Summary

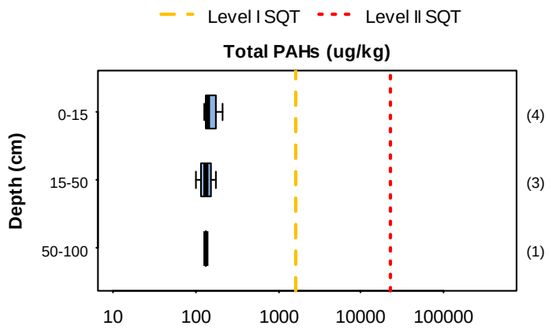
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(5) | 8(9) | 80(85) |
| Mercury | 4(5) | 8(9) | 8(9) |
| PAHs | 4(4) | 8(8) | 312(312) |
| PCBs | 4(4) | 8(8) | 56(56) |
| PCDD/Fs | 2(2) | 4(4) | 100(100) |
| Pesticides | 2(2) | 4(4) | 112(112) |
| Other parameters | 4(5) | 8(9) | 328(329) |
| TOC | 4(5) | 8(9) | 8(9) |
| Grain size | 4(5) | 8(9) | 16(23) |

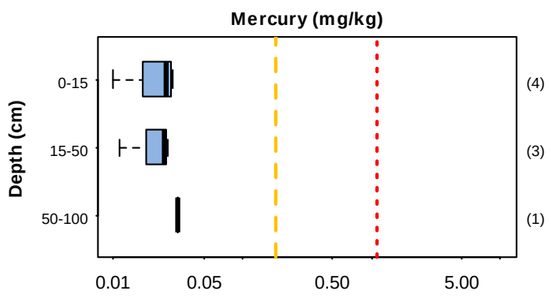
## Results Exceeding Thresholds (0-15 cm samples)

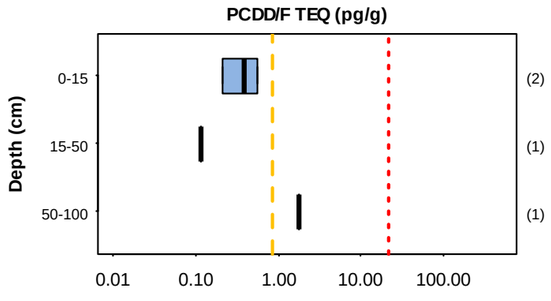



## Distributions of Constituent Concentrations




No PCBs detected in 8 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

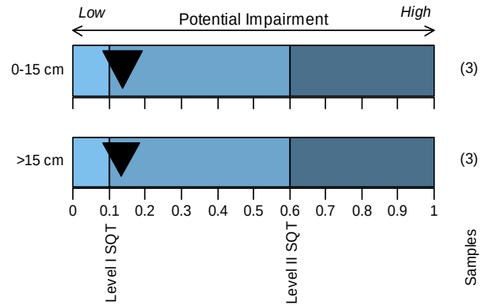
# Sediment Assessment Area Chemistry Characterization

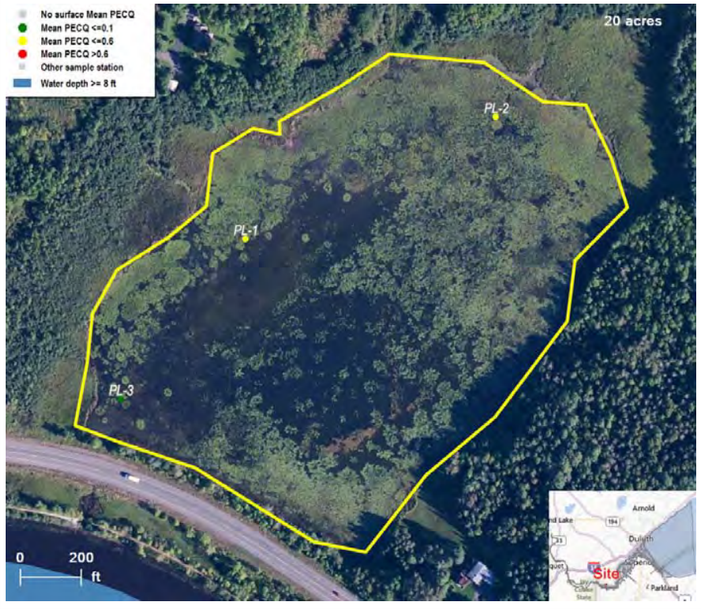
## Assessment Area # 91(Perch Lake)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

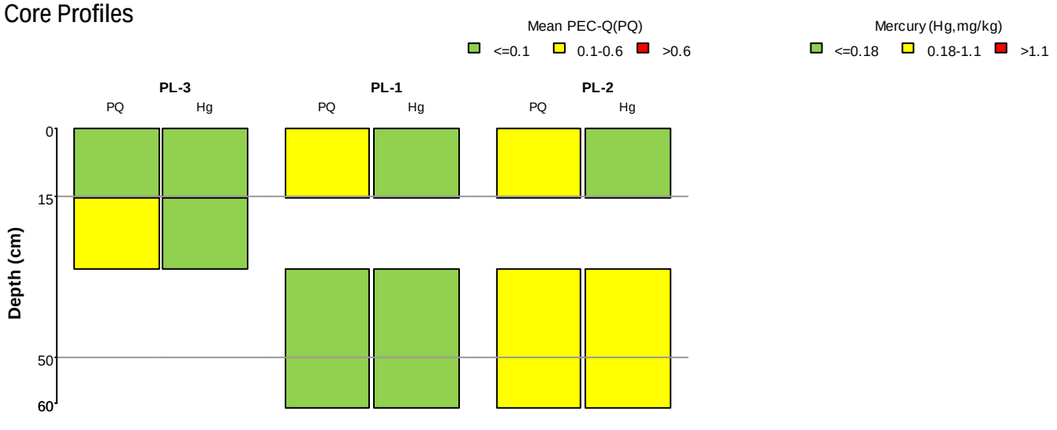
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (3 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



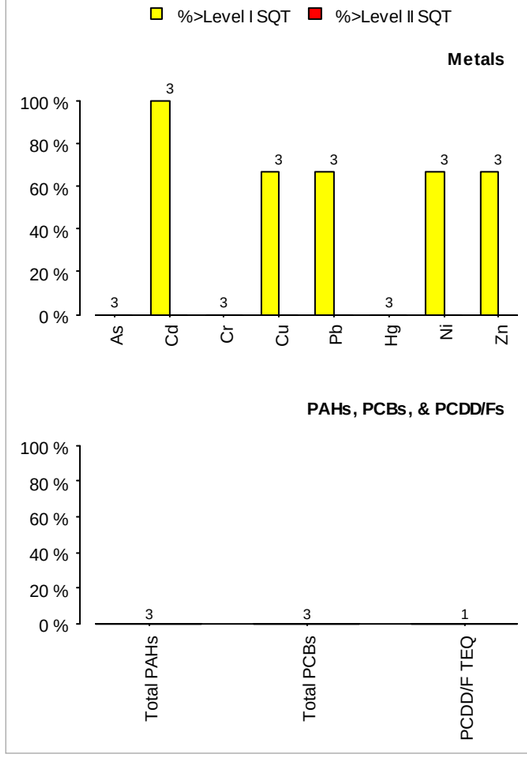

# Sediment Assessment Area Chemistry Characterization

## Data Summary

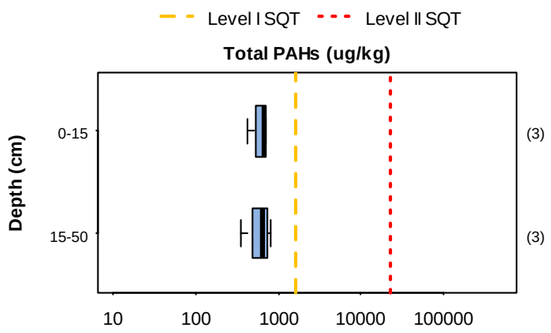
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(3) | 6(6) | 60(60) |
| Mercury | 3(3) | 6(6) | 6(6) |
| PAHs | 3(3) | 6(6) | 232(232) |
| PCBs | 3(3) | 6(6) | 42(42) |
| PCDD/Fs | 1(1) | 2(2) | 50(50) |
| Pesticides | 1(1) | 2(2) | 56(56) |
| Other parameters | 3(3) | 6(6) | 198(198) |
| TOC | 3(3) | 6(6) | 6(6) |
| Grain size | 3(3) | 6(6) | 12(12) |

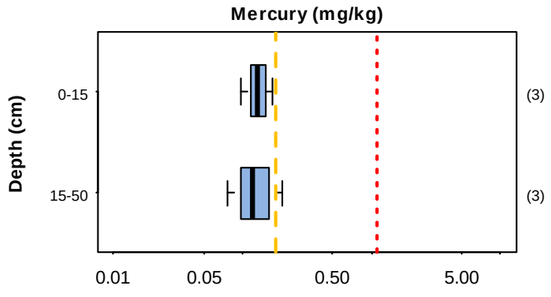
## Results Exceeding Thresholds (0-15 cm samples)

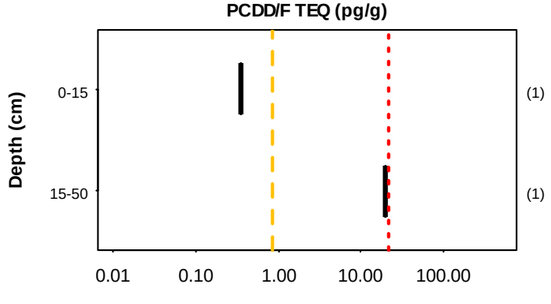



## Distributions of Constituent Concentrations




No PCBs detected in 6 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

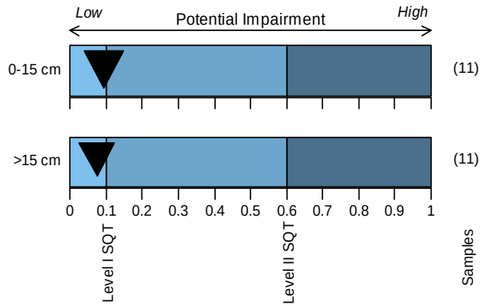
# Sediment Assessment Area Chemistry Characterization

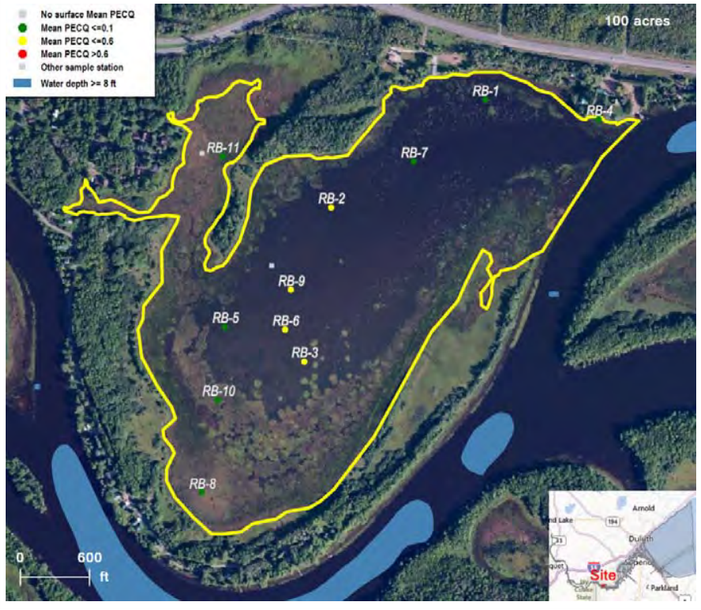
## Assessment Area # 92(Rask Bay)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

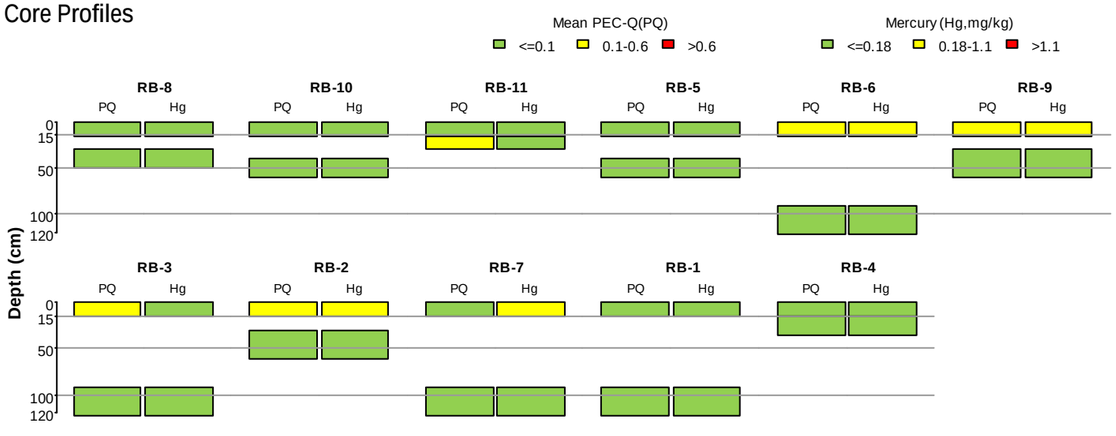
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (11 stations).*

*Other chemical studies:*
*R-EMAP Study, 1995 (2 stations).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



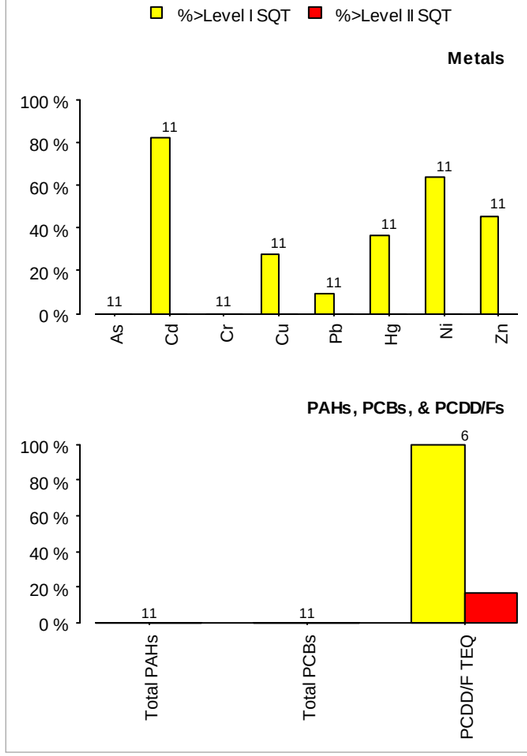

# Sediment Assessment Area Chemistry Characterization

## Data Summary

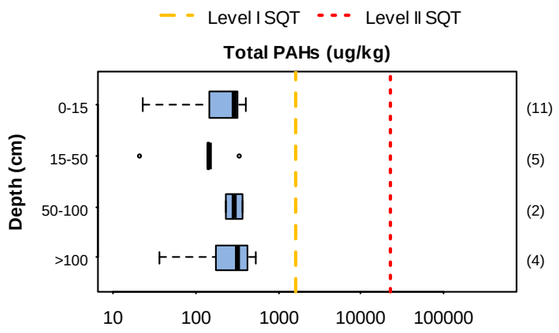
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 11(13) | 22(24) | 220(230) |
| Mercury | 11(13) | 22(24) | 22(24) |
| PAHs | 11(12) | 22(23) | 860(877) |
| PCBs | 11(11) | 22(22) | 154(154) |
| PCDD/Fs | 6(6) | 12(12) | 300(300) |
| Pesticides | 6(6) | 12(12) | 336(336) |
| Other parameters | 11(13) | 22(24) | 948(959) |
| TOC | 11(13) | 21(23) | 21(23) |
| Grain size | 11(13) | 22(24) | 44(58) |

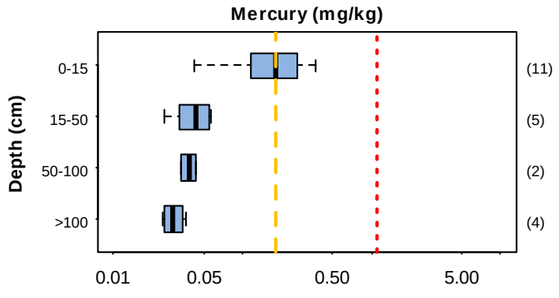
## Results Exceeding Thresholds (0-15 cm samples)

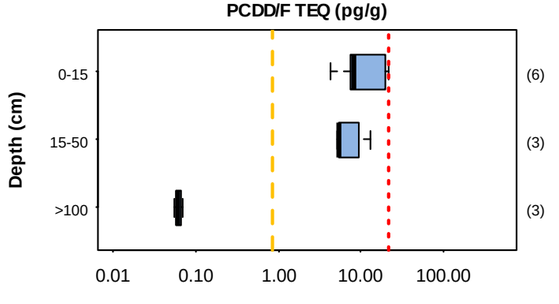



## Distributions of Constituent Concentrations




No PCBs detected in 22 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

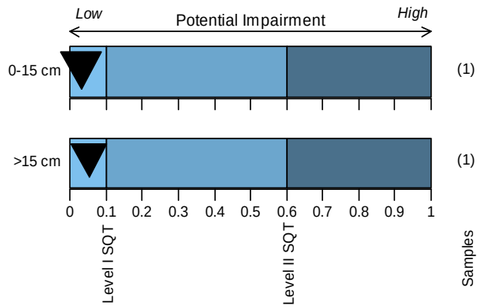
# Sediment Assessment Area Chemistry Characterization

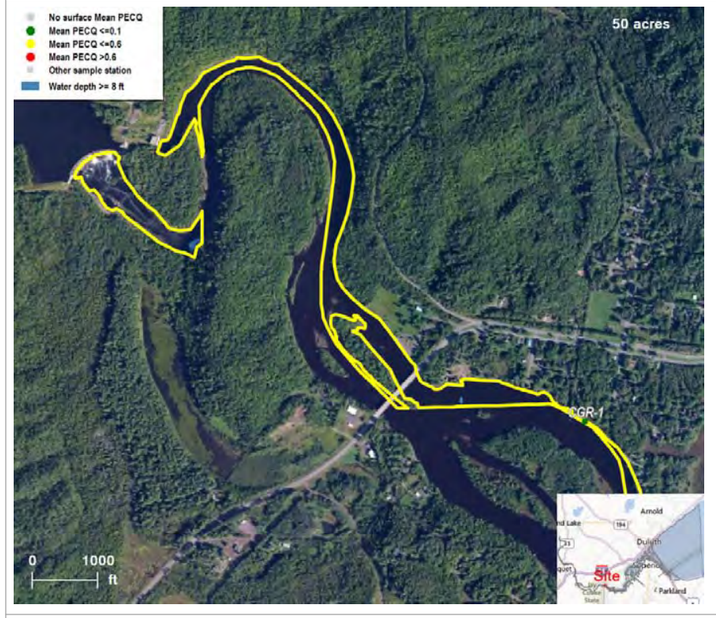
## Assessment Area # 93(Chambers Grove Reach)

*Geographic zone: Middle St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

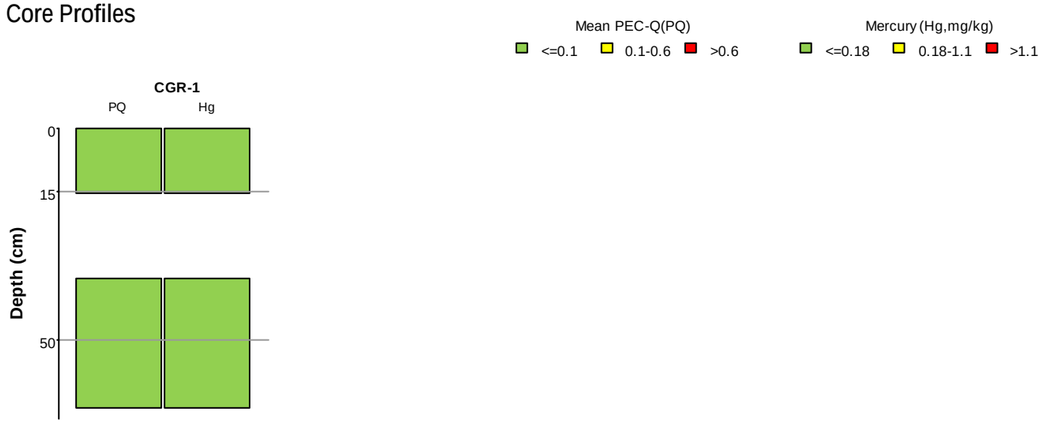
*Chemical studies used in the characterization:*
*Lower St. Louis River, 2011 (1 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Lower St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



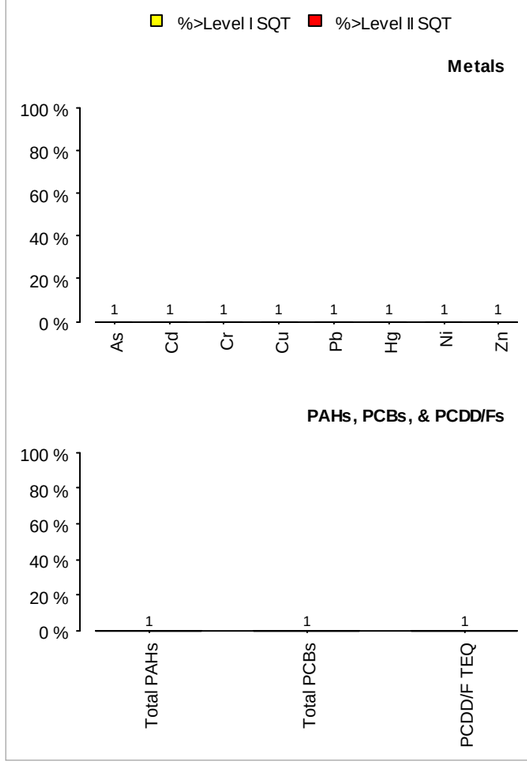

# Sediment Assessment Area Chemistry Characterization

## Data Summary

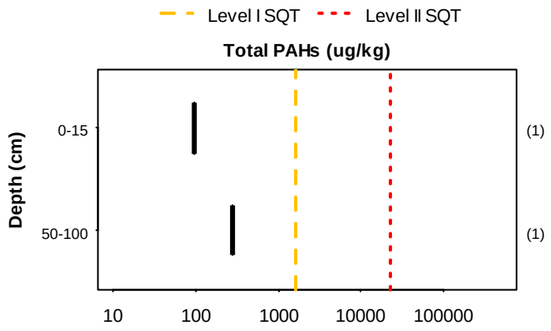
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 1(1) | 2(2) | 20(20) |
| Mercury | 1(1) | 2(2) | 2(2) |
| PAHs | 1(1) | 2(2) | 80(80) |
| PCBs | 1(1) | 2(2) | 14(14) |
| PCDD/Fs | 1(1) | 2(2) | 50(50) |
| Pesticides | 1(1) | 2(2) | 56(56) |
| Other parameters | 1(1) | 2(2) | 130(130) |
| TOC | 1(1) | 2(2) | 2(2) |
| Grain size | 1(1) | 2(2) | 4(4) |

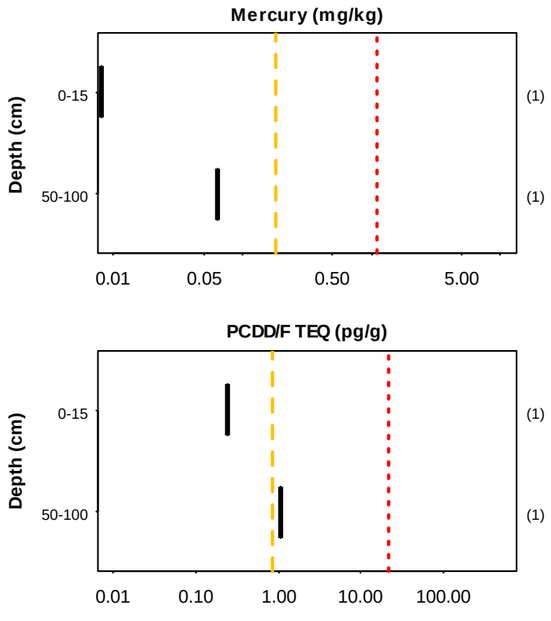
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 2 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

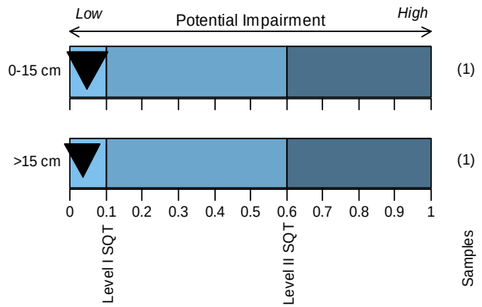
# Sediment Assessment Area Chemistry Characterization

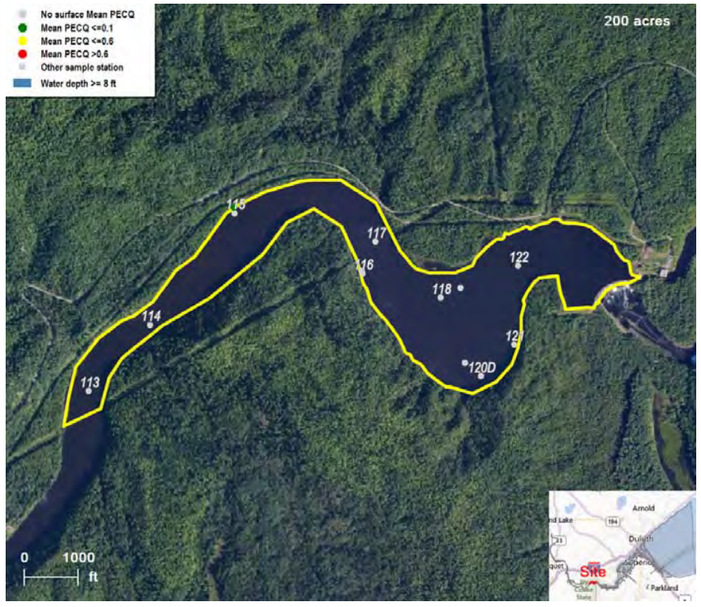
## Assessment Area # 94(Fond du Lac Reservoir)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

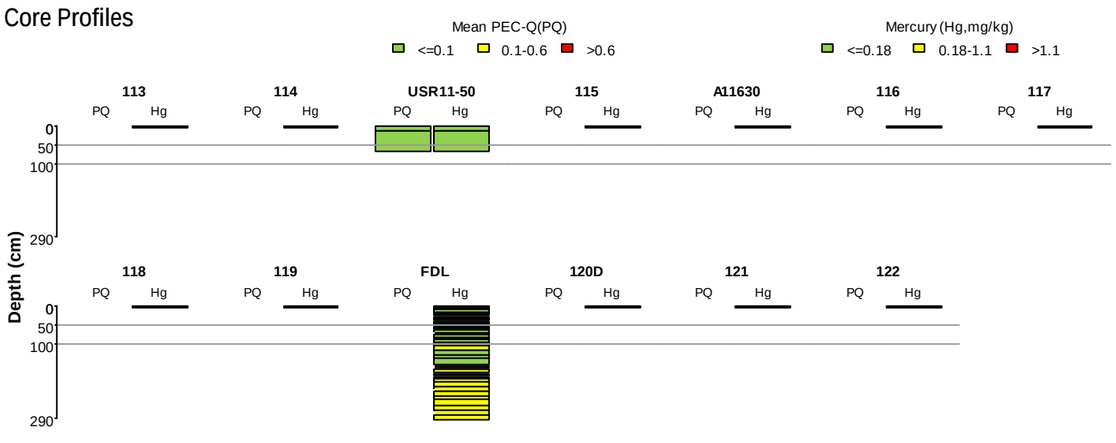
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (10 stations);R-EMAP Study, 1996 (1);Cloquet Reservoirs Study, 1992-93 (1);Upper St. Louis River, 2011 (1).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;Cloquet Reservoirs Study, 1992-93;Upper St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



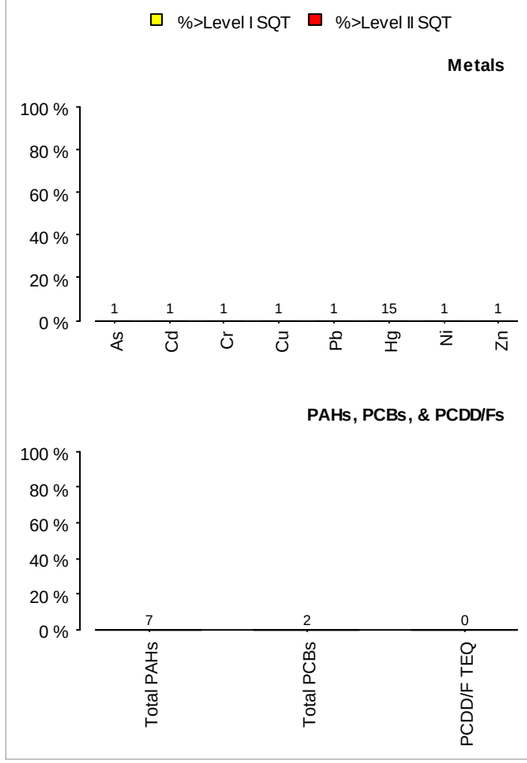

# Sediment Assessment Area Chemistry Characterization

## Data Summary

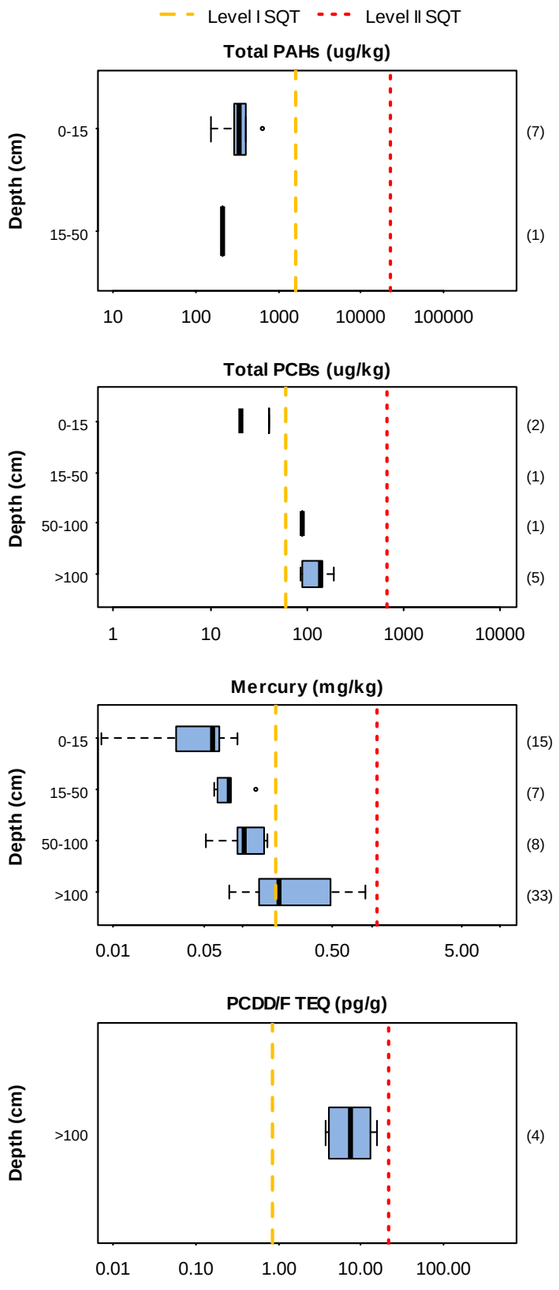
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 12(12) | 13(13) | 99(99) |
| Mercury | 13(13) | 63(63) | 63(63) |
| PAHs | 7(7) | 8(8) | 144(144) |
| PCBs | 2(2) | 10(10) | 688(688) |
| PCDD/Fs | 1(1) | 6(6) | 12(12) |
| Pesticides | 1(1) | 2(2) | 8(8) |
| Other parameters | 13(13) | 21(21) | 211(211) |
| TOC | 12(12) | 13(13) | 13(13) |
| Grain size | 11(11) | 11(11) | 77(77) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

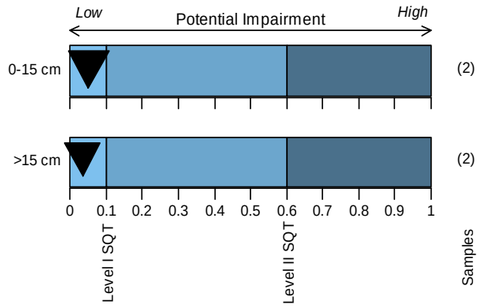
# Sediment Assessment Area Chemistry Characterization

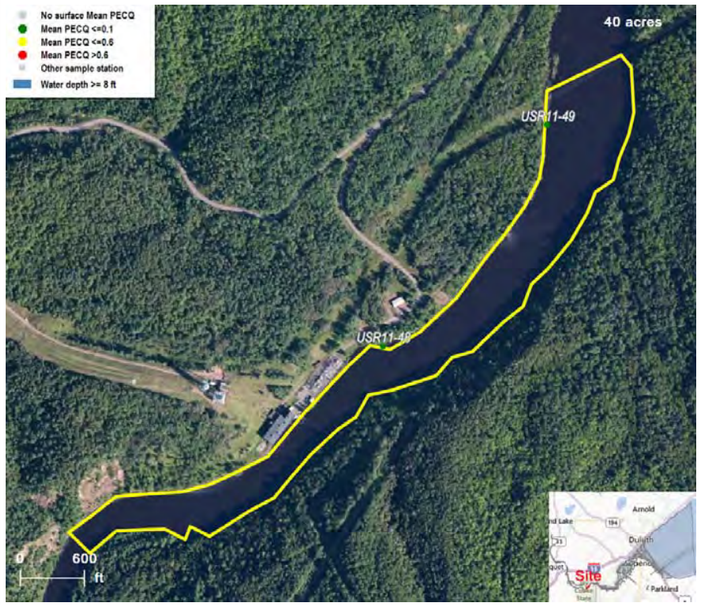
## Assessment Area # 95(Lower Jay Cooke State Park Reach)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

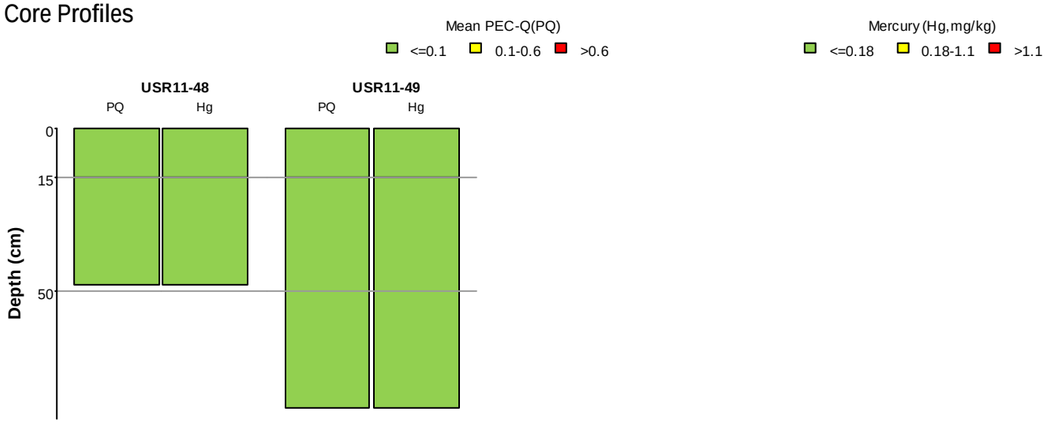
*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (2 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Upper St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



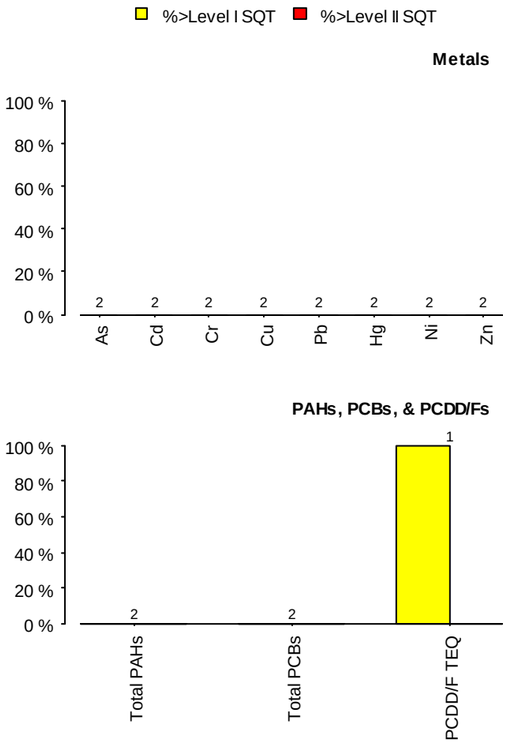

# Sediment Assessment Area Chemistry Characterization

## Data Summary

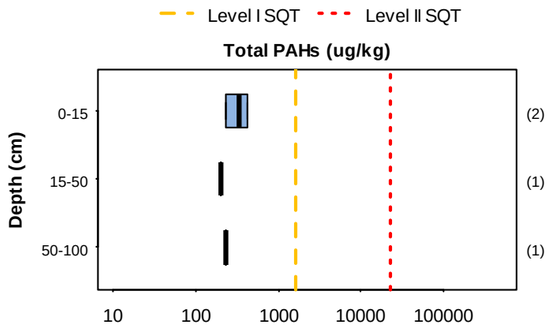
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 4(4) | 88(88) |
| Mercury | 2(2) | 4(4) | 4(4) |
| PAHs | 2(2) | 4(4) | 80(80) |
| PCBs | 2(2) | 4(4) | 40(40) |
| PCDD/Fs | 1(1) | 1(1) | 30(30) |
| Pesticides | 2(2) | 4(4) | 37(37) |
| Other parameters | 2(2) | 4(4) | 238(238) |
| TOC | 2(2) | 4(4) | 4(4) |
| Grain size | 1(1) | 1(1) | 1(1) |

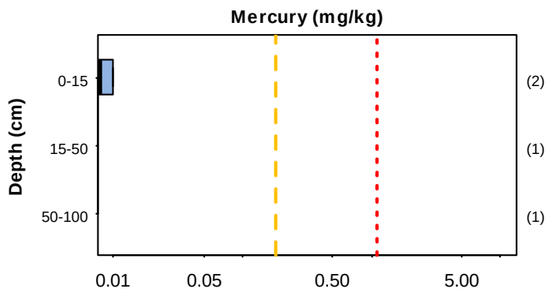
## Results Exceeding Thresholds (0-15 cm samples)

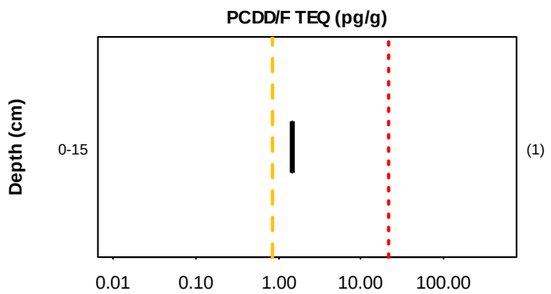



## Distributions of Constituent Concentrations




No PCBs detected in 4 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

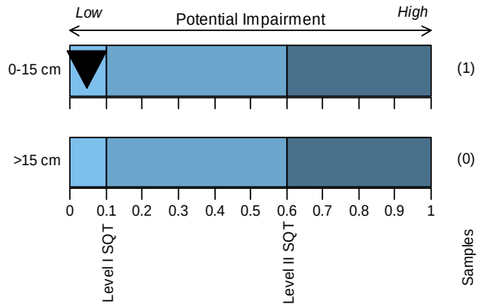
# Sediment Assessment Area Chemistry Characterization

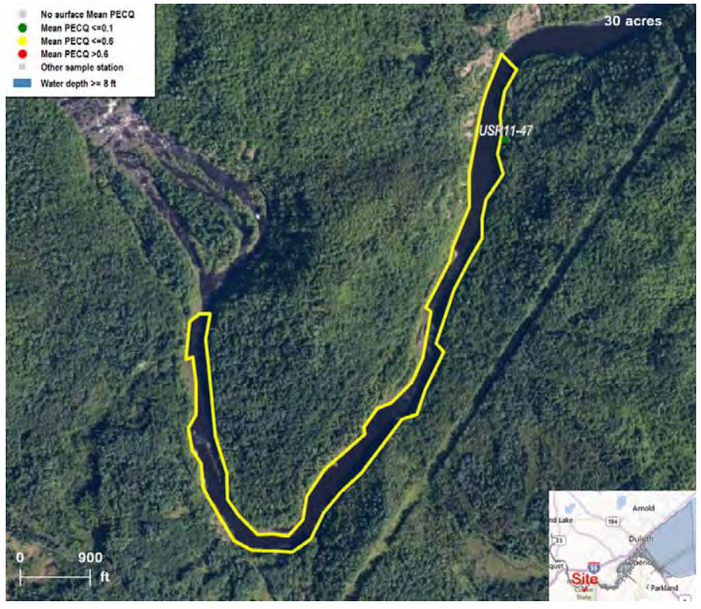
## Assessment Area # 96(Middle Jay Cooke State Park Reach)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (1 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Upper St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

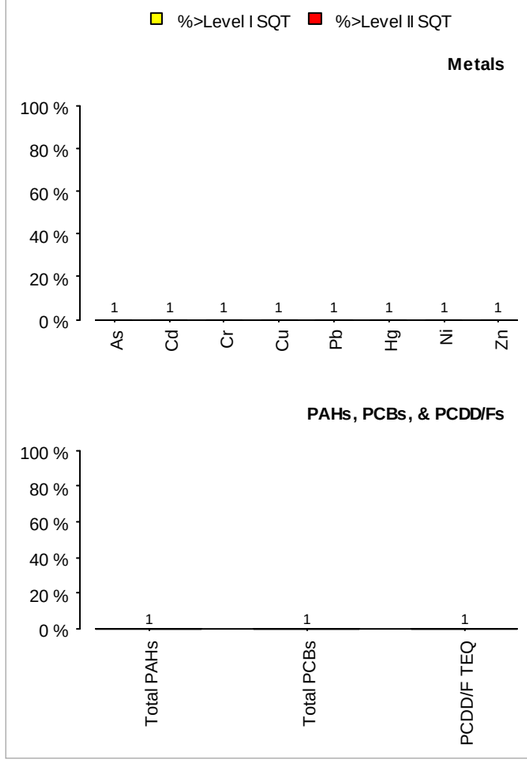

# Sediment Assessment Area Chemistry Characterization


## Data Summary

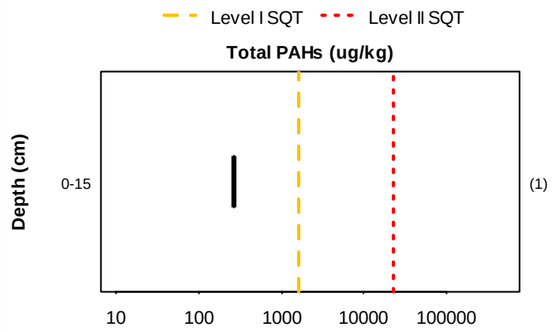
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 1(1) | 1(1) | 22(22) |
| Mercury | 1(1) | 1(1) | 1(1) |
| PAHs | 1(1) | 1(1) | 20(20) |
| PCBs | 1(1) | 1(1) | 10(10) |
| PCDD/Fs | 1(1) | 1(1) | 30(30) |
| Pesticides | 1(1) | 1(1) | 25(25) |
| Other parameters | 1(1) | 1(1) | 61(61) |
| TOC | 1(1) | 1(1) | 1(1) |
| Grain size | 1(1) | 1(1) | 1(1) |

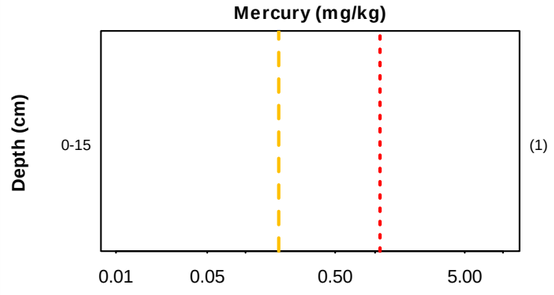
## Results Exceeding Thresholds (0-15 cm samples)

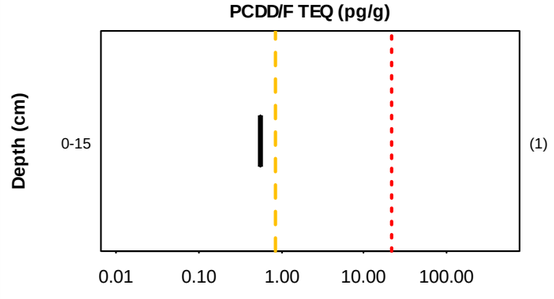



## Distributions of Constituent Concentrations




No PCBs detected in 1 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

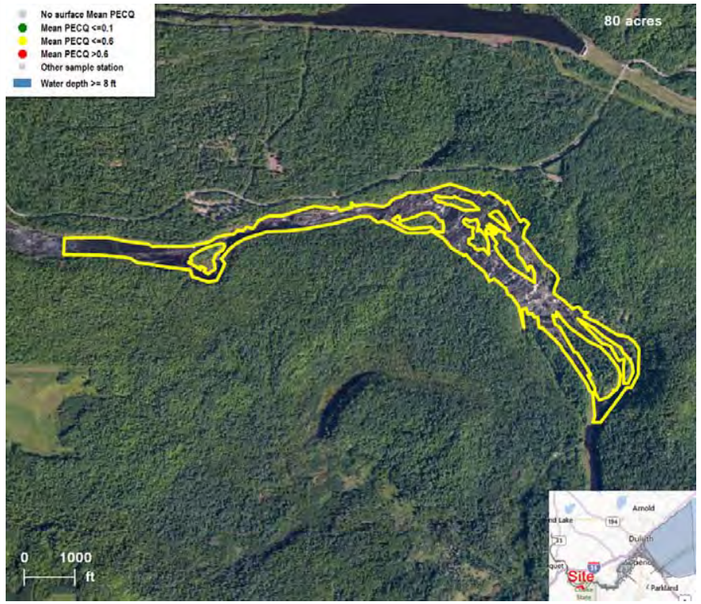
## Assessment Area # 97(Oldenburg Point Rapids Reach)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

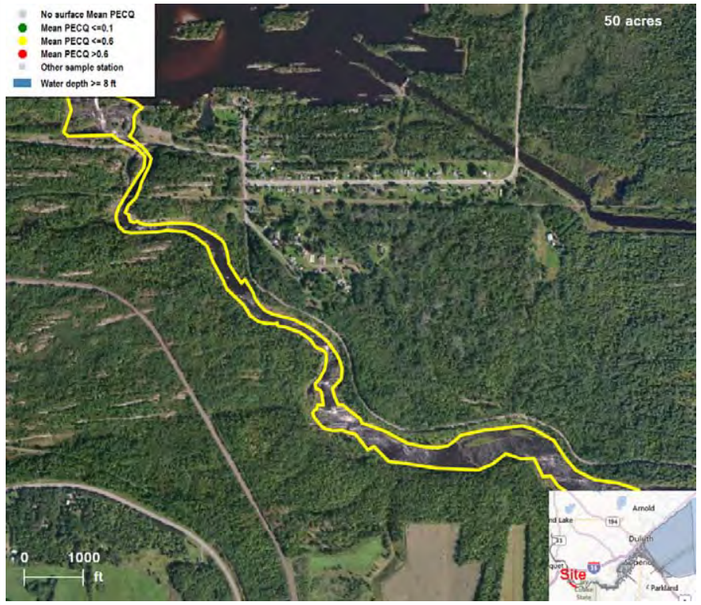
## Assessment Area # 98(Lower Thomson Reach)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

*Chemical studies used in the characterization:*

*Other chemical studies:*

*Macro-invertebrate studies:*

*Fish tissue studies:*

## Core Profiles

No data available for core profile

# Sediment Assessment Area Chemistry Characterization

## Data Summary

**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 0(0) | 0(0) | 0(0) |
| Mercury | 0(0) | 0(0) | 0(0) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 0(0) | 0(0) | 0(0) |
| PCDD/Fs | 0(0) | 0(0) | 0(0) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 0(0) | 0(0) | 0(0) |
| TOC | 0(0) | 0(0) | 0(0) |
| Grain size | 0(0) | 0(0) | 0(0) |

## Results Exceeding Thresholds (0-15 cm samples)

No surface samples available

## Distributions of Constituent Concentrations

Level I SQT  Level II SQT

No samples analyzed for PAHs

No PCBs detected in 0 analyzed samples

No samples analyzed for mercury

No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

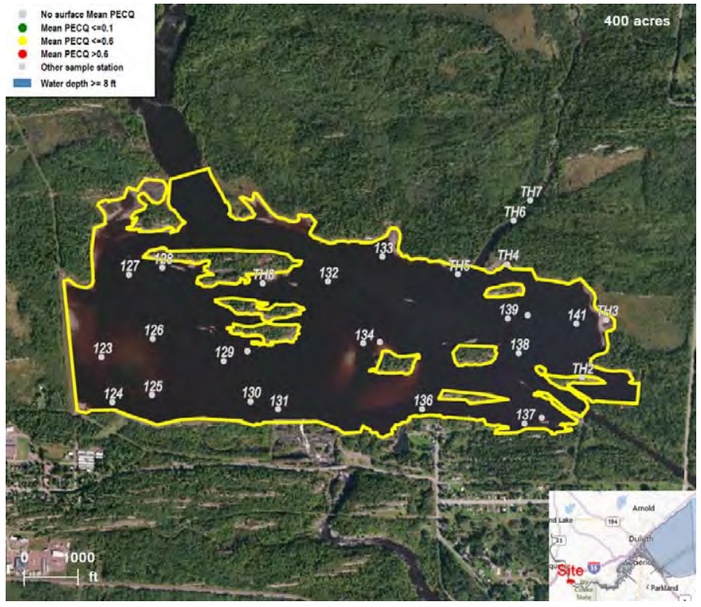
## Assessment Area # 99(Thomson Reservoir)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

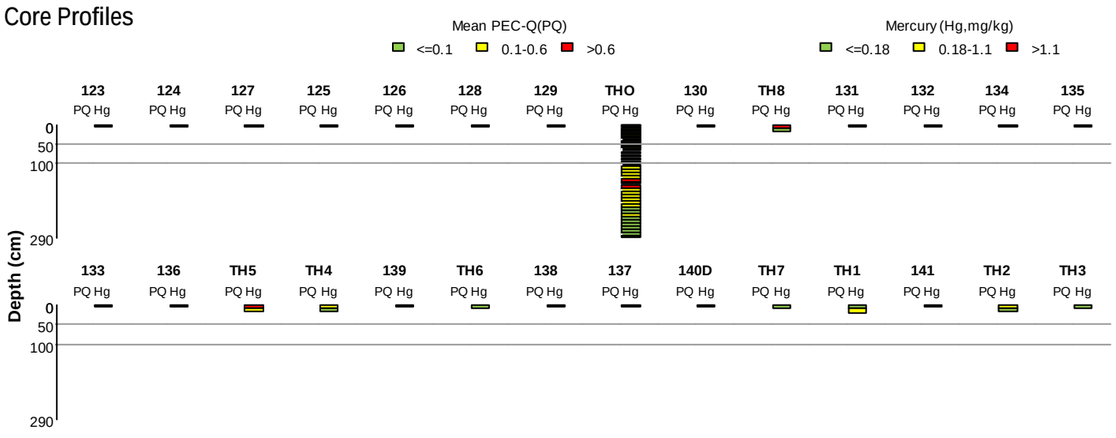
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (19 stations);ENSR Mercury Study, 1995 (8);Cloquet Reservoirs Study, 1992-93 (1).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;ENSR Mercury Study, 1995;Cloquet Reservoirs Study, 1992-93.*

*Fish tissue studies:*

## Core Profiles



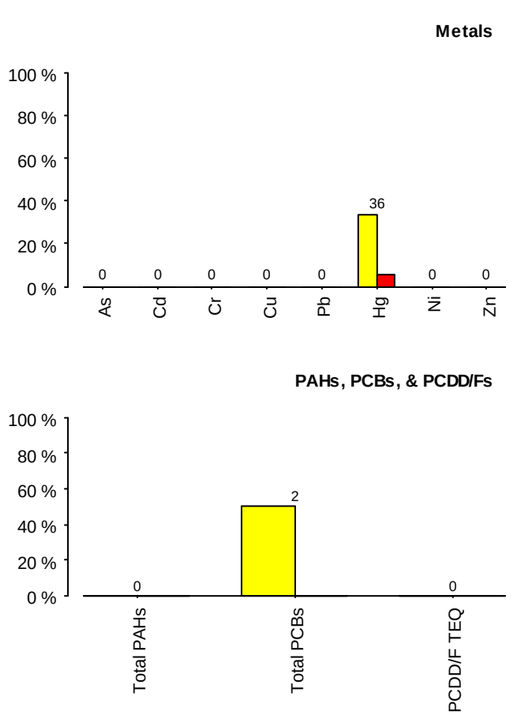

# Sediment Assessment Area Chemistry Characterization

## Data Summary

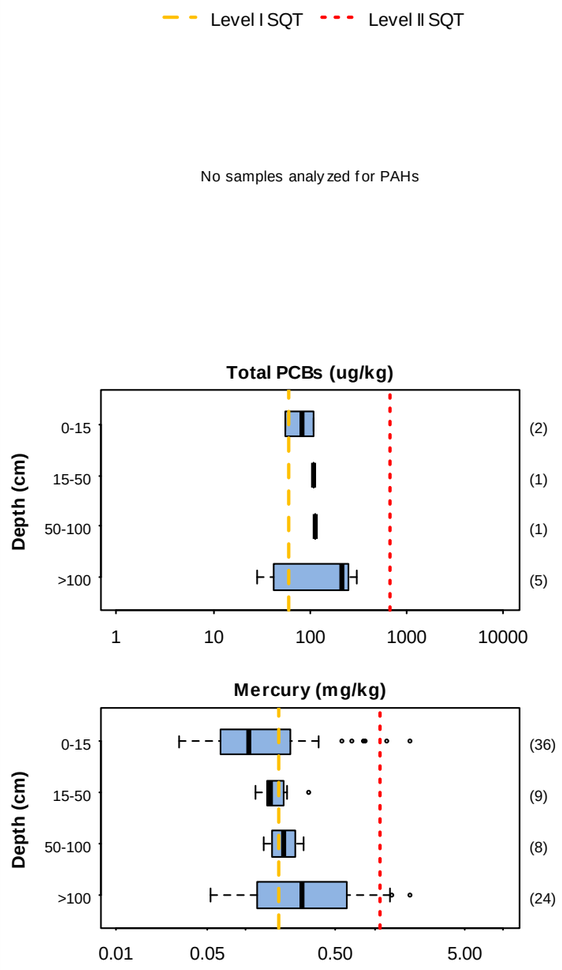
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 19(19) | 19(19) | 95(95) |
| Mercury | 28(28) | 77(77) | 77(77) |
| PAHs | 0(0) | 0(0) | 0(0) |
| PCBs | 1(1) | 9(9) | 36(36) |
| PCDD/Fs | 1(1) | 8(8) | 12(12) |
| Pesticides | 0(0) | 0(0) | 0(0) |
| Other parameters | 28(28) | 49(49) | 75(75) |
| TOC | 19(19) | 19(19) | 19(19) |
| Grain size | 19(19) | 19(19) | 133(133) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No samples analyzed for PCDD/F TEQ

Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Sediment Assessment Area Chemistry Characterization

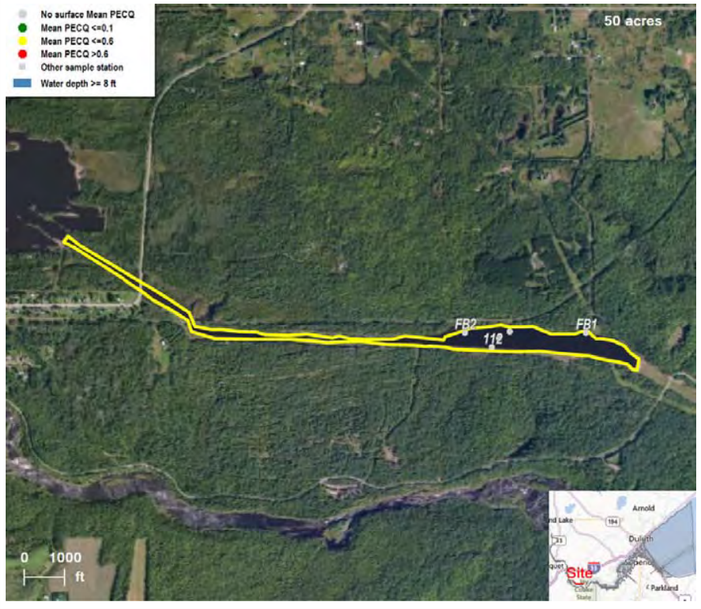
## Assessment Area # 100(Forbay Reservoir)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q

Insufficient results available for PEC-Q calculation




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

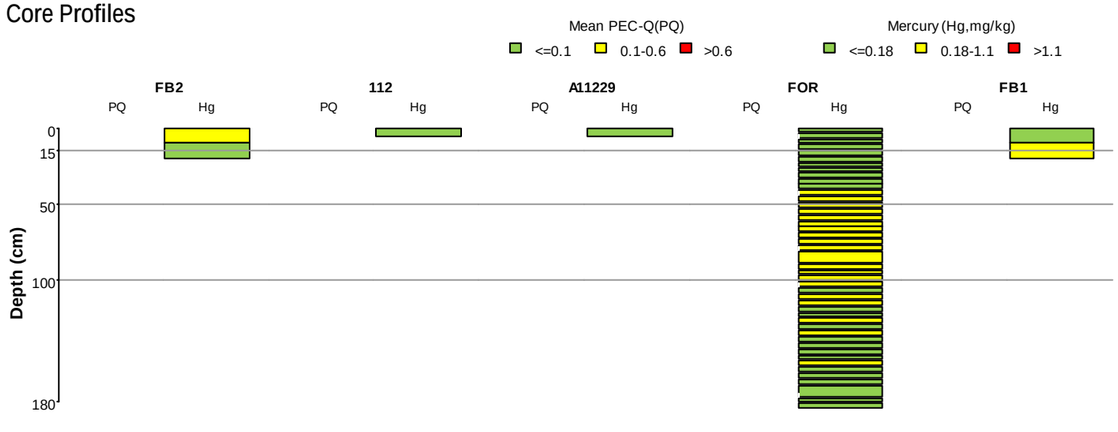
*Chemical studies used in the characterization:*
*R-EMAP Study, 1995 (1 stations);R-EMAP Study, 1996 (1);ENSR Mercury Study, 1995 (2);Cloquet Reservoirs Study, 1992-93 (1).*

*Other chemical studies:*
*Toxaphene Study, 1996 (1 stations).*

*Macro-invertebrate studies:*
*R-EMAP Study, 1995;R-EMAP Study, 1996;Toxaphene Study, 1996;ENSR Mercury Study, 1995;Cloquet Reservoirs Study, 1992-93.*

*Fish tissue studies:*

## Core Profiles



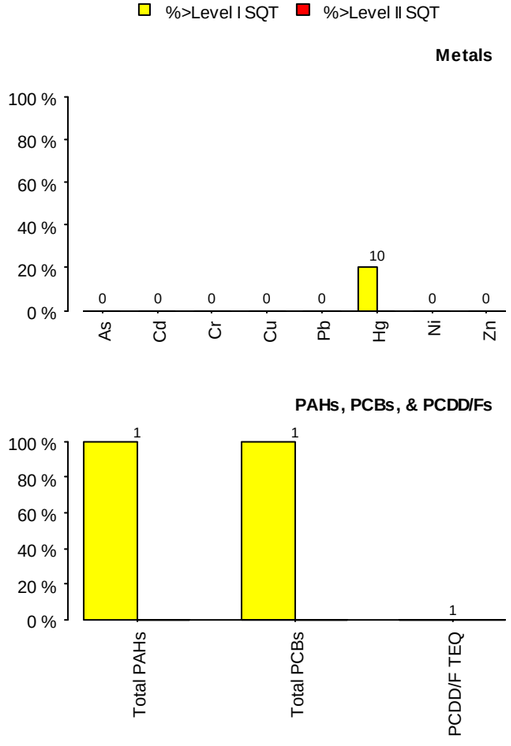

# Sediment Assessment Area Chemistry Characterization

## Data Summary

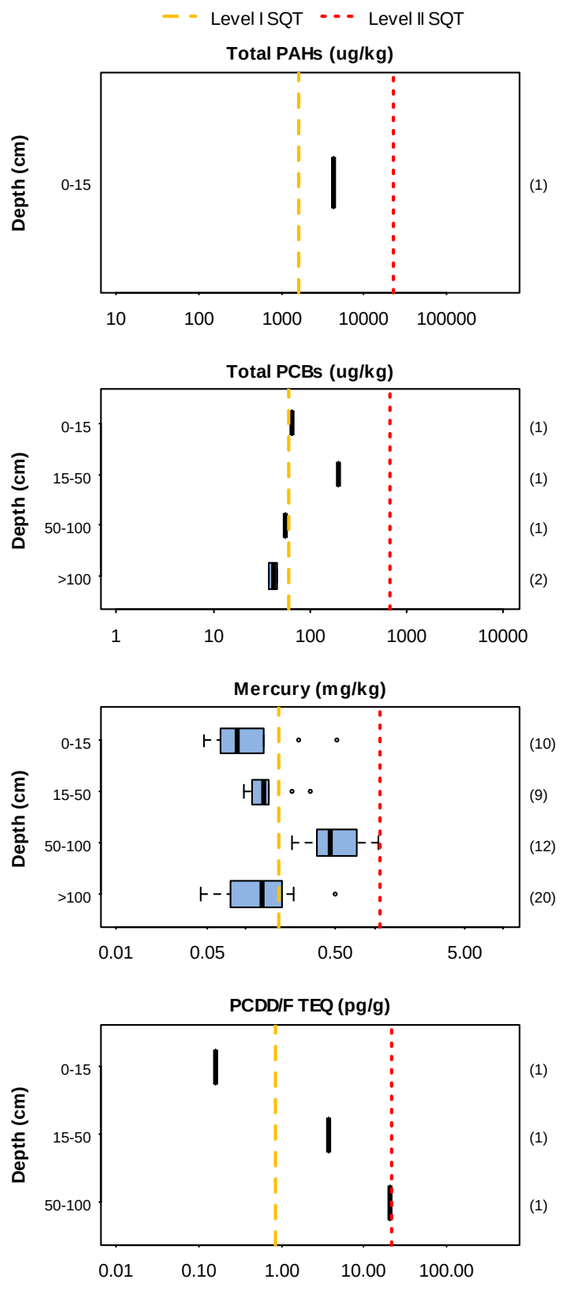
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 2(2) | 2(2) | 10(10) |
| Mercury | 5(5) | 51(51) | 51(51) |
| PAHs | 1(1) | 1(1) | 19(19) |
| PCBs | 1(1) | 5(5) | 420(420) |
| PCDD/Fs | 1(1) | 4(4) | 8(8) |
| Pesticides | 0(1) | 0(1) | 0(4) |
| Other parameters | 5(5) | 11(11) | 33(33) |
| TOC | 1(1) | 1(1) | 1(1) |
| Grain size | 2(2) | 2(2) | 14(14) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

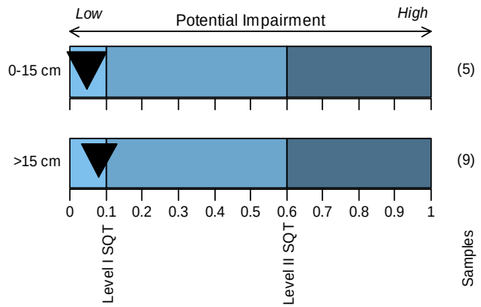
# Sediment Assessment Area Chemistry Characterization

## Assessment Area # 101(Scanlon to Thomson W. Rch)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q





## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

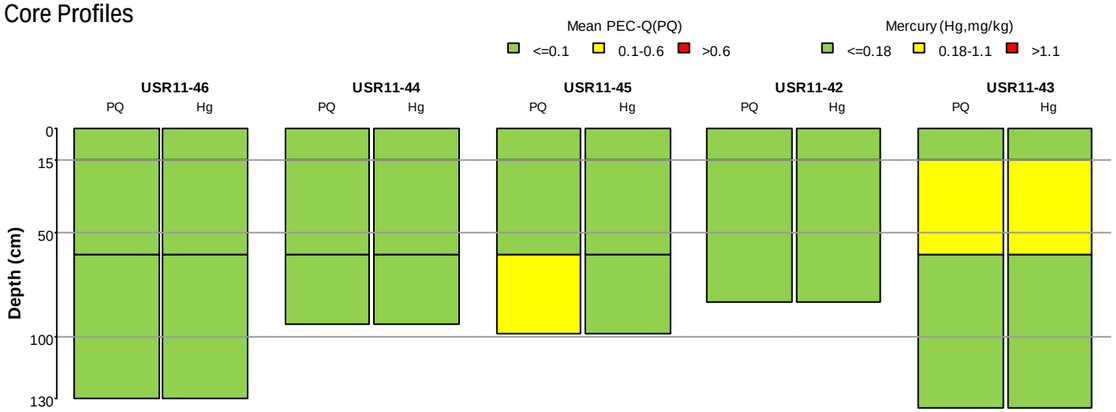
*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (5 stations).*

*Other chemical studies:*
*ENSR Mercury Study, 1995 (2 stations).*

*Macro-invertebrate studies:*
*ENSR Mercury Study, 1995;Upper St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



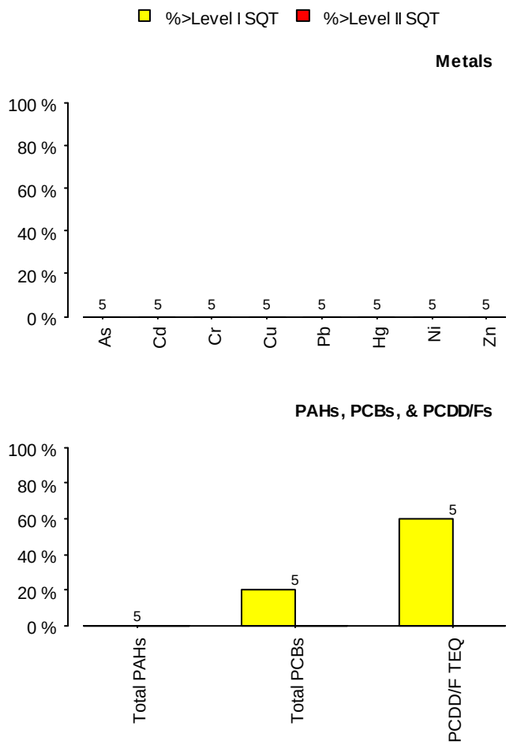

# Sediment Assessment Area Chemistry Characterization

## Data Summary

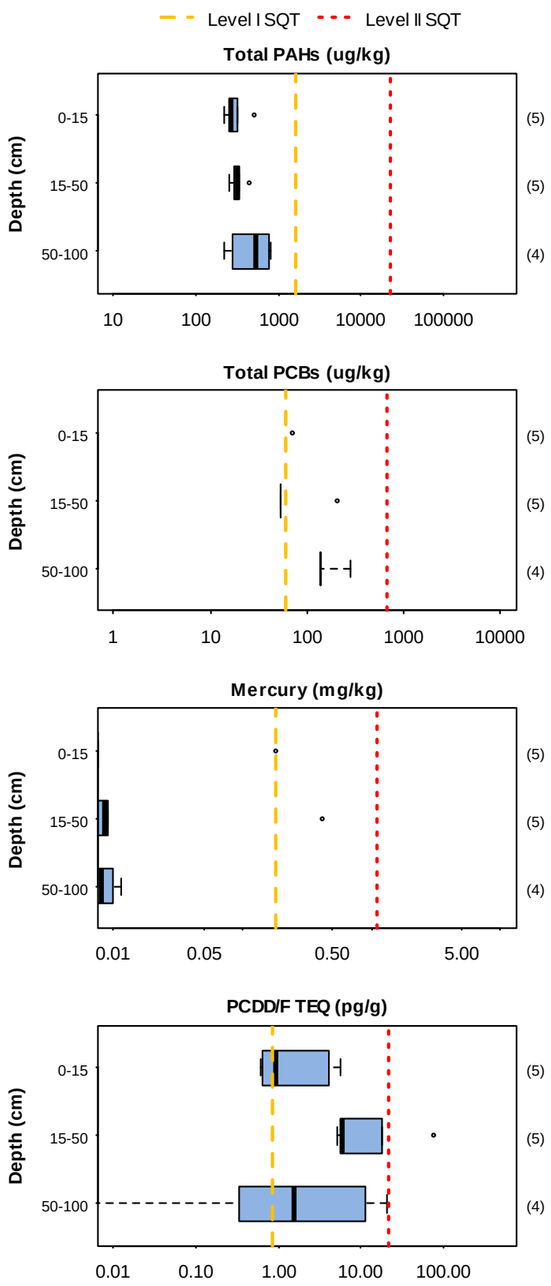
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 5(5) | 14(14) | 308(308) |
| Mercury | 5(7) | 14(18) | 14(18) |
| PAHs | 5(5) | 14(14) | 280(280) |
| PCBs | 5(5) | 14(14) | 140(140) |
| PCDD/Fs | 5(5) | 14(14) | 436(436) |
| Pesticides | 5(5) | 14(14) | 119(119) |
| Other parameters | 5(7) | 14(18) | 854(858) |
| TOC | 5(5) | 14(14) | 14(14) |
| Grain size | 5(5) | 14(14) | 14(14) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

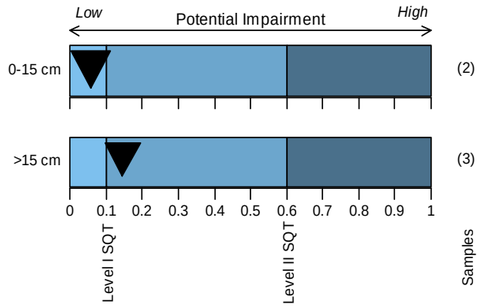
# Sediment Assessment Area Chemistry Characterization

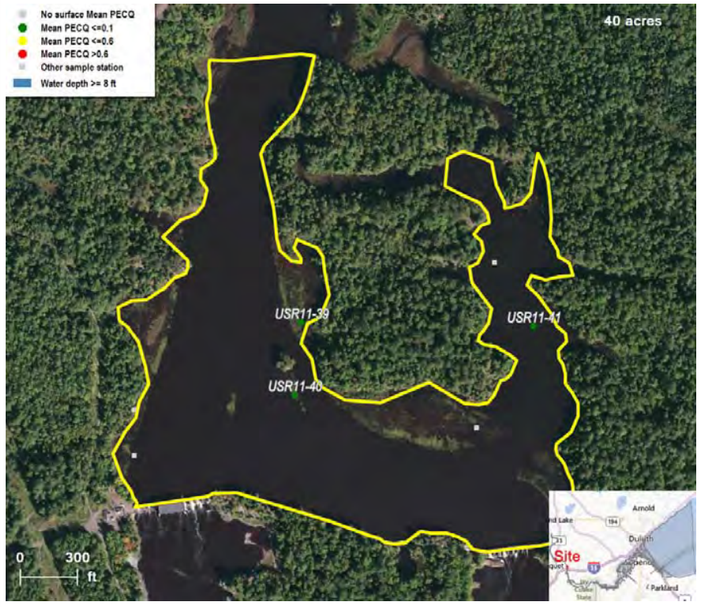
## Assessment Area # 102(ScanIon Reservoir)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

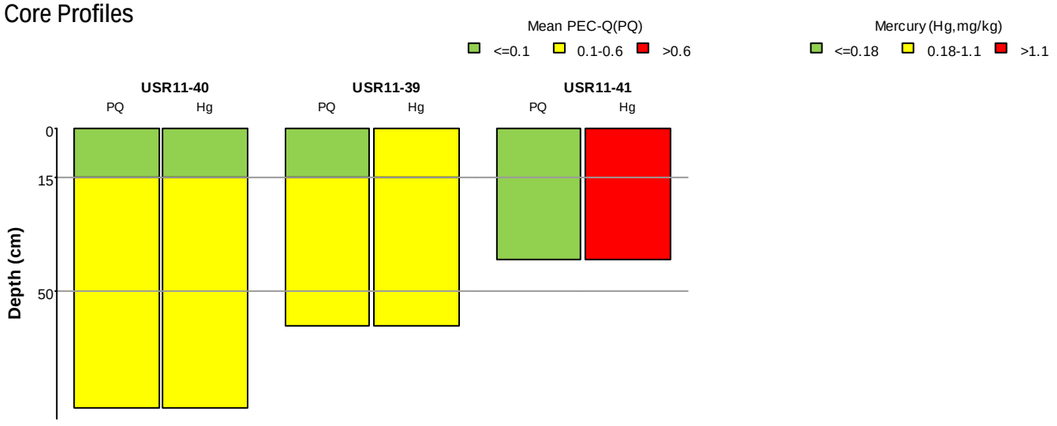
*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (3 stations).*

*Other chemical studies:*
*ENSR Mercury Study, 1995 (4 stations).*

*Macro-invertebrate studies:*
*ENSR Mercury Study, 1995;Upper St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



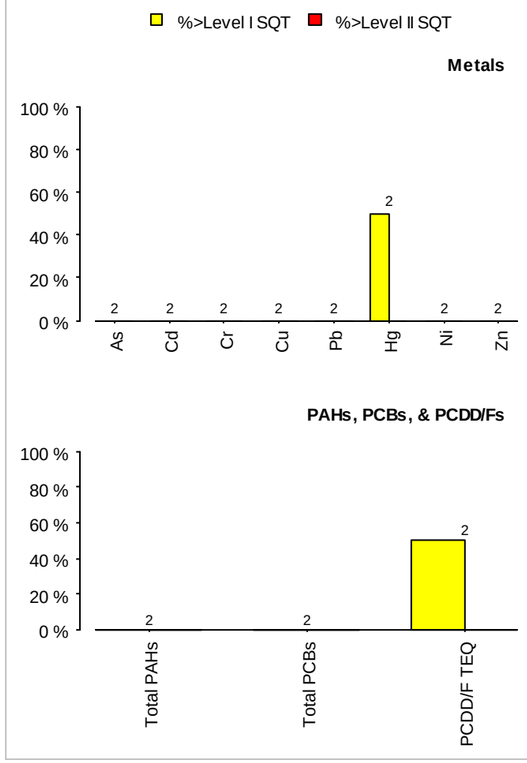

# Sediment Assessment Area Chemistry Characterization

## Data Summary

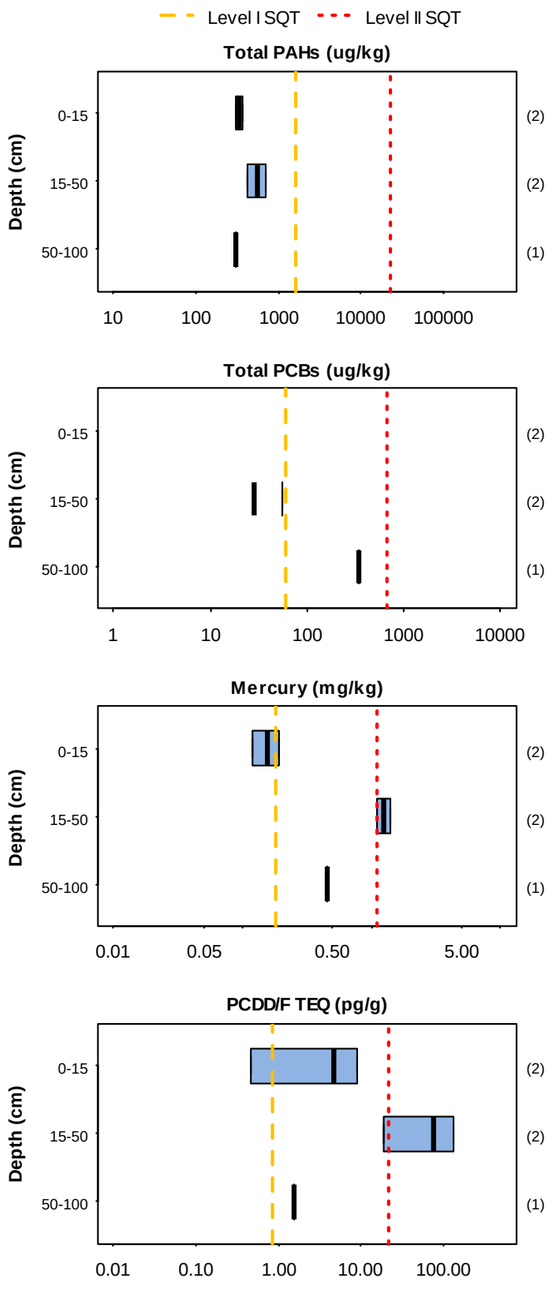
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 3(3) | 5(5) | 110(110) |
| Mercury | 3(7) | 5(13) | 5(13) |
| PAHs | 3(3) | 5(5) | 100(100) |
| PCBs | 3(3) | 5(5) | 50(50) |
| PCDD/Fs | 3(3) | 5(5) | 158(158) |
| Pesticides | 3(3) | 5(5) | 20(20) |
| Other parameters | 3(7) | 5(13) | 305(313) |
| TOC | 3(3) | 5(5) | 5(5) |
| Grain size | 3(3) | 5(5) | 5(5) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

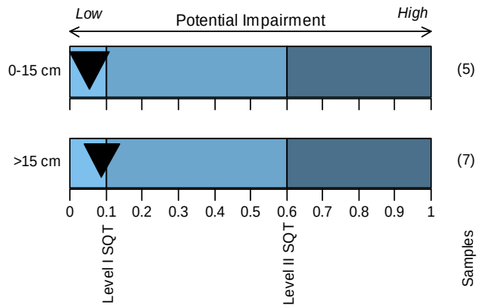
# Sediment Assessment Area Chemistry Characterization

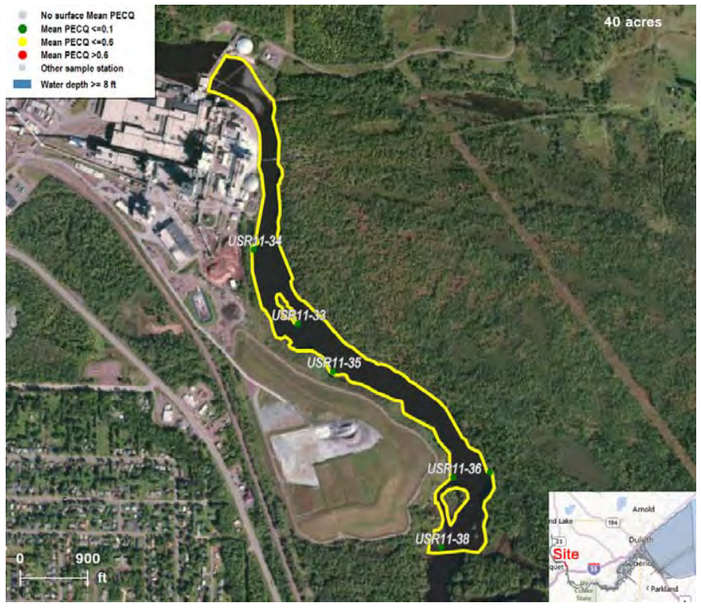
## Assessment Area # 103(NW Paper Company Reach)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

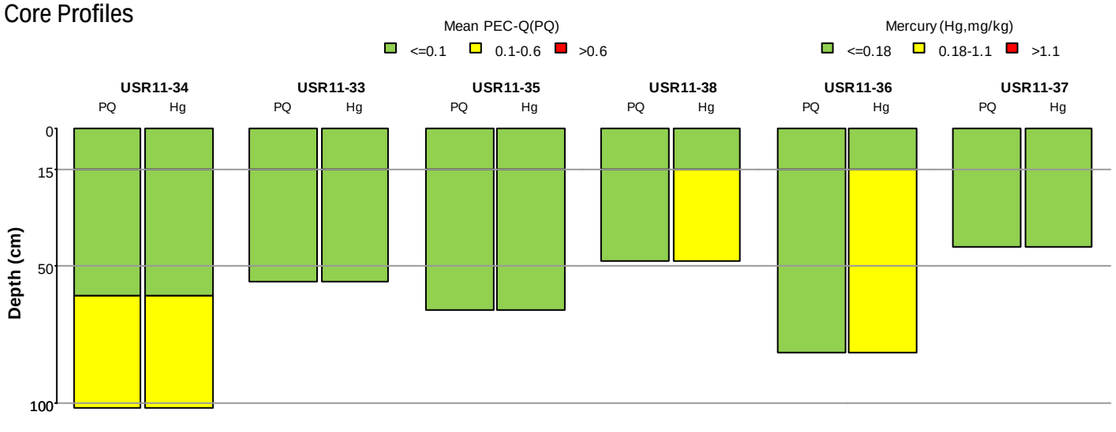
*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (6 stations).*

*Other chemical studies:*

*Macro-invertebrate studies:*
*Upper St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



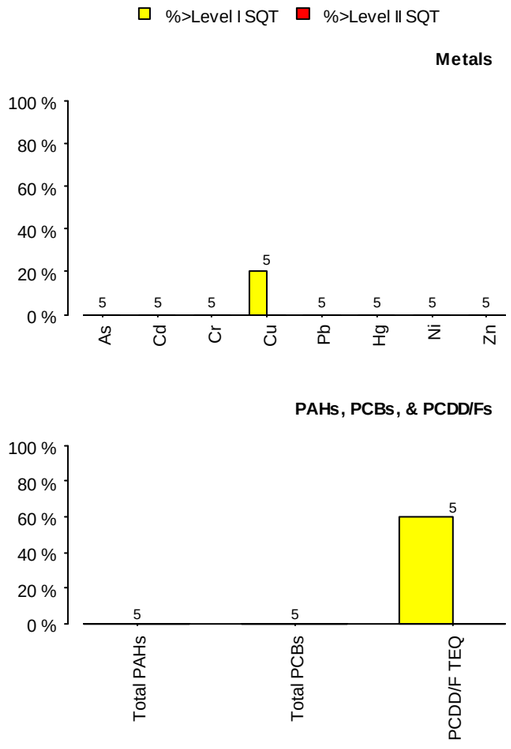

# Sediment Assessment Area Chemistry Characterization

## Data Summary

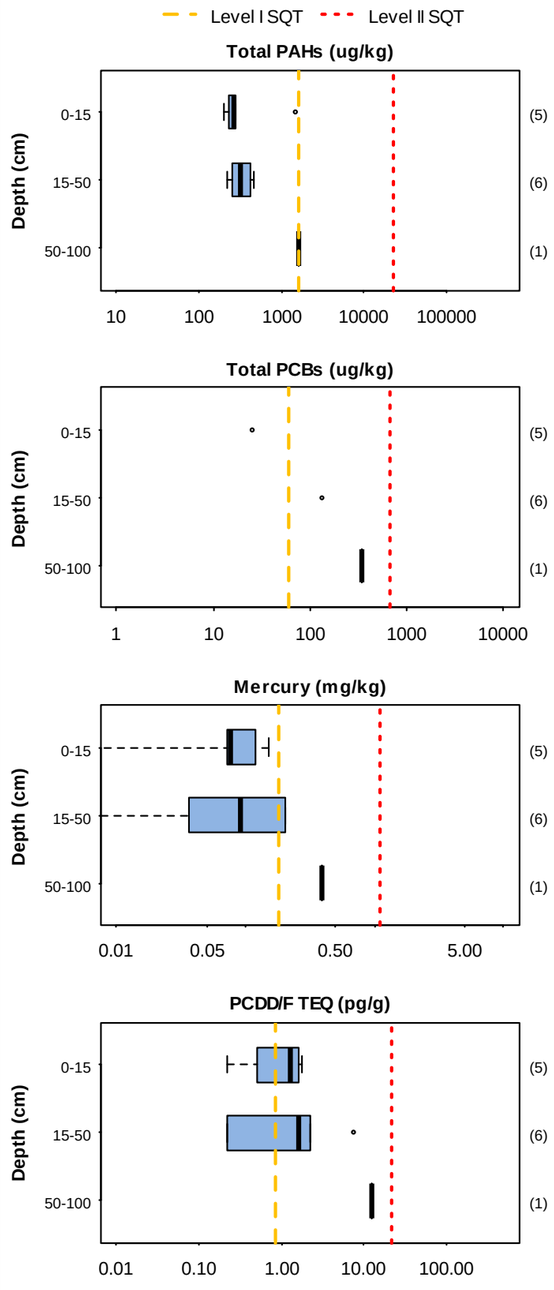
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 6(6) | 12(12) | 264(264) |
| Mercury | 6(6) | 12(12) | 12(12) |
| PAHs | 6(6) | 12(12) | 240(240) |
| PCBs | 6(6) | 12(12) | 120(120) |
| PCDD/Fs | 6(6) | 12(12) | 360(360) |
| Pesticides | 6(6) | 12(12) | 69(69) |
| Other parameters | 6(6) | 12(12) | 732(732) |
| TOC | 6(6) | 12(12) | 12(12) |
| Grain size | 6(6) | 12(12) | 12(12) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

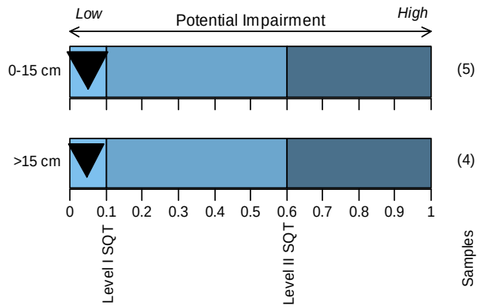
# Sediment Assessment Area Chemistry Characterization

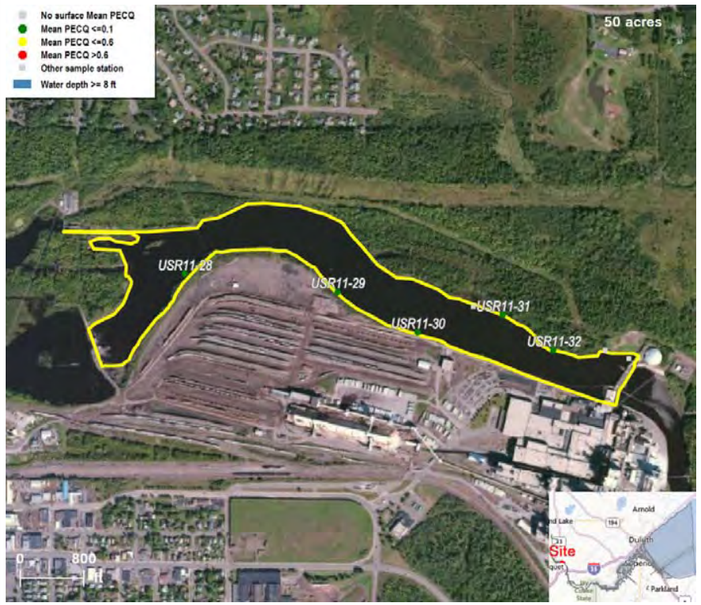
## Assessment Area # 104(Cloquet Reservoir)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

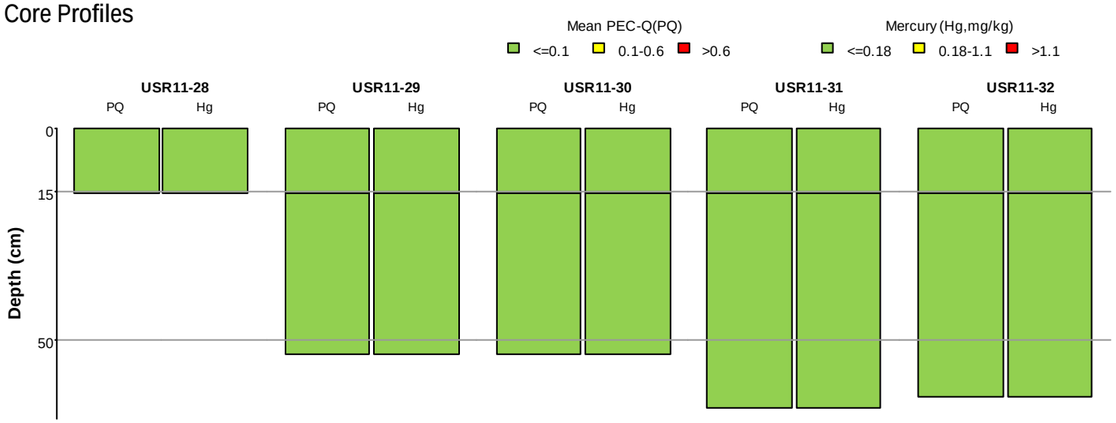
*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (5 stations).*

*Other chemical studies:*
*ENSR Mercury Study, 1995 (3 stations).*

*Macro-invertebrate studies:*
*ENSR Mercury Study, 1995;Upper St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



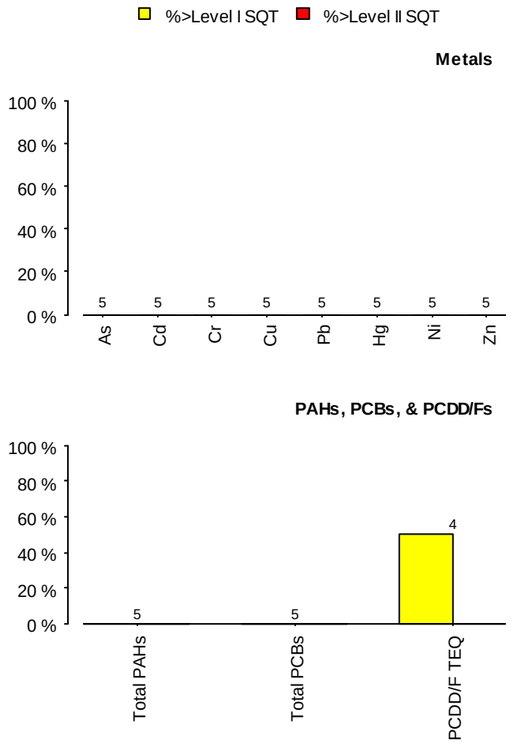

# Sediment Assessment Area Chemistry Characterization

## Data Summary

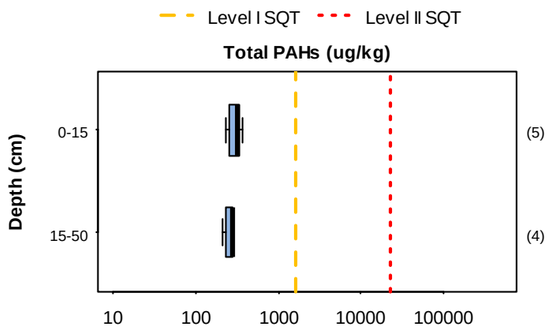
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 5(5) | 9(9) | 198(198) |
| Mercury | 5(8) | 9(14) | 9(14) |
| PAHs | 5(5) | 9(9) | 180(180) |
| PCBs | 5(5) | 9(9) | 90(90) |
| PCDD/Fs | 4(4) | 8(8) | 248(248) |
| Pesticides | 5(5) | 9(9) | 78(78) |
| Other parameters | 5(8) | 9(14) | 547(552) |
| TOC | 5(5) | 9(9) | 9(9) |
| Grain size | 4(4) | 8(8) | 8(8) |

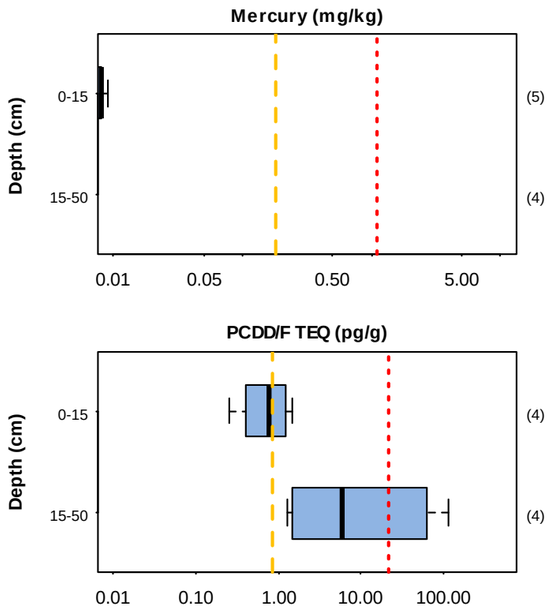
## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




No PCBs detected in 9 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

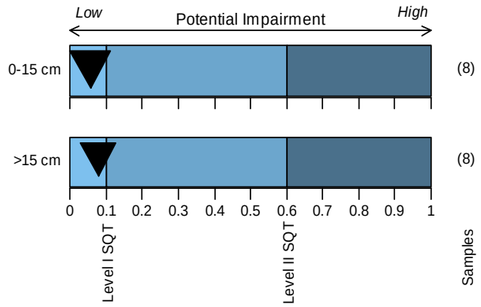
# Sediment Assessment Area Chemistry Characterization

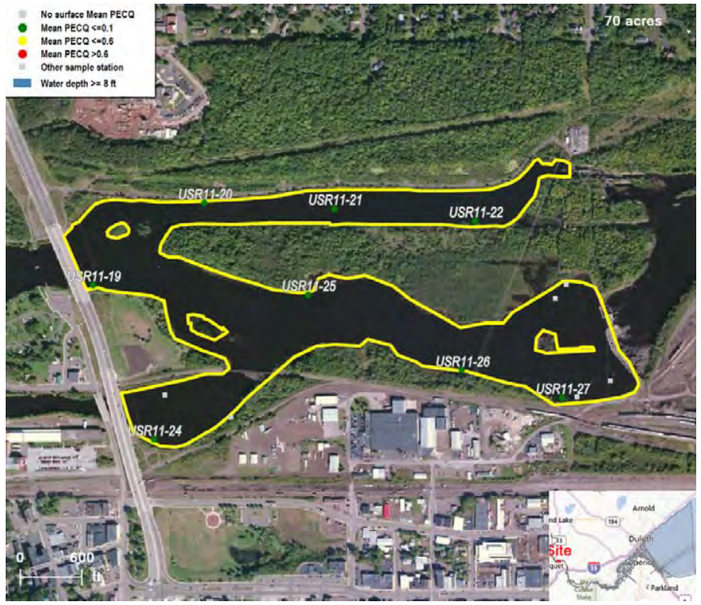
## Assessment Area # 105(Knife Falls Reservoir)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

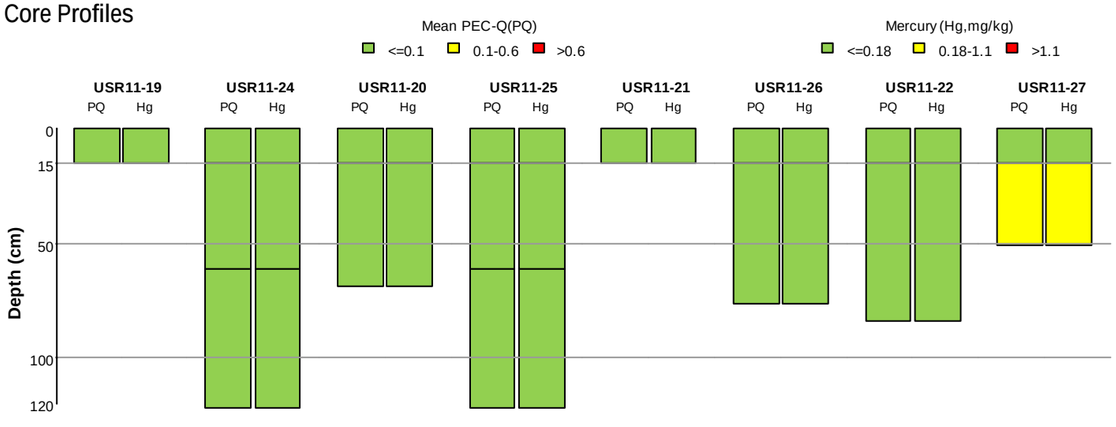
*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (8 stations).*

*Other chemical studies:*
*ENSR Mercury Study, 1995 (6 stations).*

*Macro-invertebrate studies:*
*ENSR Mercury Study, 1995;Upper St. Louis River, 2011.*

*Fish tissue studies:*

## Core Profiles



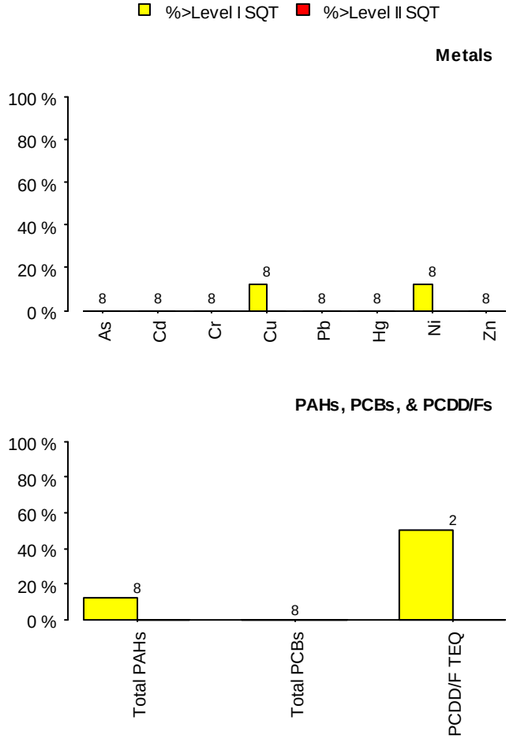

# Sediment Assessment Area Chemistry Characterization

## Data Summary

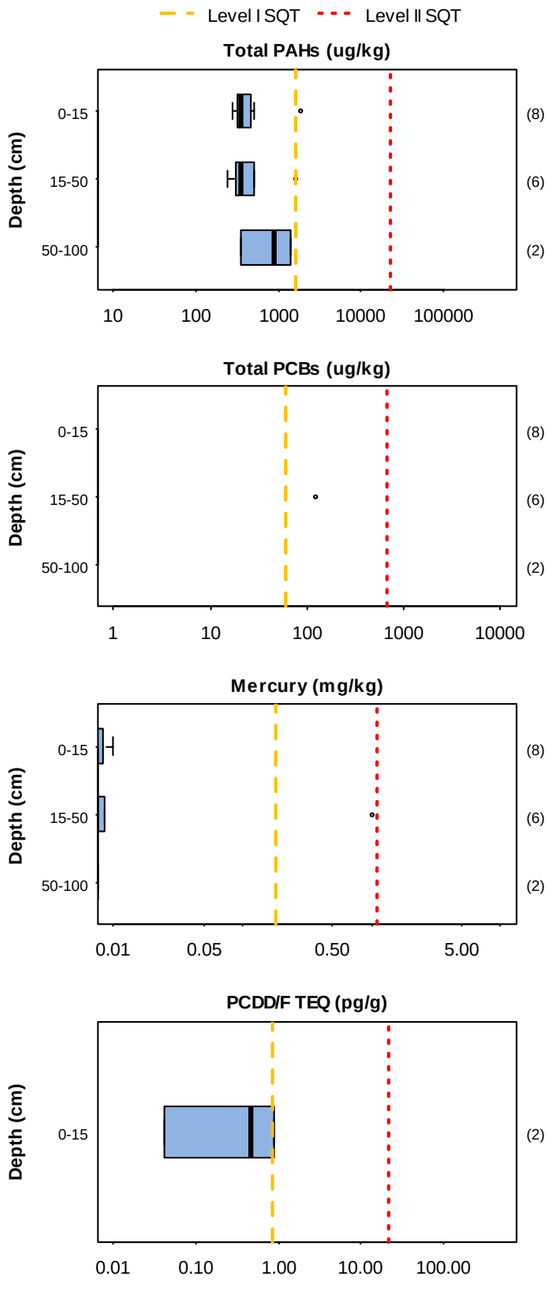
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 8(8) | 16(16) | 352(352) |
| Mercury | 8(14) | 16(28) | 16(28) |
| PAHs | 8(8) | 16(16) | 320(320) |
| PCBs | 8(8) | 16(16) | 160(160) |
| PCDD/Fs | 2(2) | 2(2) | 60(60) |
| Pesticides | 8(8) | 16(16) | 106(106) |
| Other parameters | 8(14) | 16(28) | 948(960) |
| TOC | 8(8) | 16(16) | 16(16) |
| Grain size | 2(2) | 2(2) | 2(2) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

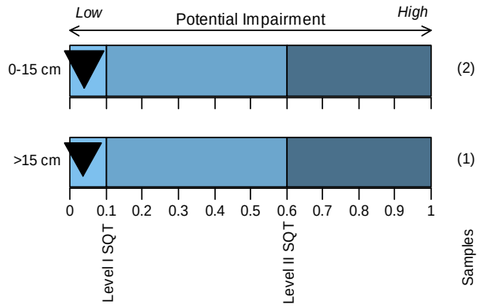
# Sediment Assessment Area Chemistry Characterization

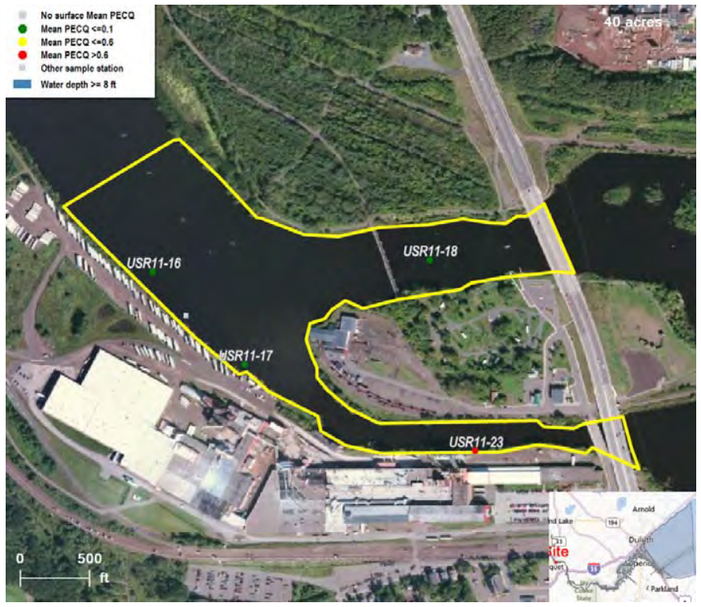
## Assessment Area # 106(Spafford Park Reach)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

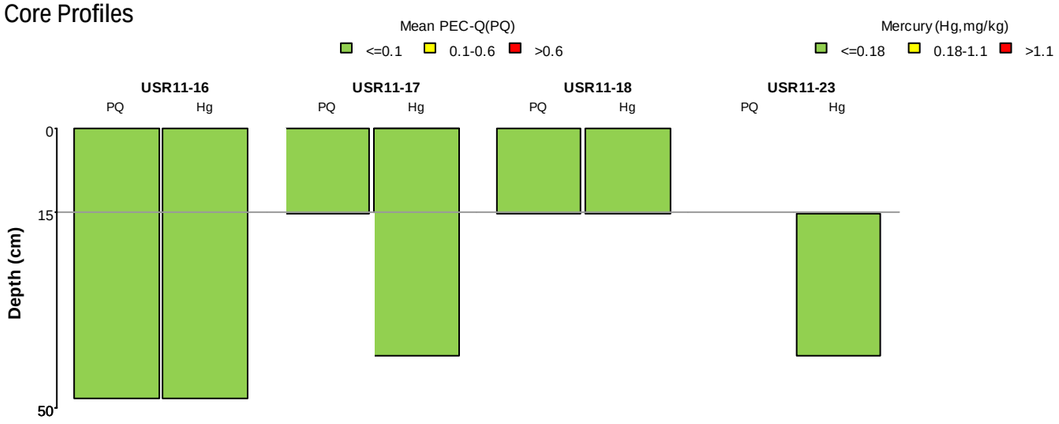
*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (4 stations).*

*Other chemical studies:*
*ENSR Mercury Study, 1995 (2 stations).*

*Macro-invertebrate studies:*
*ENSR Mercury Study, 1995;Upper St. Louis River, 2011.*

*Fish tissue studies:*
*Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



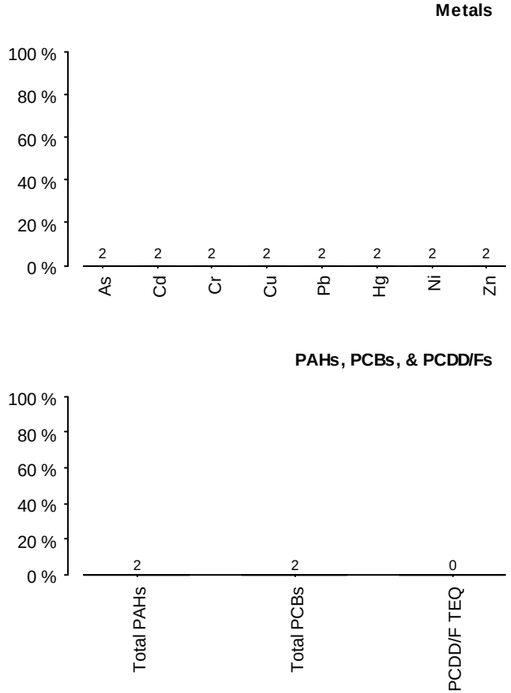

# Sediment Assessment Area Chemistry Characterization

## Data Summary

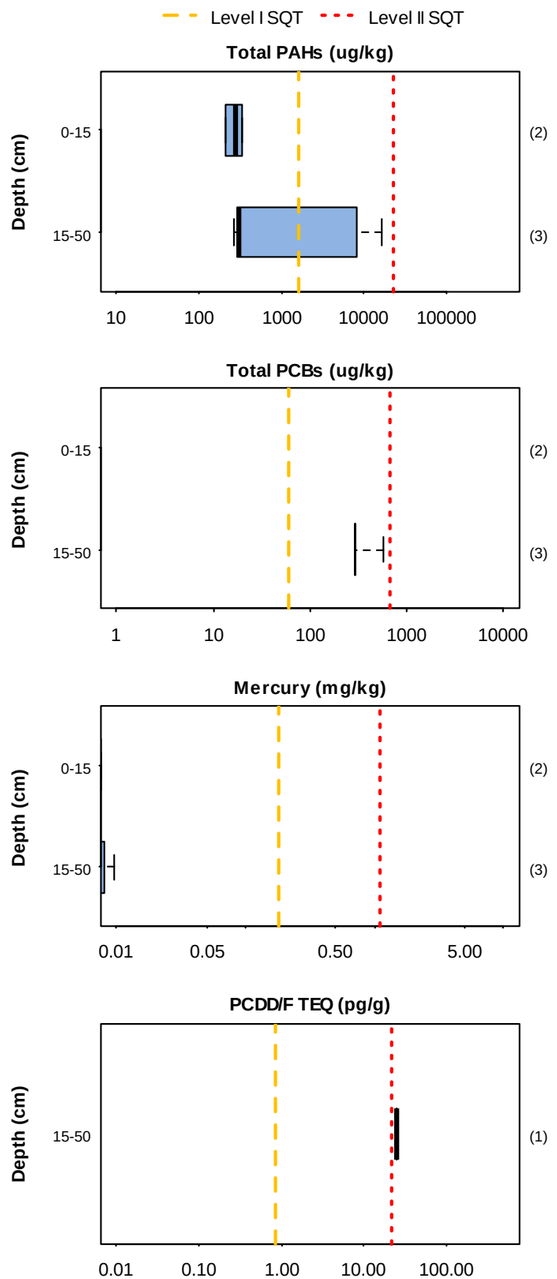
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 4(4) | 5(5) | 110(110) |
| Mercury | 4(6) | 5(9) | 5(9) |
| PAHs | 4(4) | 5(5) | 100(100) |
| PCBs | 4(4) | 5(5) | 50(50) |
| PCDD/Fs | 1(1) | 1(1) | 38(38) |
| Pesticides | 4(4) | 5(5) | 41(41) |
| Other parameters | 4(6) | 7(11) | 305(309) |
| TOC | 4(4) | 5(5) | 5(5) |
| Grain size | 1(1) | 1(1) | 1(1) |

## Results Exceeding Thresholds (0-15 cm samples)




## Distributions of Constituent Concentrations




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

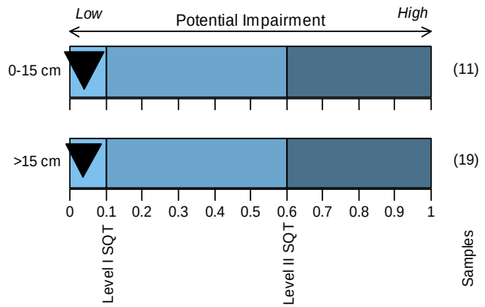
# Sediment Assessment Area Chemistry Characterization

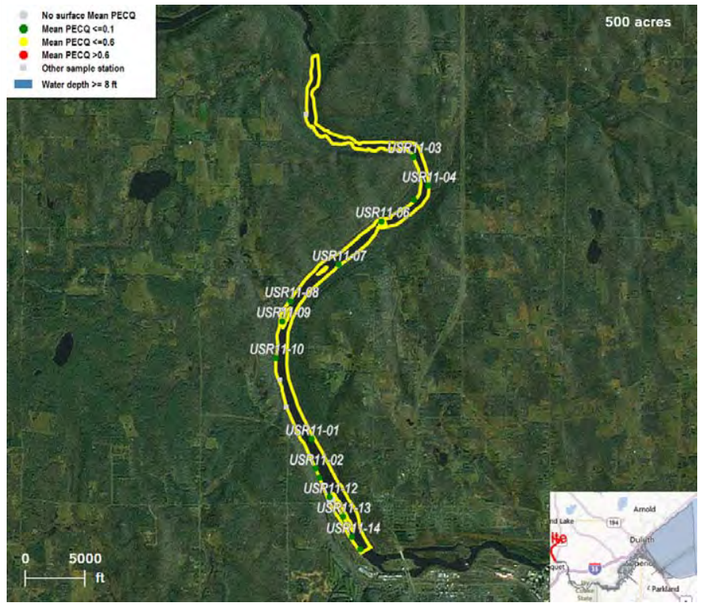
## Assessment Area # 107(Fond du Lac Indian Reserv. Reach)

*Geographic zone: Upper St. Louis River*
*Date Generated : 6/28/2013*

The sediment assessment area chemistry characterizations provide screening-level displays of the sediment chemical data available for individual assessment areas within the St. Louis River Area of Concern and are based on benthic toxicity guidelines. They are intended to assist in decision-making related to remedial and restoration activities. However, they do not provide a final remedial category designation. This decision will be made by Minnesota and Wisconsin regulatory personnel following careful review of available site information. Sediment chemistry is not the only source of information by which remediation and restoration decisions are made. Biological studies are also available for some of the sediment assessment areas and qualitative considerations may also affect remediation and restoration decision-making.

## Mean PEC-Q




## Map of Assessment Area Cores

***Labeled Stations Used in Characterization***

## Studies with Samples in Sediment Assessment Area:

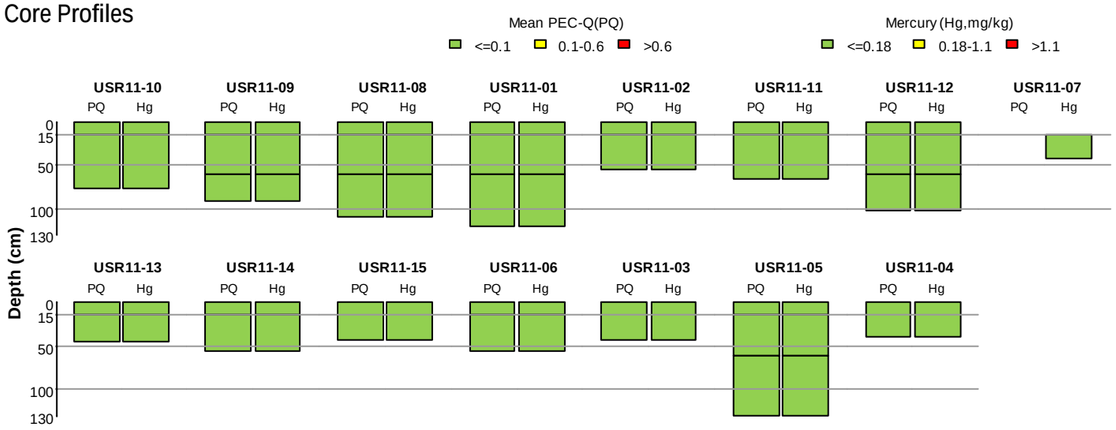
*Chemical studies used in the characterization:*
*Upper St. Louis River, 2011 (15 stations).*

*Other chemical studies:*
*Fond du Lac Reservation Lakes Ph 2 2002 (7 stations).*

*Macro-invertebrate studies:*
*Fond du Lac Reservation Lakes Ph 2 2002;Upper St. Louis River, 2011.*

*Fish tissue studies:*
*Fond du Lac Fish Tissue Study 2000.*

## Core Profiles



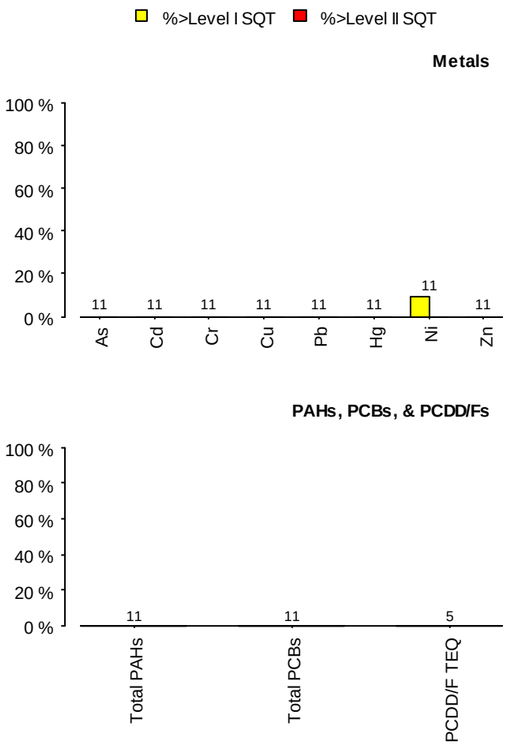

# Sediment Assessment Area Chemistry Characterization

## Data Summary

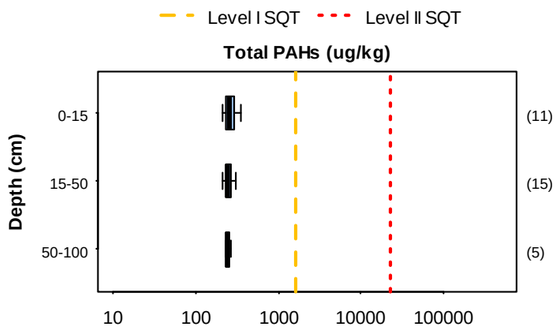
**Available data in studies used for characterization (All available data)**

| Constituent | Number of Stations | Number of Samples | Number of Results |
|---|---|---|---|
| Metals (without Hg) | 15(22) | 31(38) | 682(689) |
| Mercury | 15(22) | 31(38) | 31(38) |
| PAHs | 15(15) | 31(31) | 620(620) |
| PCBs | 15(22) | 31(38) | 310(373) |
| PCDD/Fs | 8(8) | 8(8) | 240(240) |
| Pesticides | 15(15) | 31(31) | 292(292) |
| Other parameters | 15(22) | 34(41) | 1855(1876) |
| TOC | 15(15) | 31(31) | 31(31) |
| Grain size | 8(15) | 8(15) | 8(57) |

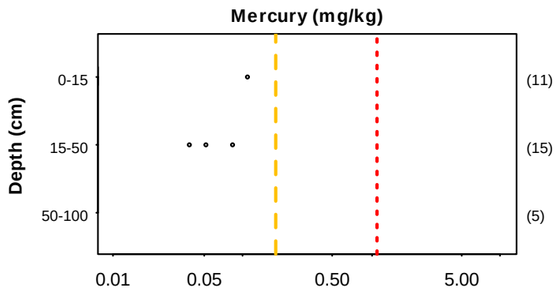
## Results Exceeding Thresholds (0-15 cm samples)

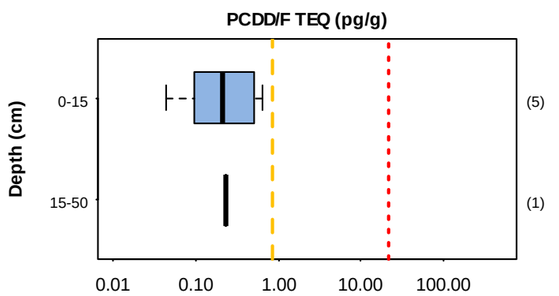



## Distributions of Constituent Concentrations




No PCBs detected in 31 analyzed samples




Boxes show 25th percentile, median, and 75th percentile values . Whiskers extend to 1.5 times the inter-quartile range, and individual samples outside the whiskers are shown as open circles.

# Appendix B
# Contaminant Concentration Maps

Blank Page

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

# Mean PEC-Q in Surface Sediment: Geographic Zones

Mean PEC-Q in surface samples

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

blord 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130602\MeanPecQ\MeanPec-q_Surface_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Mean PEC-Q in the 15 cm to 50 cm Sediment Layer: Geographic Zones

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

blord 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130602\MeanPecQ\MeanPec-q_15to50_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

# Mean PEC-Q in the 50 cm to 100 cm Sediment Layer: Geographic Zones

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

mxd 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_50to100_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Mean PEC-Q in the > 100 cm Sediment Layer: Geographic Zones

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

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ST. LOUIS RIVER AOC

# Mean PEC-Q in Surface Sediment: Allouez Bay

Mean PEC-Q in surface samples

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mean PEC-q samples were found for this geographic zone.

0 1 km

Superior Bay

Lake Superior

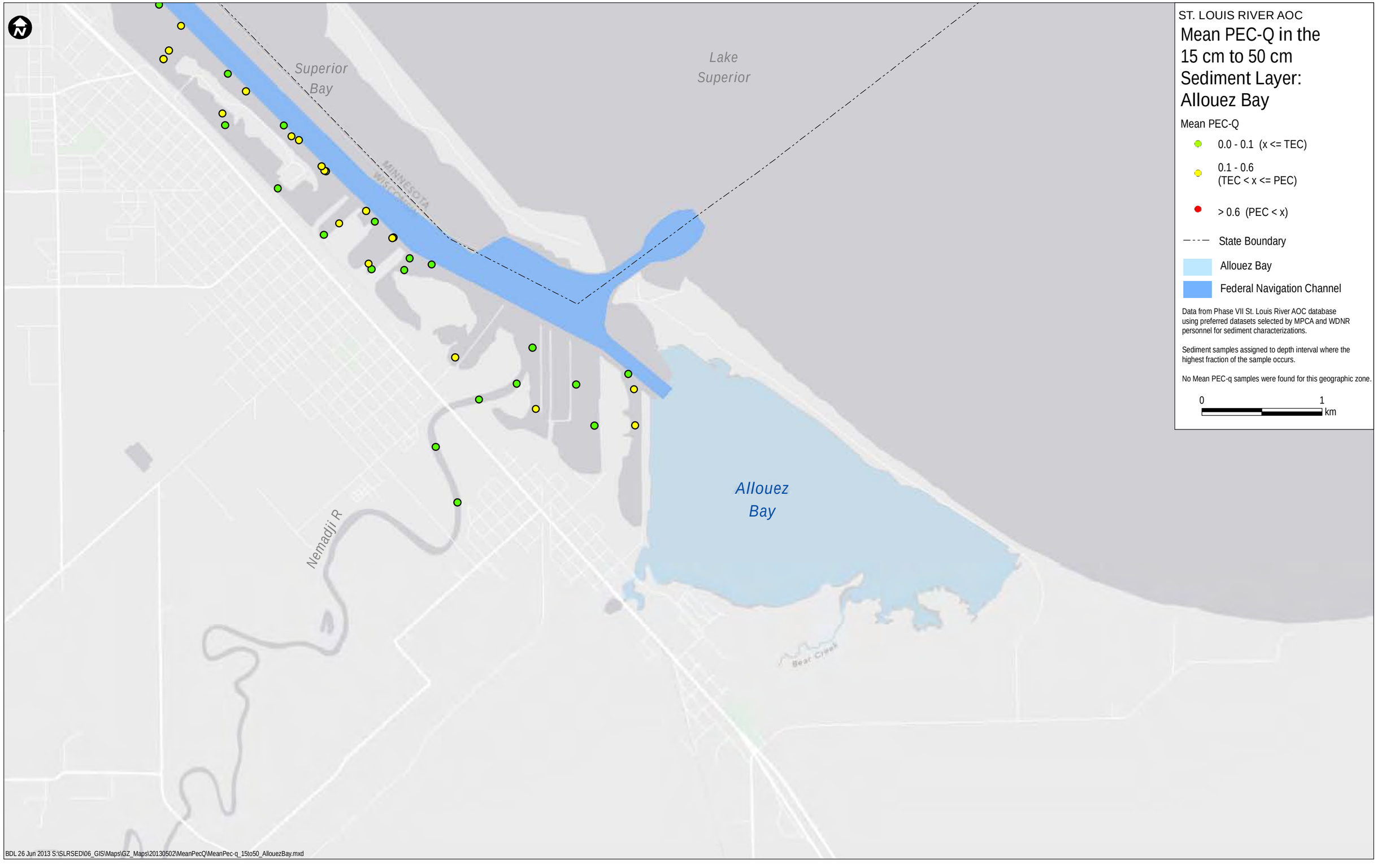
MINNESOTA WISCONSIN

Allouez Bay

Nemadji R

Bear Creek

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_Surface_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Mean PEC-Q in the 15 cm to 50 cm Sediment Layer: Allouez Bay

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

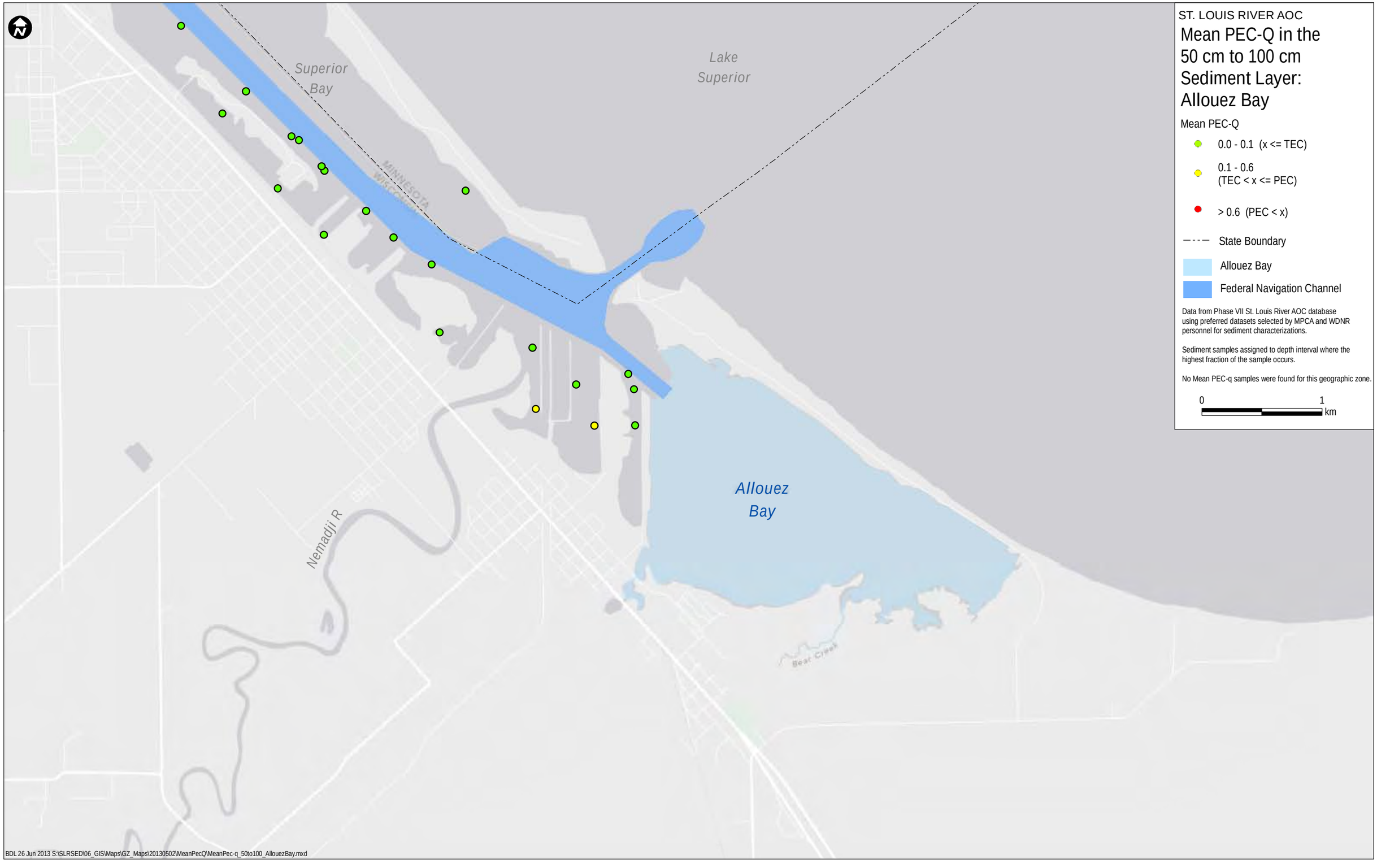
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mean PEC-q samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_15to50_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Mean PEC-Q in the 50 cm to 100 cm Sediment Layer: Allouez Bay

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mean PEC-q samples were found for this geographic zone.

0 1 km

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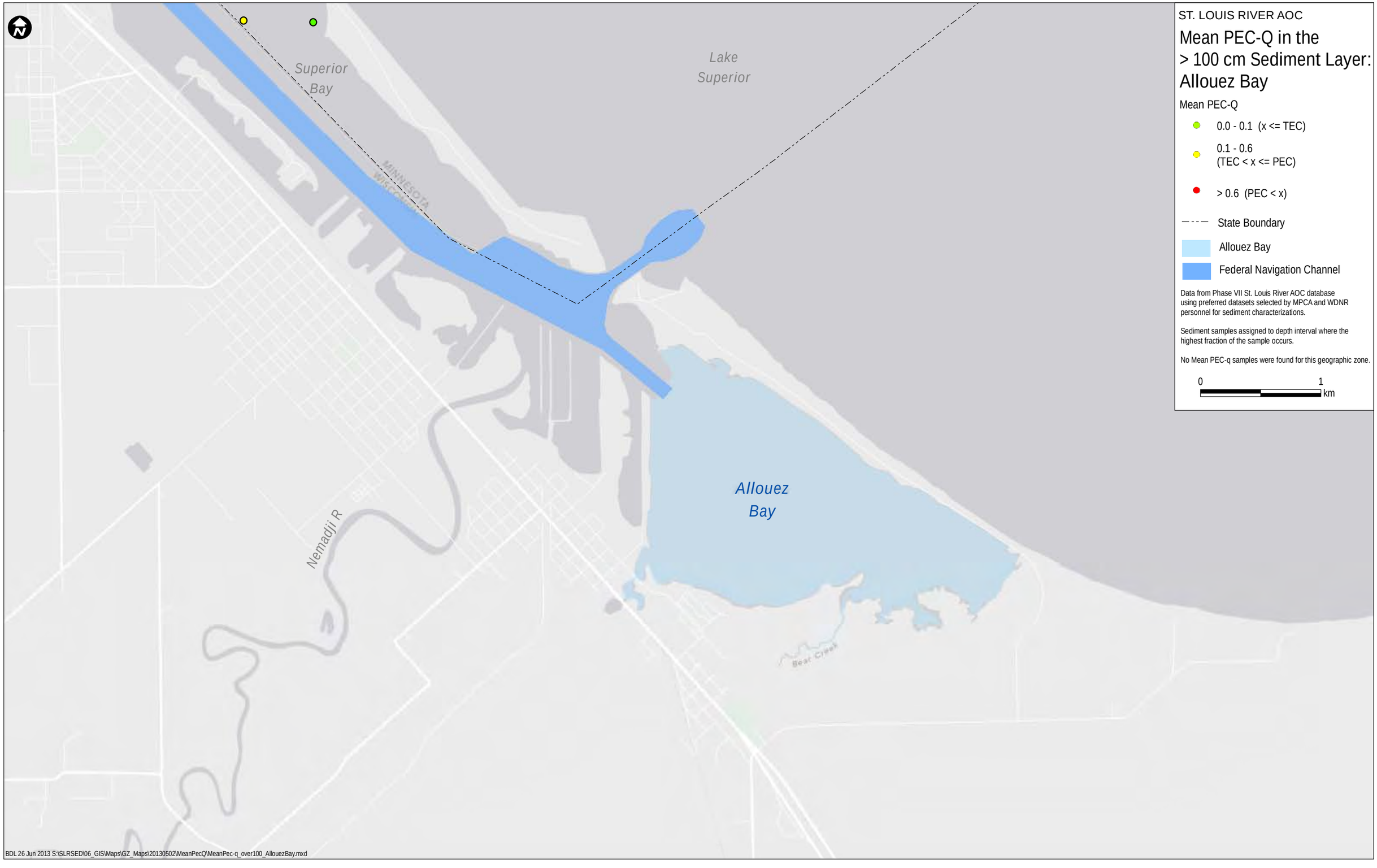



ST. LOUIS RIVER AOC

## Mean PEC-Q in the > 100 cm Sediment Layer: Allouez Bay

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mean PEC-q samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_over100_AllouezBay.mxd

ST. LOUIS RIVER AOC

# Mean PEC-Q in Surface Sediment: Superior Bay

Mean PEC-Q in surface samples

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Superior Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_Surface_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Mean PEC-Q in the 15 cm to 50 cm Sediment Layer: Superior Bay

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_15to50_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Mean PEC-Q in the 50 cm to 100 cm Sediment Layer: Superior Bay

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Superior Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

MINNESOTA WISCONSIN

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_50to100_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Mean PEC-Q in the > 100 cm Sediment Layer: Superior Bay

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Superior Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

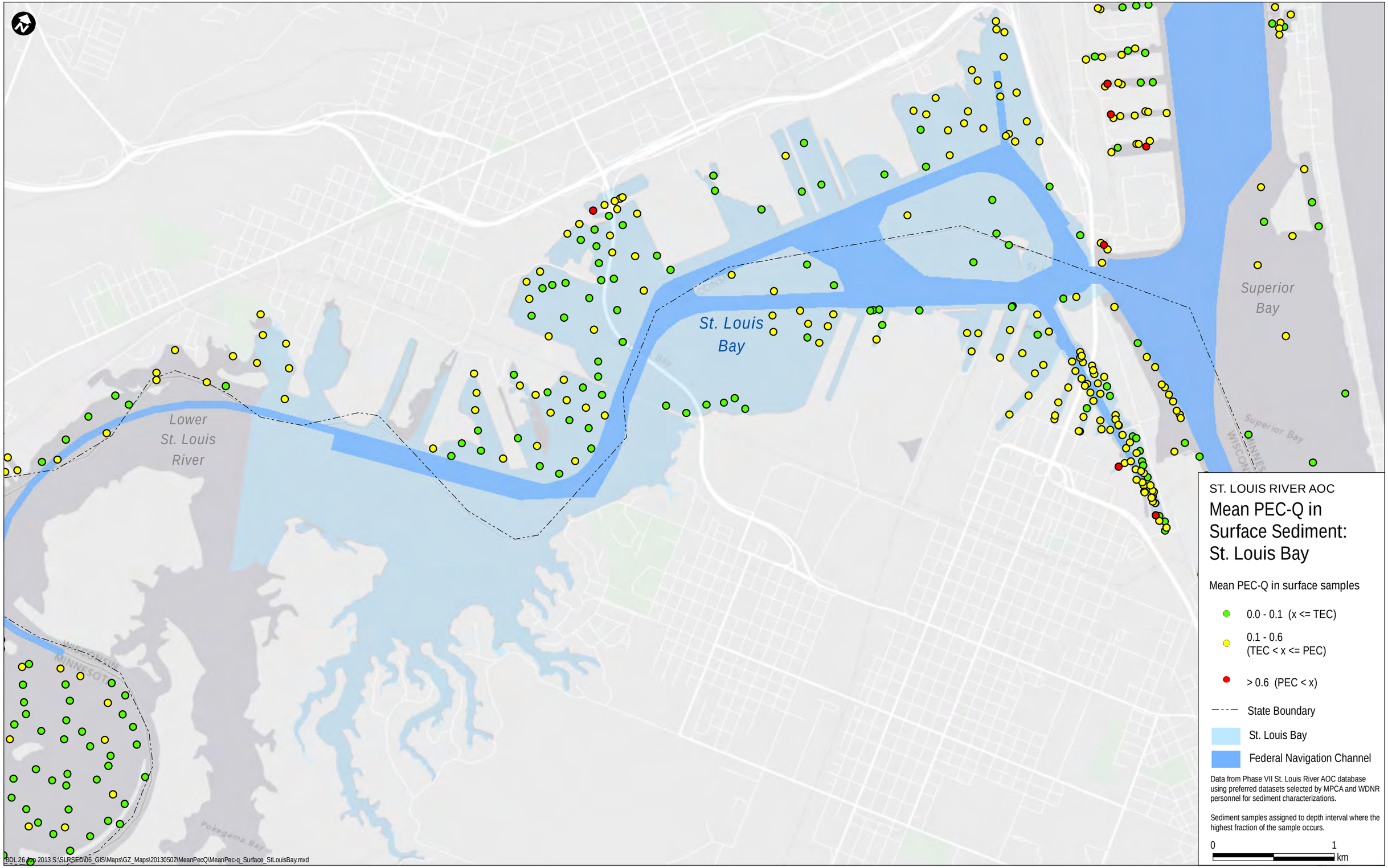
Lake Superior

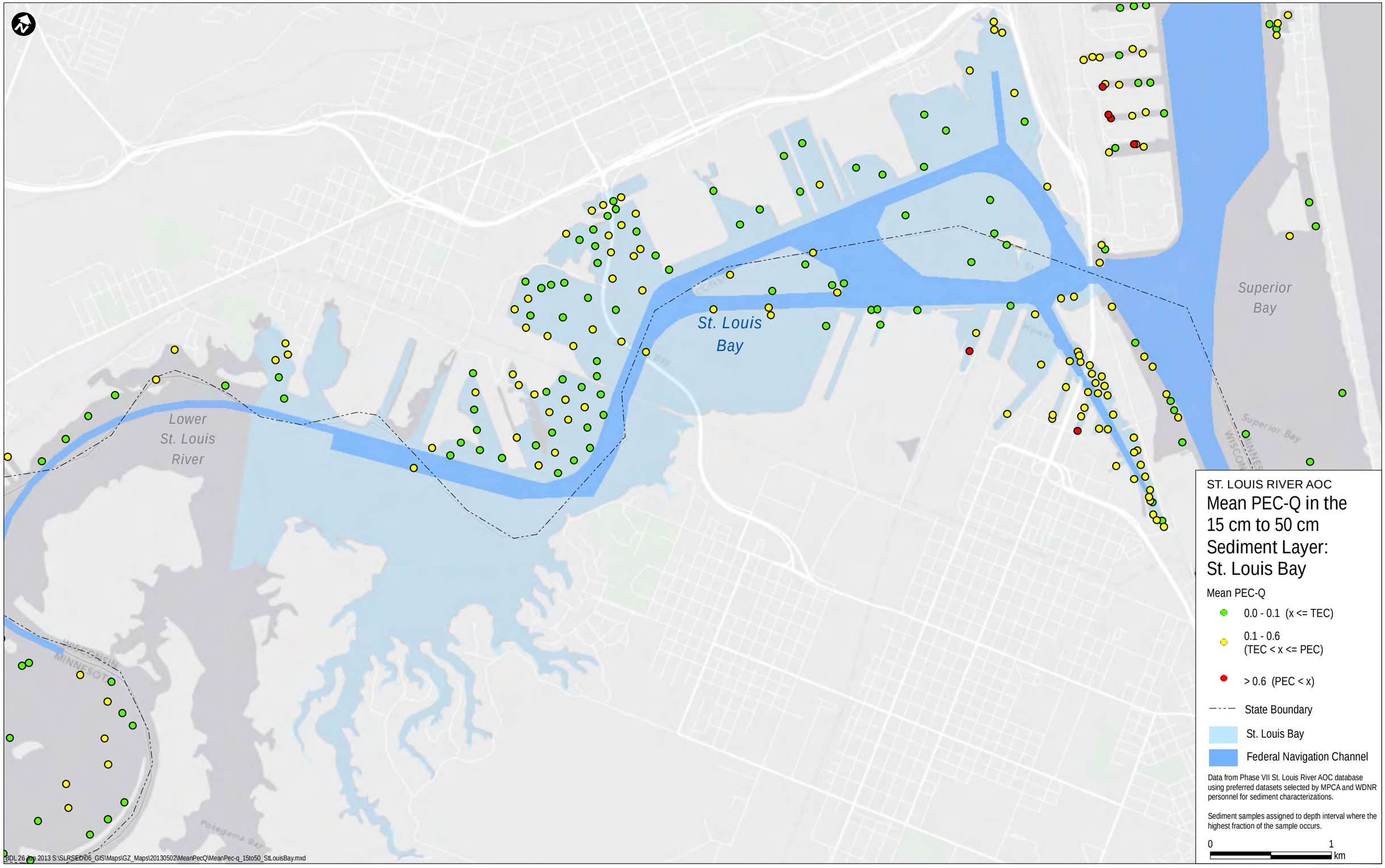
Superior Bay

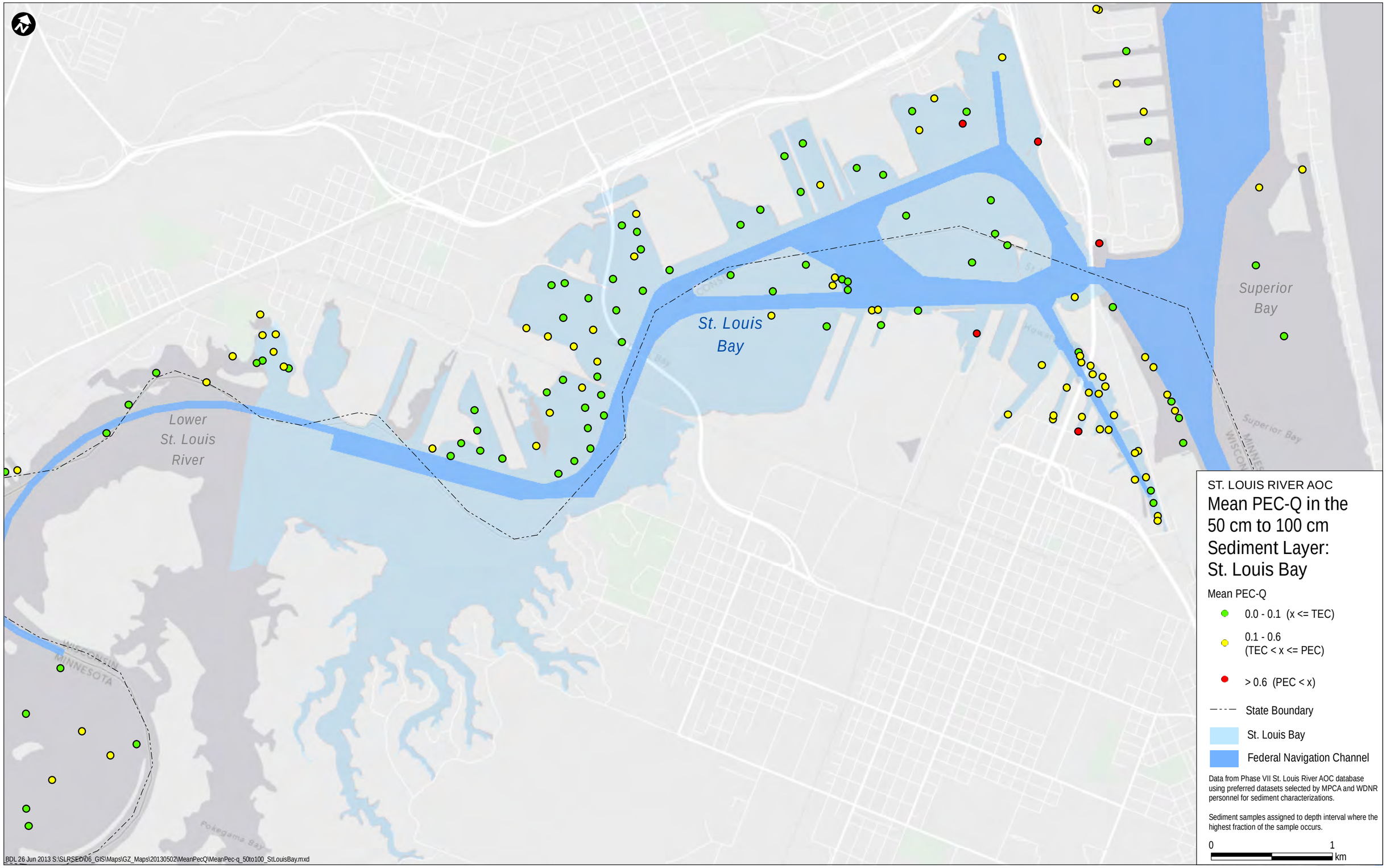
St. Louis Bay

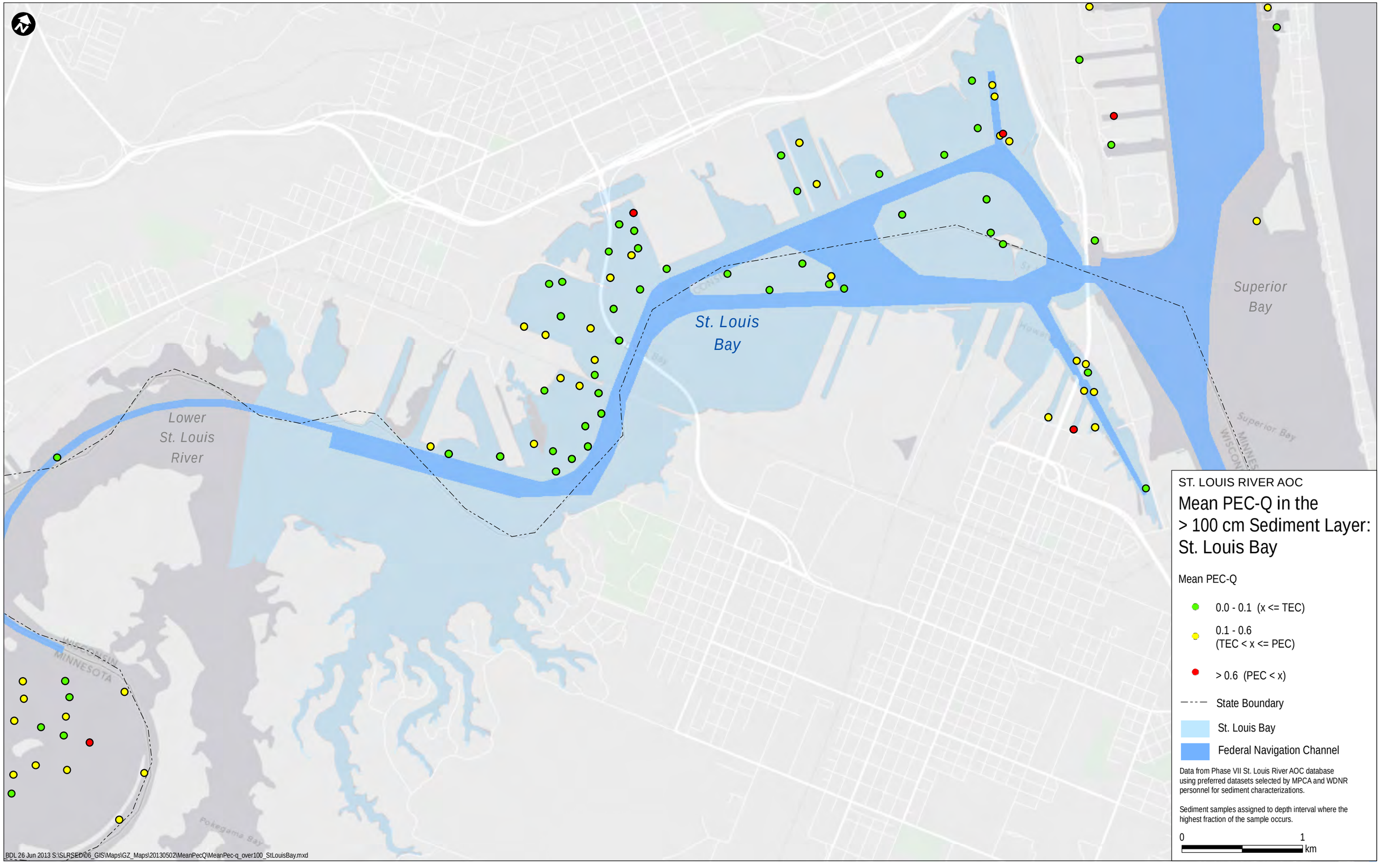
Allouez Bay

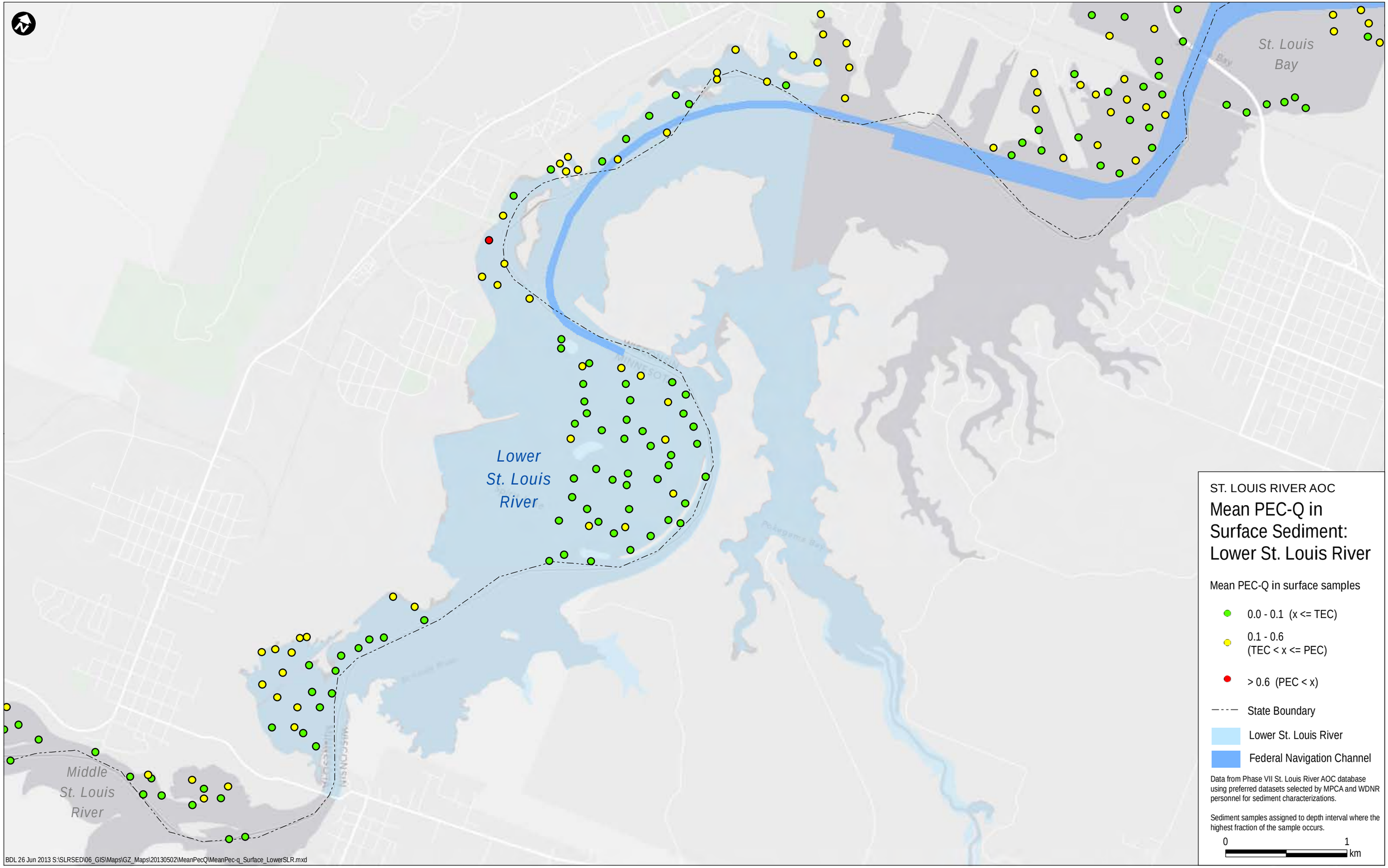
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_over100_SuperiorBay.mxd

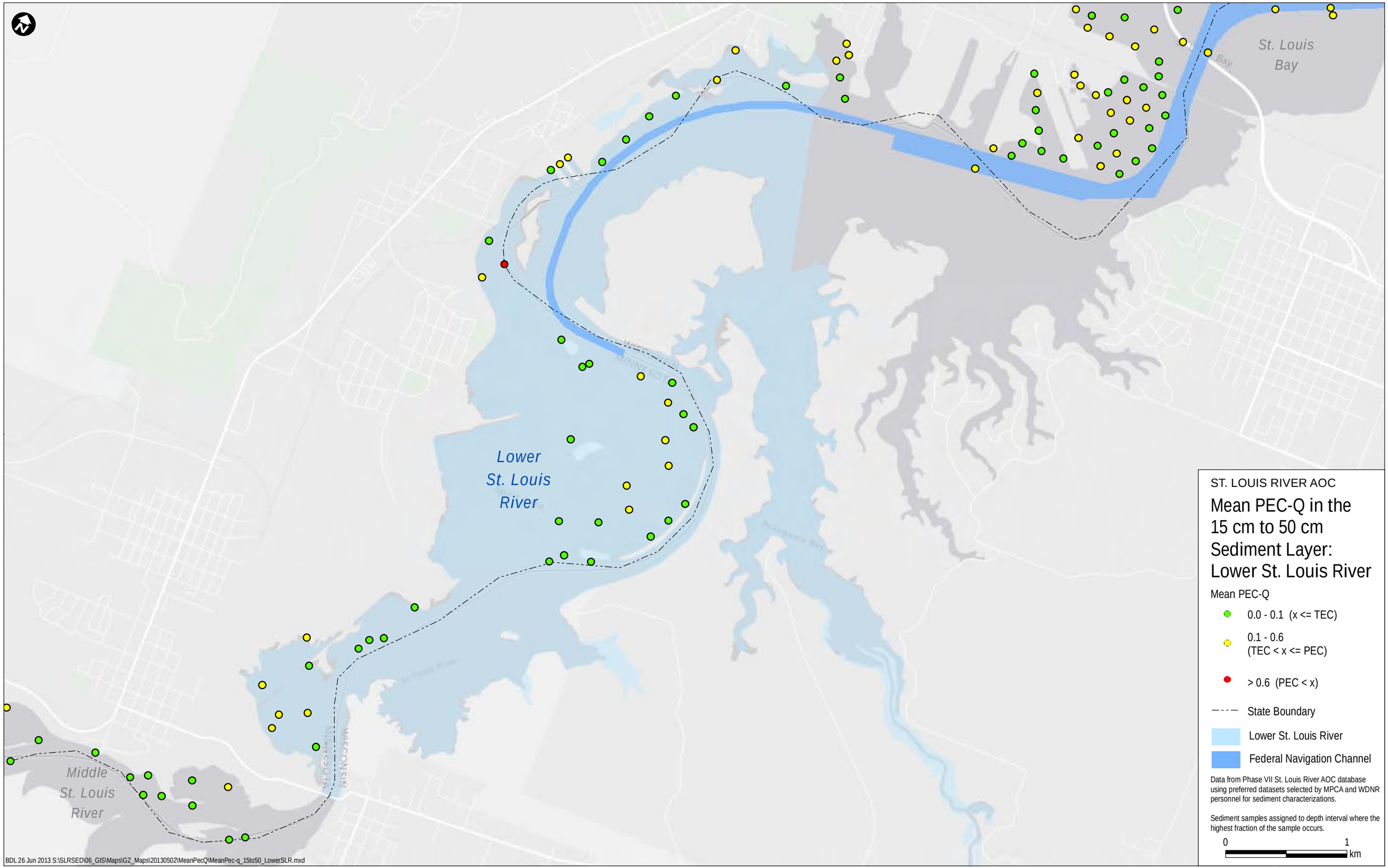

St. Louis Bay
Superior Bay
Lower St. Louis River
Superior Bay
Pokegama Bay
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mean PEC-Q in Surface Sediment: St. Louis Bay
Mean PEC-Q in surface samples
0.0 - 0.1 (x <= TEC)
0.1 - 0.6 (TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_Surface_StLouisBay.mxd

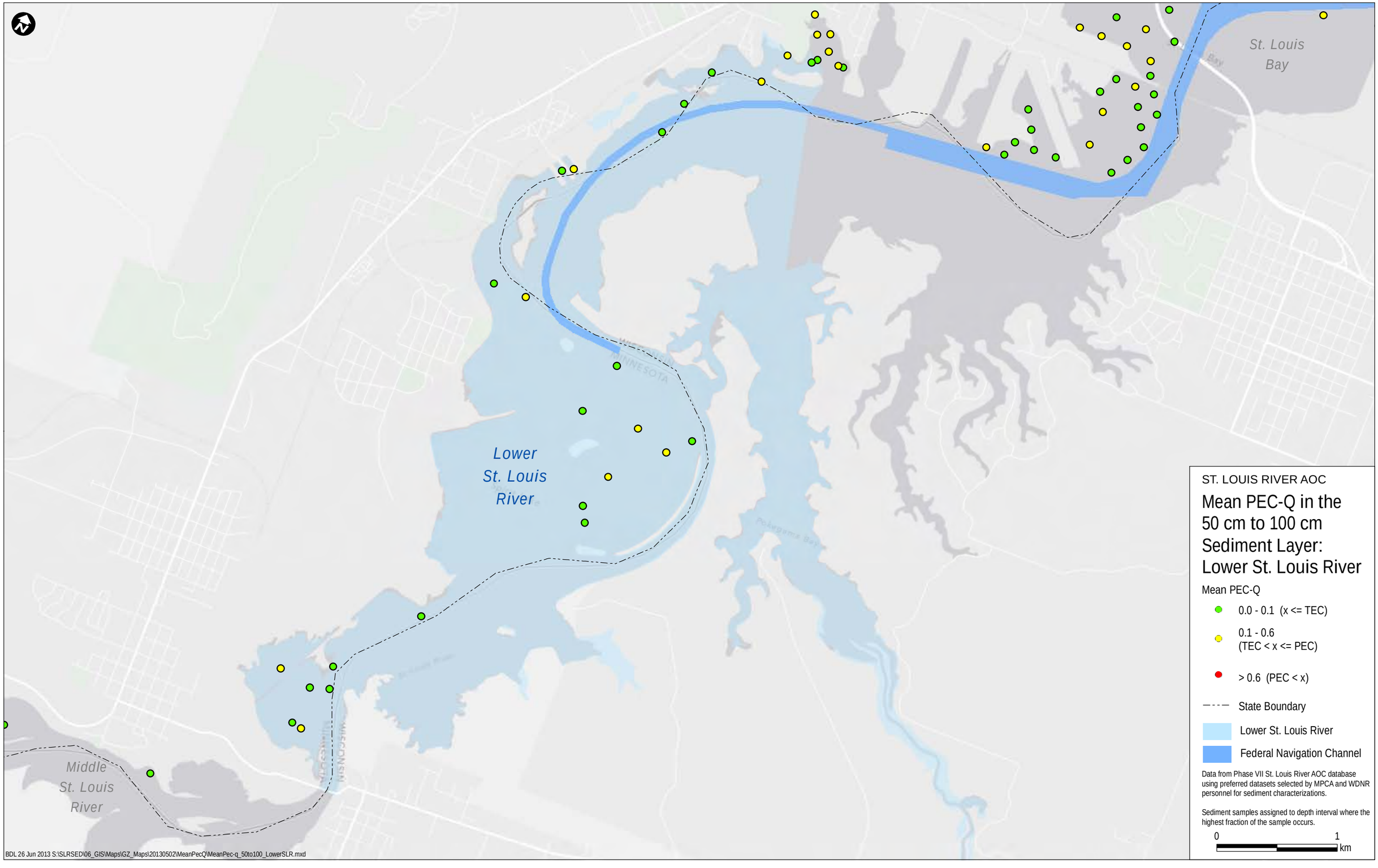

St. Louis
Bay
Superior
Bay
Lower
St. Louis
River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Mean PEC-Q in the
15 cm to 50 cm
Sediment Layer:
St. Louis Bay
Mean PEC-Q
0.0 - 0.1 (x <= TEC)
0.1 - 0.6
(TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
GDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_15to50_StLouisBay.mxd

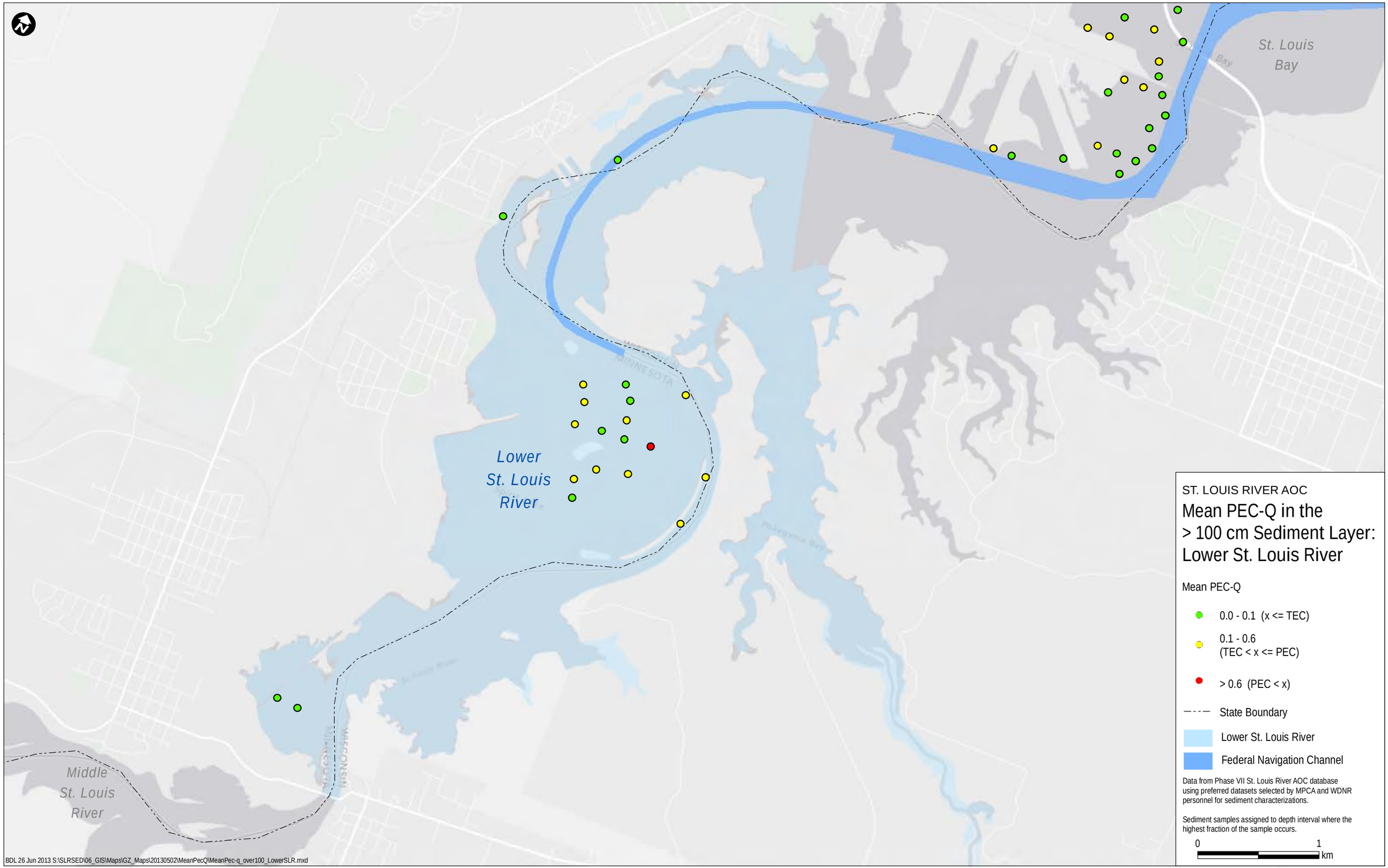

Lower
St. Louis
River
St. Louis
Bay
Superior
Bay
Superior Bay
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Mean PEC-Q in the
50 cm to 100 cm
Sediment Layer:
St. Louis Bay
Mean PEC-Q
0.0 - 0.1 (x <= TEC)
0.1 - 0.6
(TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_50to100_StLouisBay.mxd

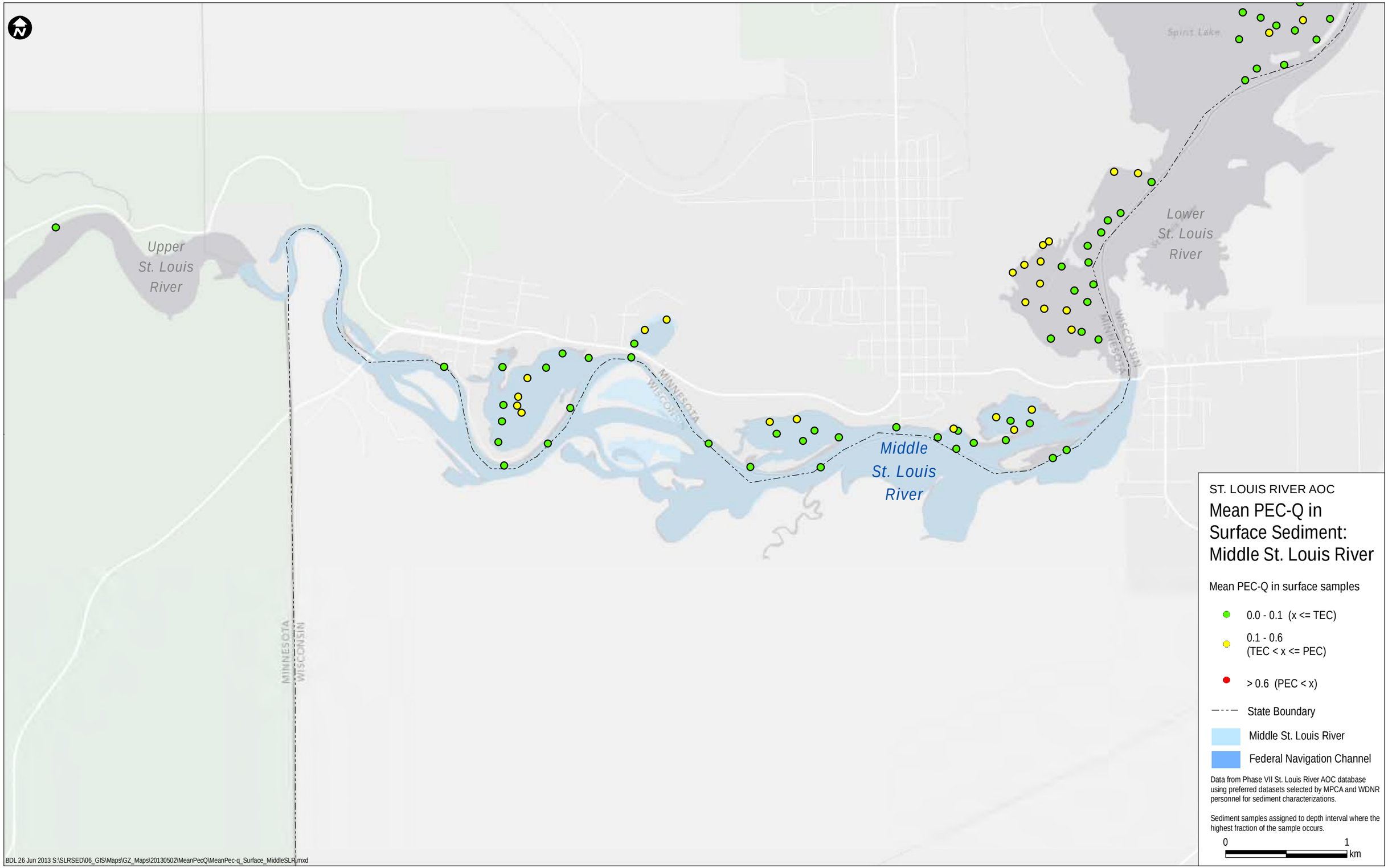

St. Louis
Bay
Superior
Bay
Lower
St. Louis
River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Mean PEC-Q in the
> 100 cm Sediment Layer:
St. Louis Bay
Mean PEC-Q
0.0 - 0.1 (x <= TEC)
0.1 - 0.6
(TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_over100_StLouisBay.mxd

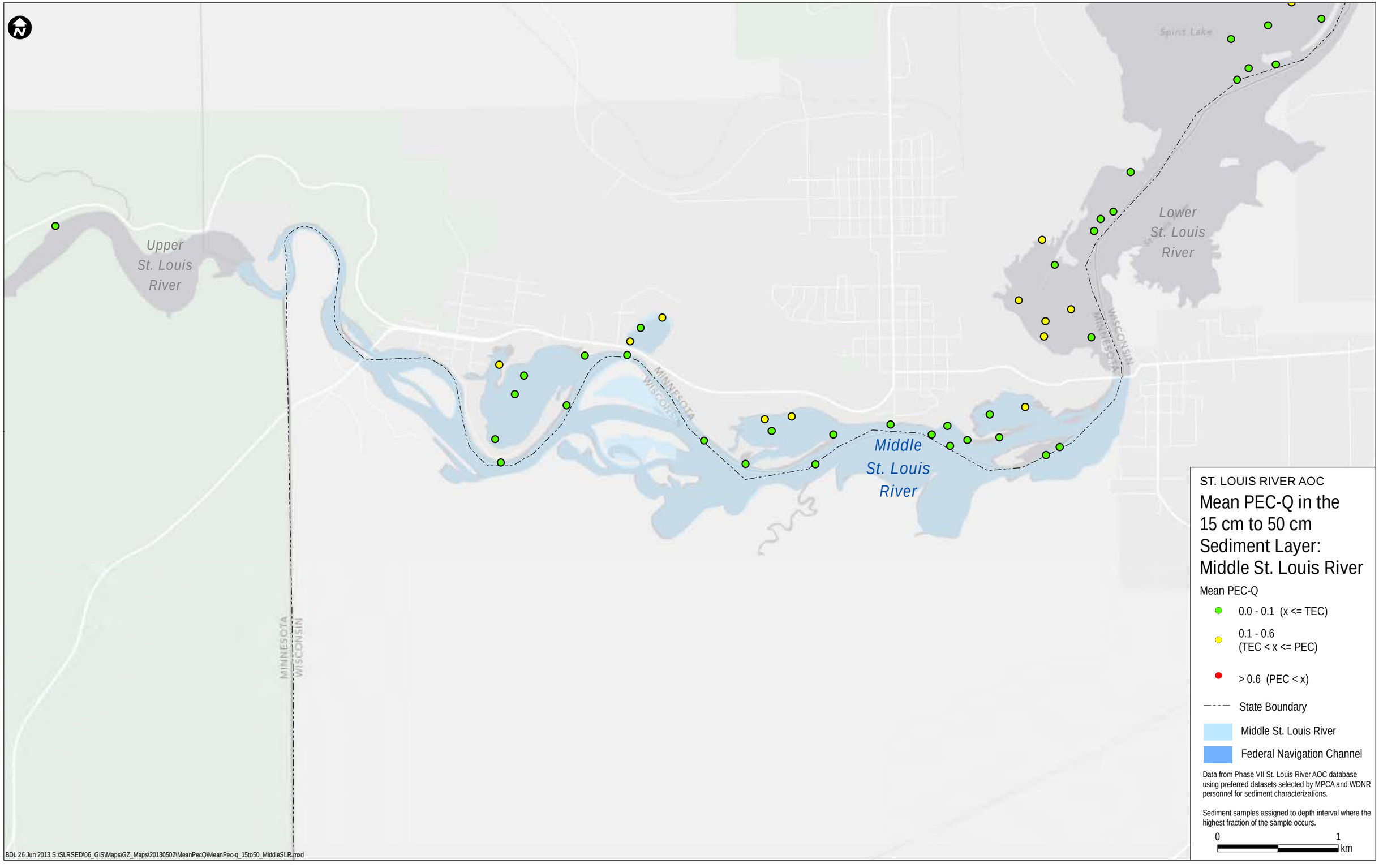

St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mean PEC-Q in Surface Sediment: Lower St. Louis River
Mean PEC-Q in surface samples
0.0 - 0.1 (x <= TEC)
0.1 - 0.6 (TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_Surface_LowerSLR.mxd

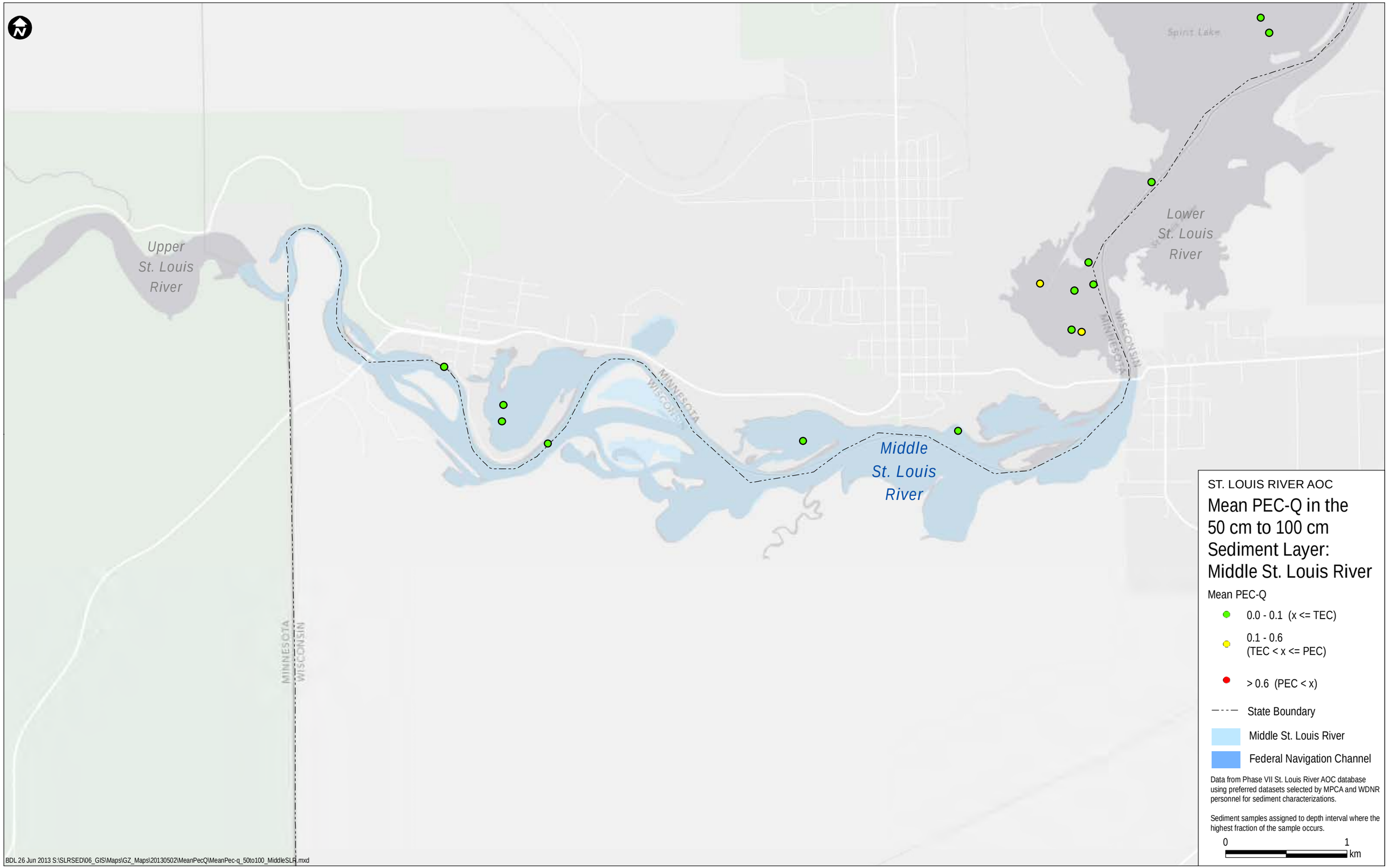

St. Louis Bay
Lower St. Louis River
Middle St. Louis River
ST. LOUIS RIVER AOC
Mean PEC-Q in the 15 cm to 50 cm Sediment Layer: Lower St. Louis River
Mean PEC-Q
0.0 - 0.1 (x <= TEC)
0.1 - 0.6 (TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_15to50_LowerSLR.mxd

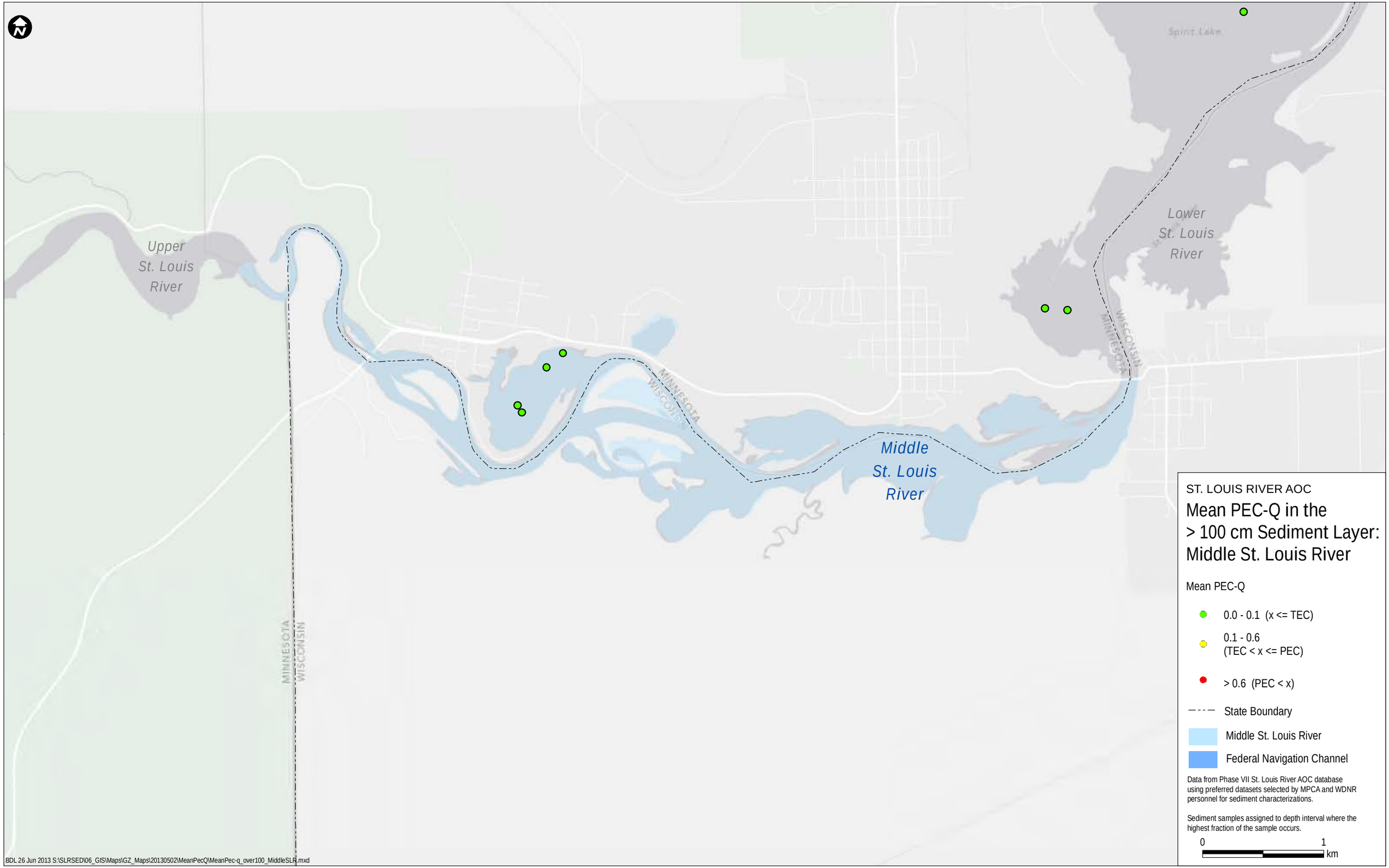

St. Louis
Bay
Lower
St. Louis
River
Middle
St. Louis
River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mean PEC-Q in the 50 cm to 100 cm Sediment Layer: Lower St. Louis River
Mean PEC-Q
0.0 - 0.1 (x <= TEC)
0.1 - 0.6
(TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_50to100_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
MINNESOTA
WISCONSIN
Pokegama Bay
ST. LOUIS RIVER AOC
Mean PEC-Q in the > 100 cm Sediment Layer: Lower St. Louis River
Mean PEC-Q
0.0 - 0.1 (x <= TEC)
0.1 - 0.6 (TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_over100_LowerSLR.mxd


Upper
St. Louis
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Mean PEC-Q in Surface Sediment: Middle St. Louis River
Mean PEC-Q in surface samples
0.0 - 0.1 (x <= TEC)
0.1 - 0.6
(TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_Surface_MiddleSLR.mxd


Upper
St. Louis
River
Lower
St. Louis
River
Middle
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Mean PEC-Q in the 15 cm to 50 cm Sediment Layer: Middle St. Louis River
Mean PEC-Q
0.0 - 0.1 (x <= TEC)
0.1 - 0.6
(TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_15to50_MiddleSLR.mxd


Spirit Lake
Upper
St. Louis
River
Lower
St. Louis
River
Middle
St. Louis
River
MINNESOTA
WISCONSIN
MINNESOTA
WISCONSIN
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Mean PEC-Q in the
50 cm to 100 cm
Sediment Layer:
Middle St. Louis River
Mean PEC-Q
0.0 - 0.1 (x <= TEC)
0.1 - 0.6
(TEC < x <= PEC)
> 0.6 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_50to100_MiddleSLR.mxd




ST. LOUIS RIVER AOC

## Mean PEC-Q in the > 100 cm Sediment Layer: Middle St. Louis River

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Middle St. Louis River
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_over100_MiddleSLR.mxd

ST. LOUIS RIVER AOC

# Mean PEC-Q in Surface Sediment: Upper St. Louis River

Mean PEC-Q in surface samples

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Upper St. Louis River
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_Surface_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Mean PEC-Q in the 15 cm to 50 cm Sediment Layer: Upper St. Louis River

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Upper St. Louis River
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_15to50_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Mean PEC-Q in the 50 cm to 100 cm Sediment Layer: Upper St. Louis River

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_50to100_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Mean PEC-Q in the > 100 cm Sediment Layer: Upper St. Louis River

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Upper St. Louis River
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

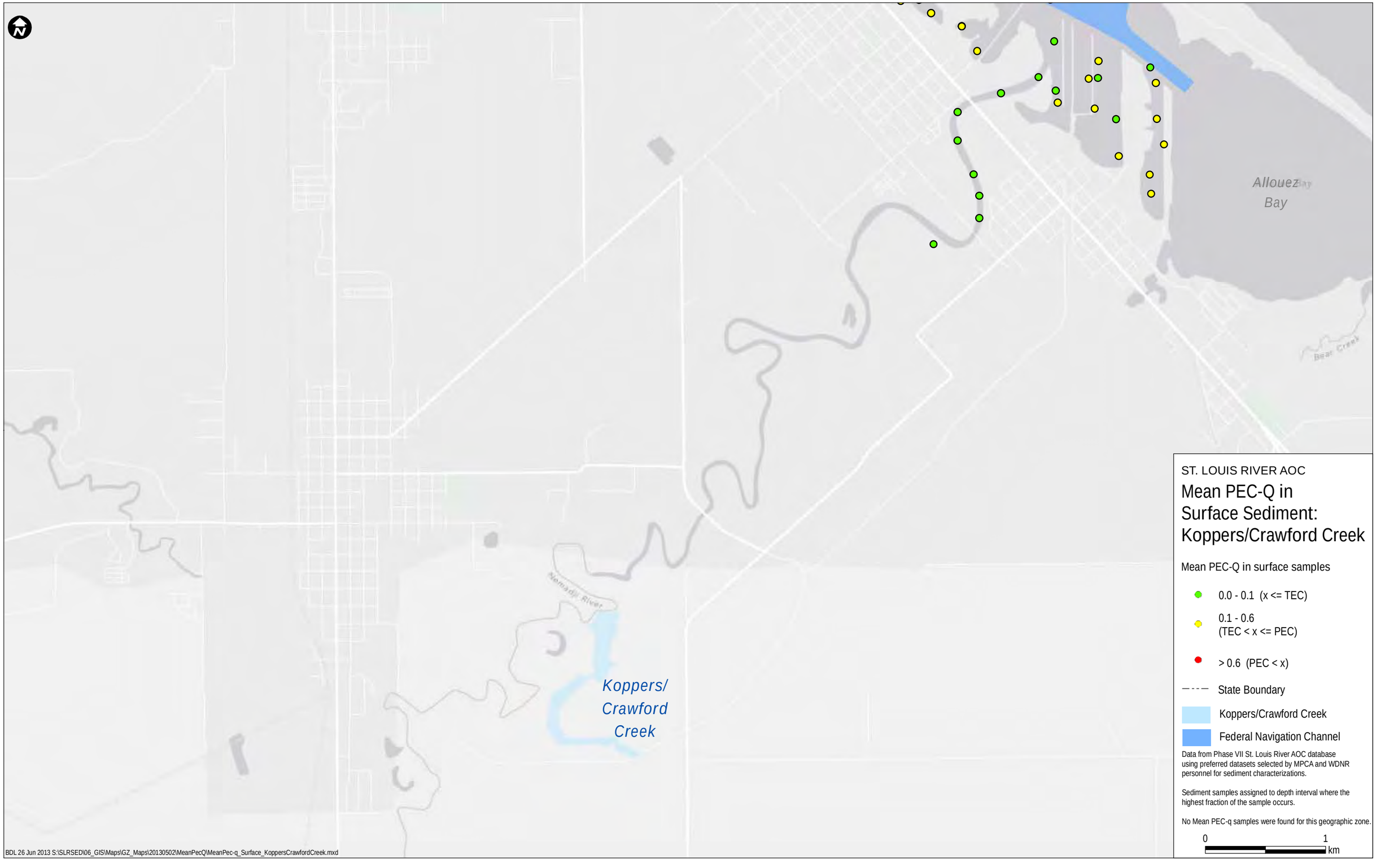
No Mean PEC-q samples were found for this geographic zone.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_over100_UpperSLR.mxd




ST. LOUIS RIVER AOC

## Mean PEC-Q in Surface Sediment: Koppers/Crawford Creek

Mean PEC-Q in surface samples

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mean PEC-q samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_Surface_KoppersCrawfordCreek.mxd


ST. LOUIS RIVER AOC

# Mean PEC-Q in the 15 cm to 50 cm Sediment Layer: Koppers/Crawford Creek

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

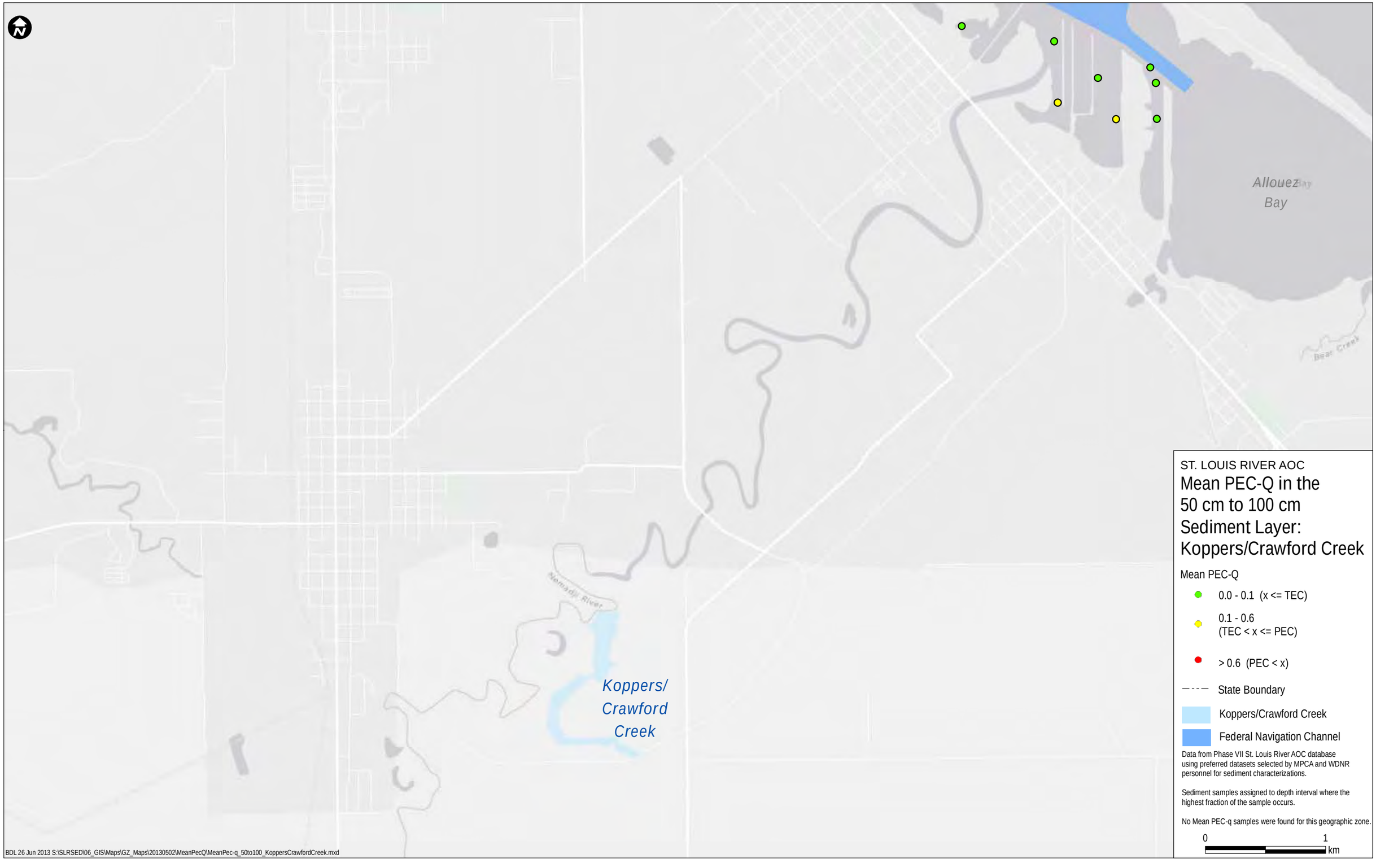
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mean PEC-q samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_15to50_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

# Mean PEC-Q in the 50 cm to 100 cm Sediment Layer: Koppers/Crawford Creek

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

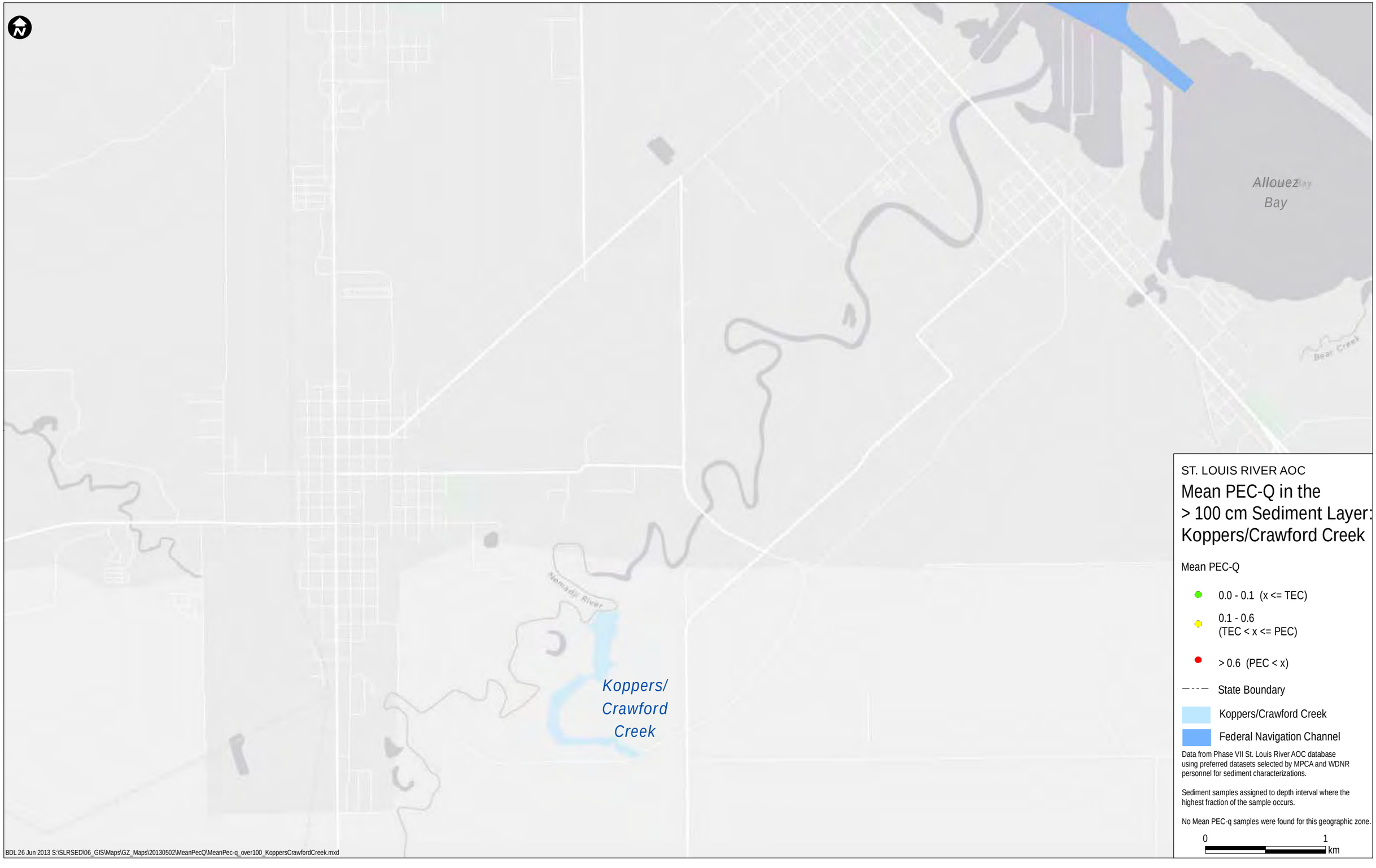
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mean PEC-q samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_50to100_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

## Mean PEC-Q in the > 100 cm Sediment Layer: Koppers/Crawford Creek

Mean PEC-Q

- 0.0 - 0.1 (x <= TEC)
- 0.1 - 0.6 (TEC < x <= PEC)
- > 0.6 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mean PEC-q samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\MeanPecQ\MeanPec-q_over100_KoppersCrawfordCreek.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Mercury in Surface Sediment: Geographic Zones

Mercury concentrations in surface samples (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

blord 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GIZ_Maps\20130602\HgHH_Surface_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

# Mercury in the 15 cm to 50 cm Sediment Layer: Geographic Zones

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km



bford 26 Jun 2013 S:\SLR\SED\06_GIS\Maps\GIS_Maps\20130602\Hg\Hg_15to50_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Superior

Middle St. Louis River

Allouez Bay

Koppers/Crawford Creek

ST. LOUIS RIVER AOC

## Mercury in the 50 cm to 100 cm Sediment Layer: Geographic Zones

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

MINNESOTA WISCONSIN



mxd 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\HgHg_50to100_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

ST. LOUIS RIVER AOC

## Mercury in the >100 cm Sediment Layer: Geographic Zones

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km



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ST. LOUIS RIVER AOC

# Mercury in Surface Sediment: Allouez Bay

Mercury concentrations in surface samples (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Superior Bay

Lake Superior

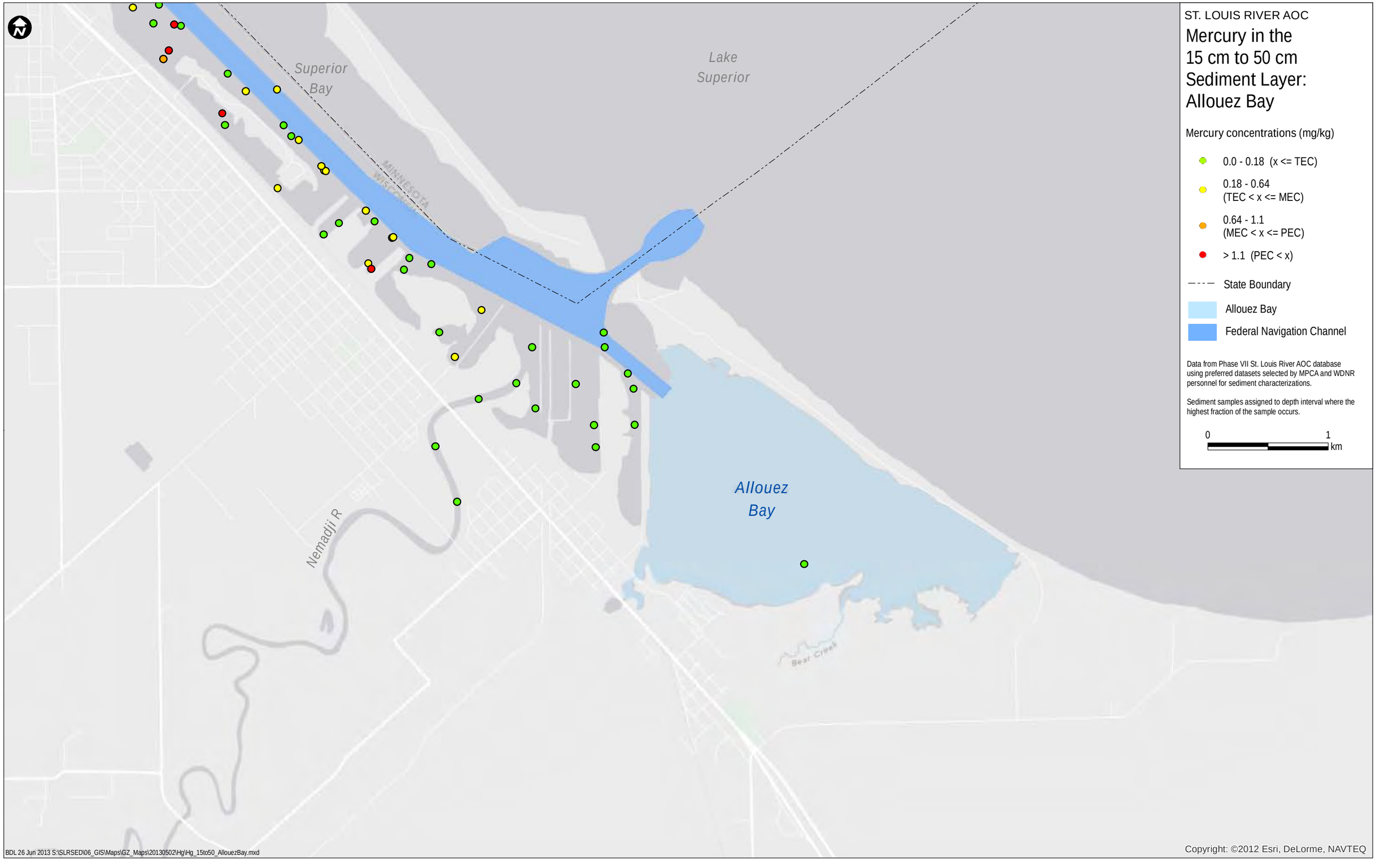
MINNESOTA WISCONSIN

Allouez Bay

Nemadji R

Bear Creek

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_Surface_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Mercury in the 15 cm to 50 cm Sediment Layer: Allouez Bay

Mercury concentrations (mg/kg)

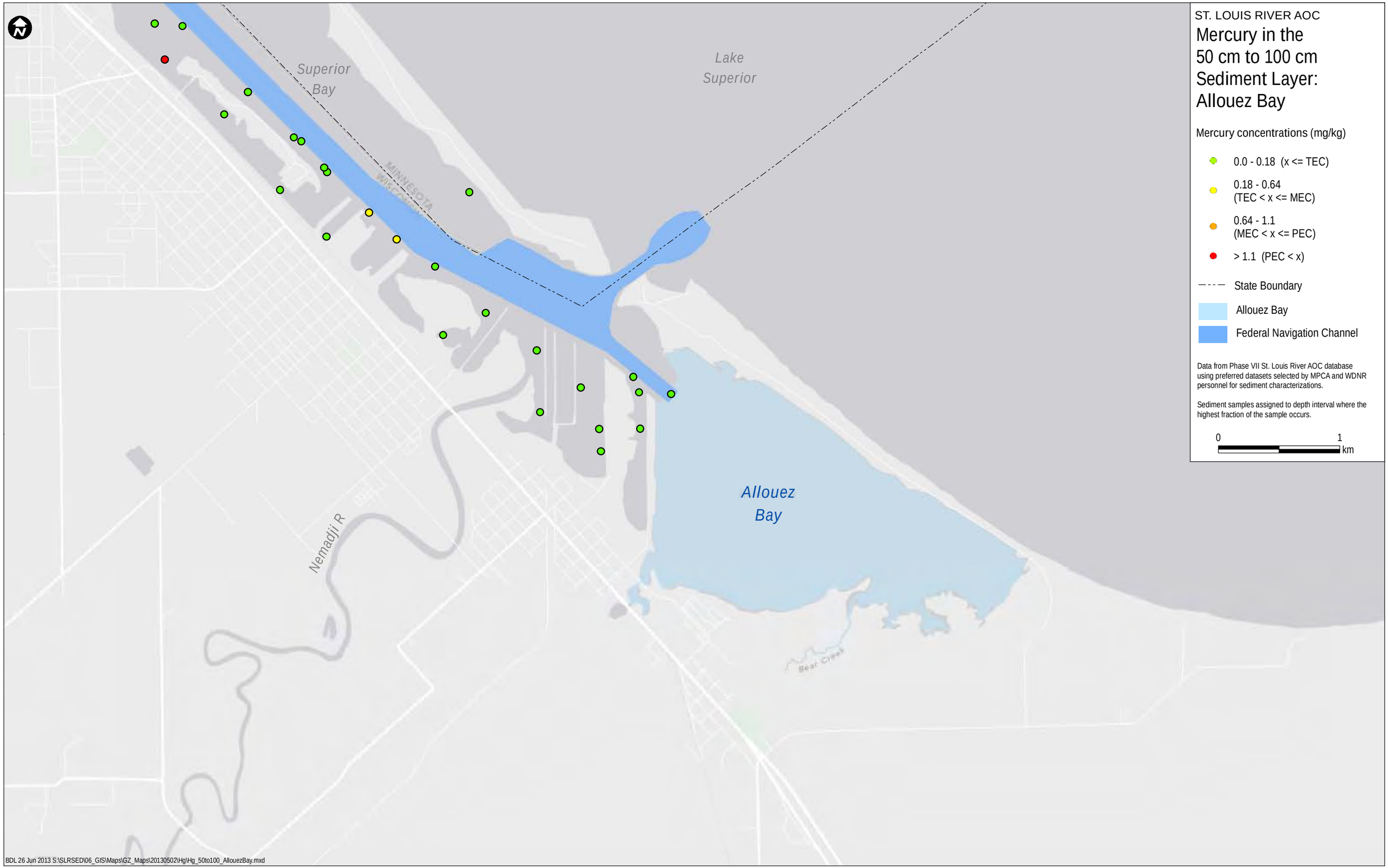
- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_15to50_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Mercury in the 50 cm to 100 cm Sediment Layer: Allouez Bay

Mercury concentrations (mg/kg)

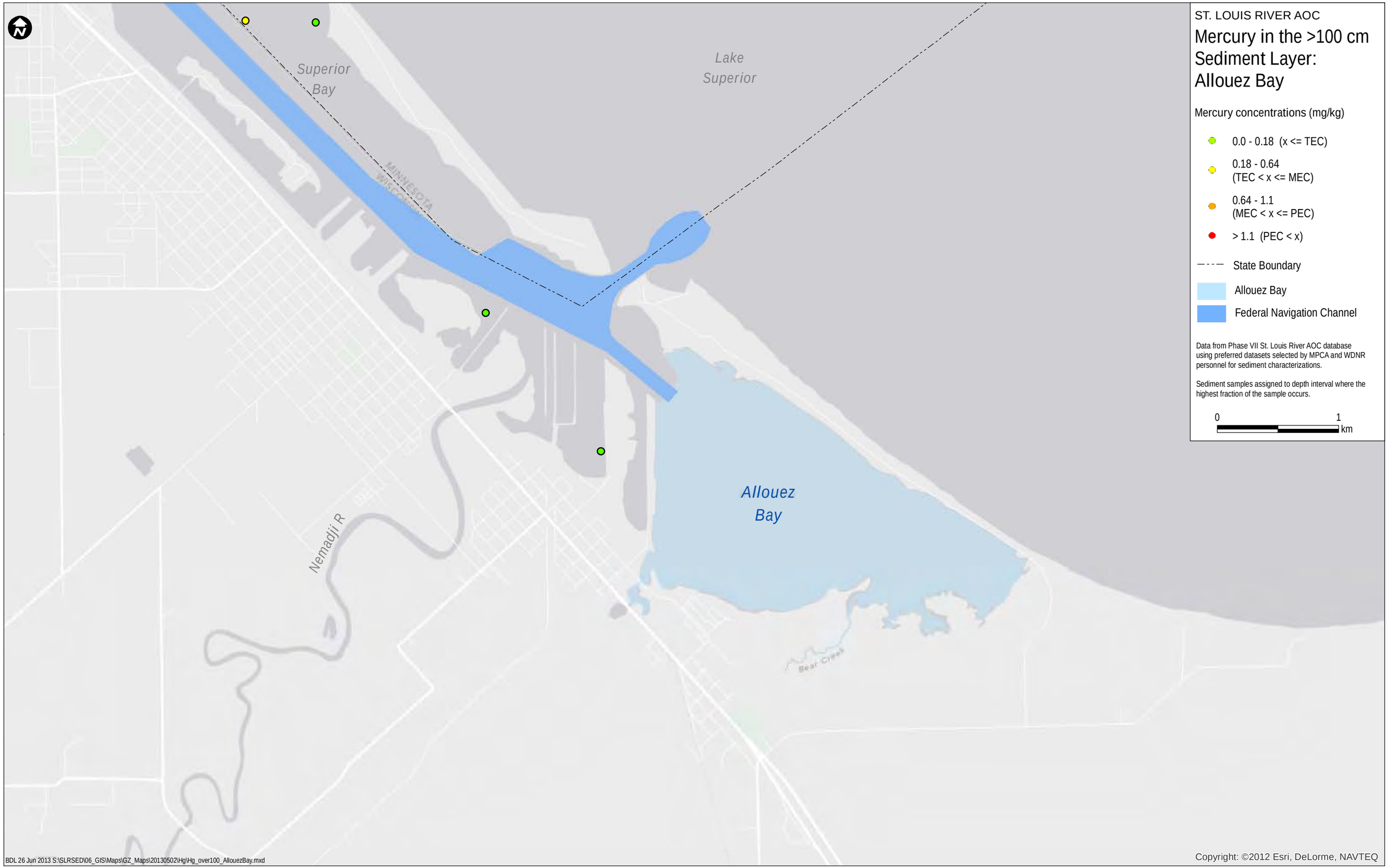
- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_50to100_AllouezBay.mxd


Superior Bay
Lake Superior
MINNESOTA
WISCONSIN
Allouez Bay
Nemadji R
Bear Creek
ST. LOUIS RIVER AOC
Mercury in the >100 cm Sediment Layer: Allouez Bay
Mercury concentrations (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64 (TEC < x <= MEC)
0.64 - 1.1 (MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
Allouez Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_over100_AllouezBay.mxd
Copyright: ©2012 Esri, DeLorme, NAVTEQ

ST. LOUIS RIVER AOC

# Mercury in Surface Sediment: Superior Bay

Mercury concentrations in surface samples (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

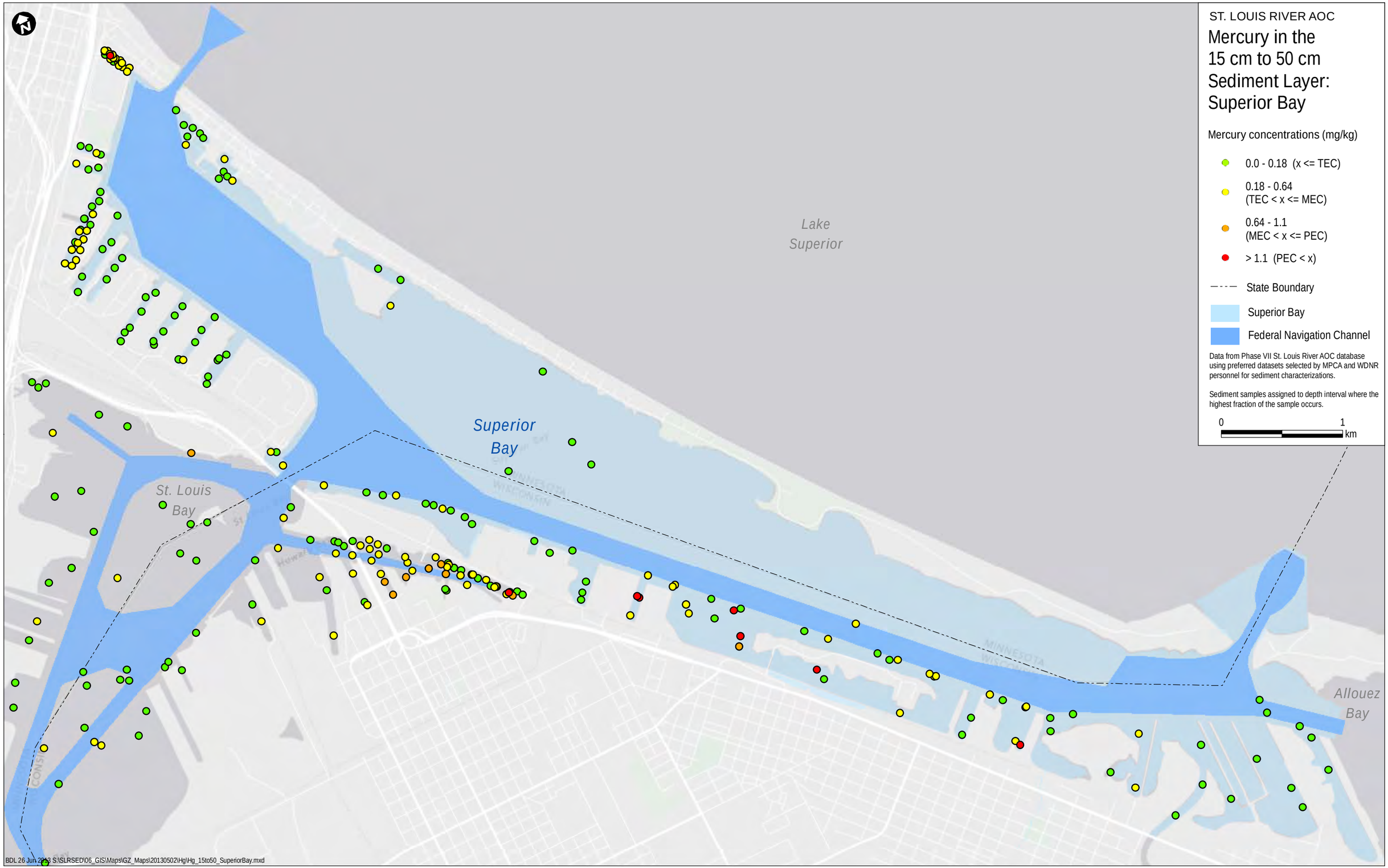
Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_Surface_SuperiorBay.mxd




ST. LOUIS RIVER AOC

# Mercury in the 15 cm to 50 cm Sediment Layer: Superior Bay

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)
- State Boundary
- Superior Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_15to50_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Mercury in the 50 cm to 100 cm Sediment Layer: Superior Bay

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Lake Superior

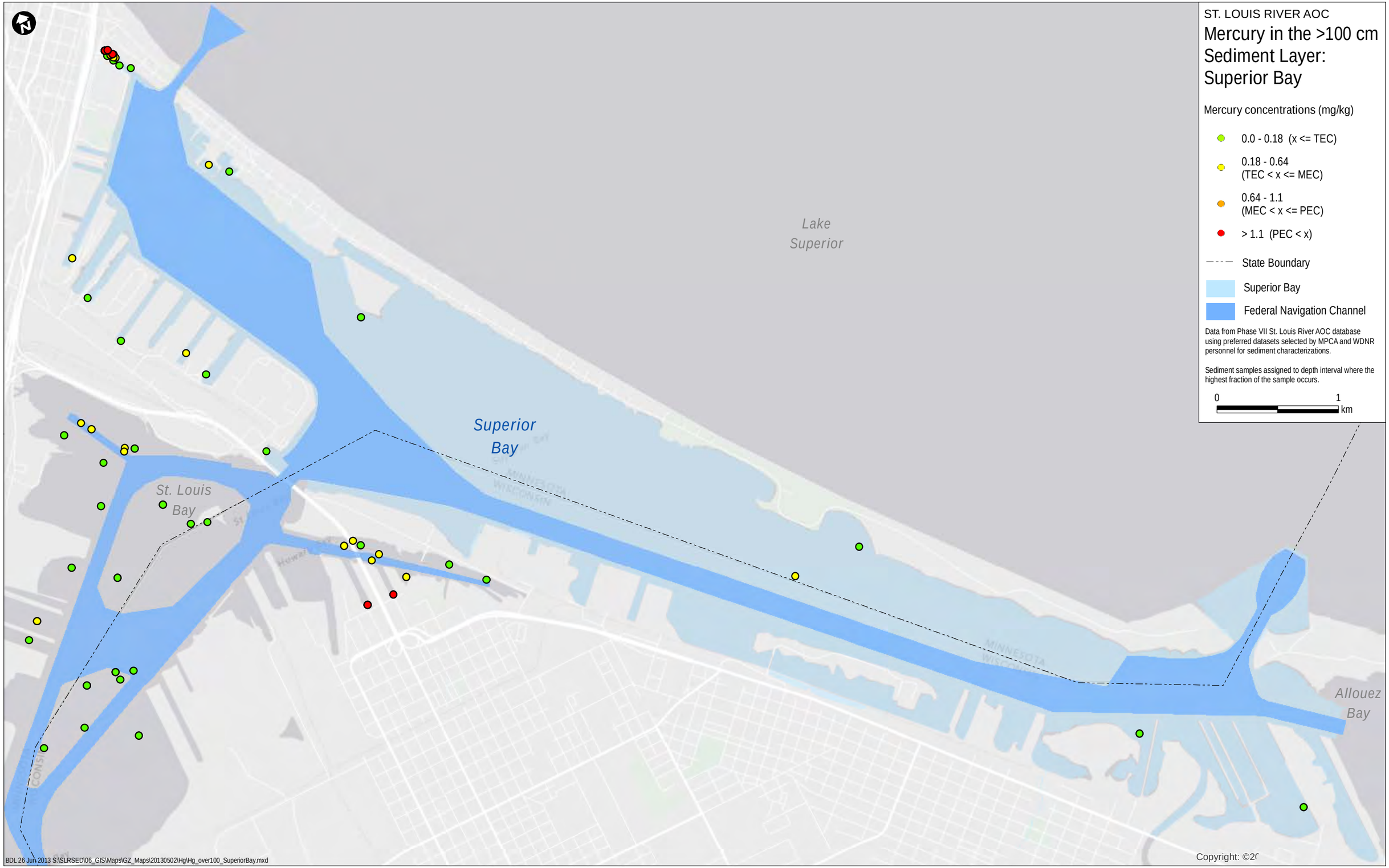
Superior Bay

St. Louis Bay

Allouez Bay

MINNESOTA WISCONSIN

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_50to100_SuperiorBay.mxd




ST. LOUIS RIVER AOC

# Mercury in the >100 cm Sediment Layer: Superior Bay

Mercury concentrations (mg/kg)

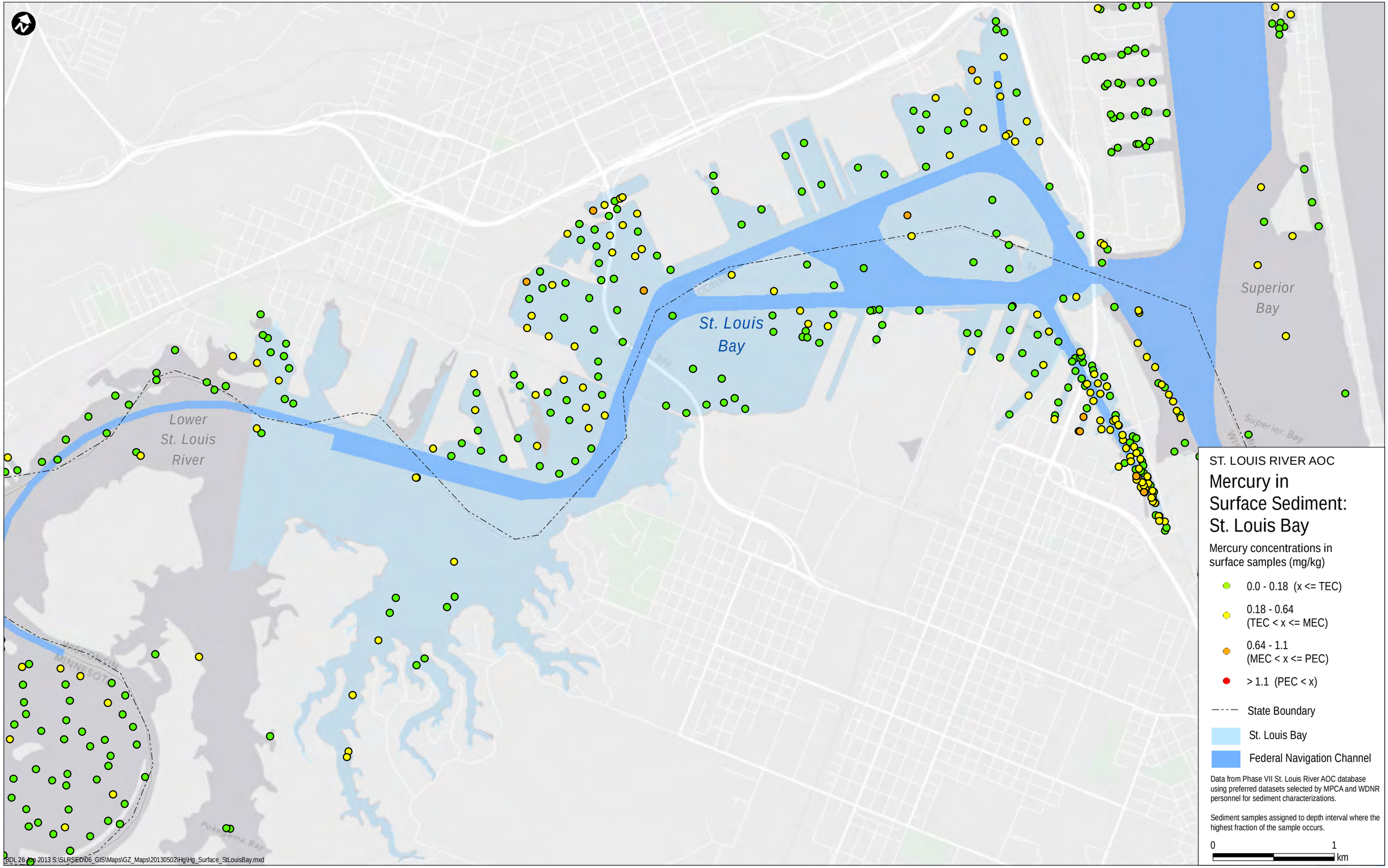
- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)
- State Boundary
- Superior Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_over100_SuperiorBay.mxd


Lower
St. Louis
River
St. Louis
Bay
Superior
Bay
Superior Bay
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Mercury in
Surface Sediment:
St. Louis Bay
Mercury concentrations in
surface samples (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64
(TEC < x <= MEC)
0.64 - 1.1
(MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database
using preferred datasets selected by MPCA and WDNR
personnel for sediment characterizations.
Sediment samples assigned to depth interval where the
highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_Surface_StLouisBay.mxd

St. Louis Bay

Superior Bay

Lower St. Louis River

Pokegama Bay

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_15to50_StLouisBay.mxd

ST. LOUIS RIVER AOC

# Mercury in the 15 cm to 50 cm Sediment Layer: St. Louis Bay

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

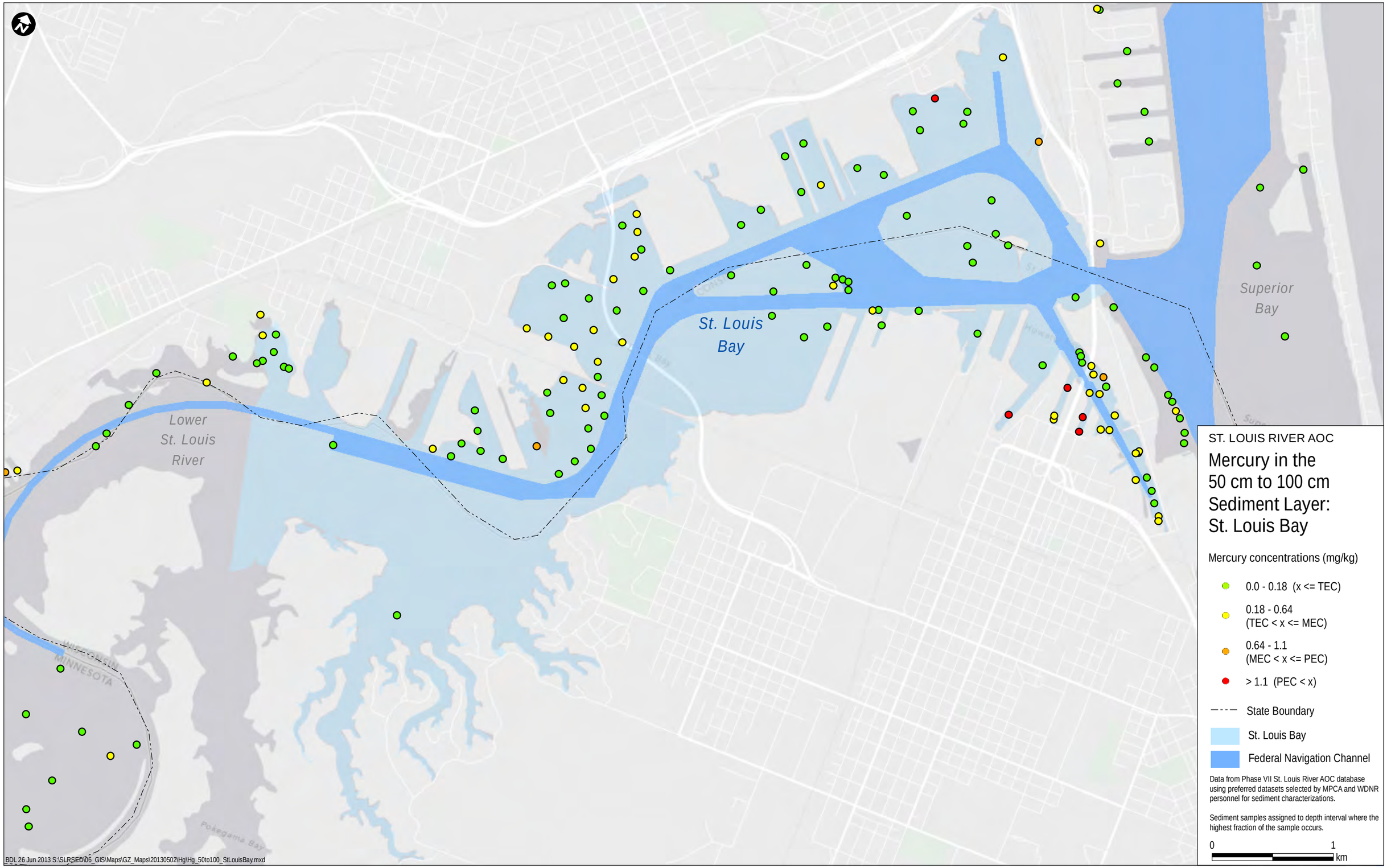
St. Louis Bay

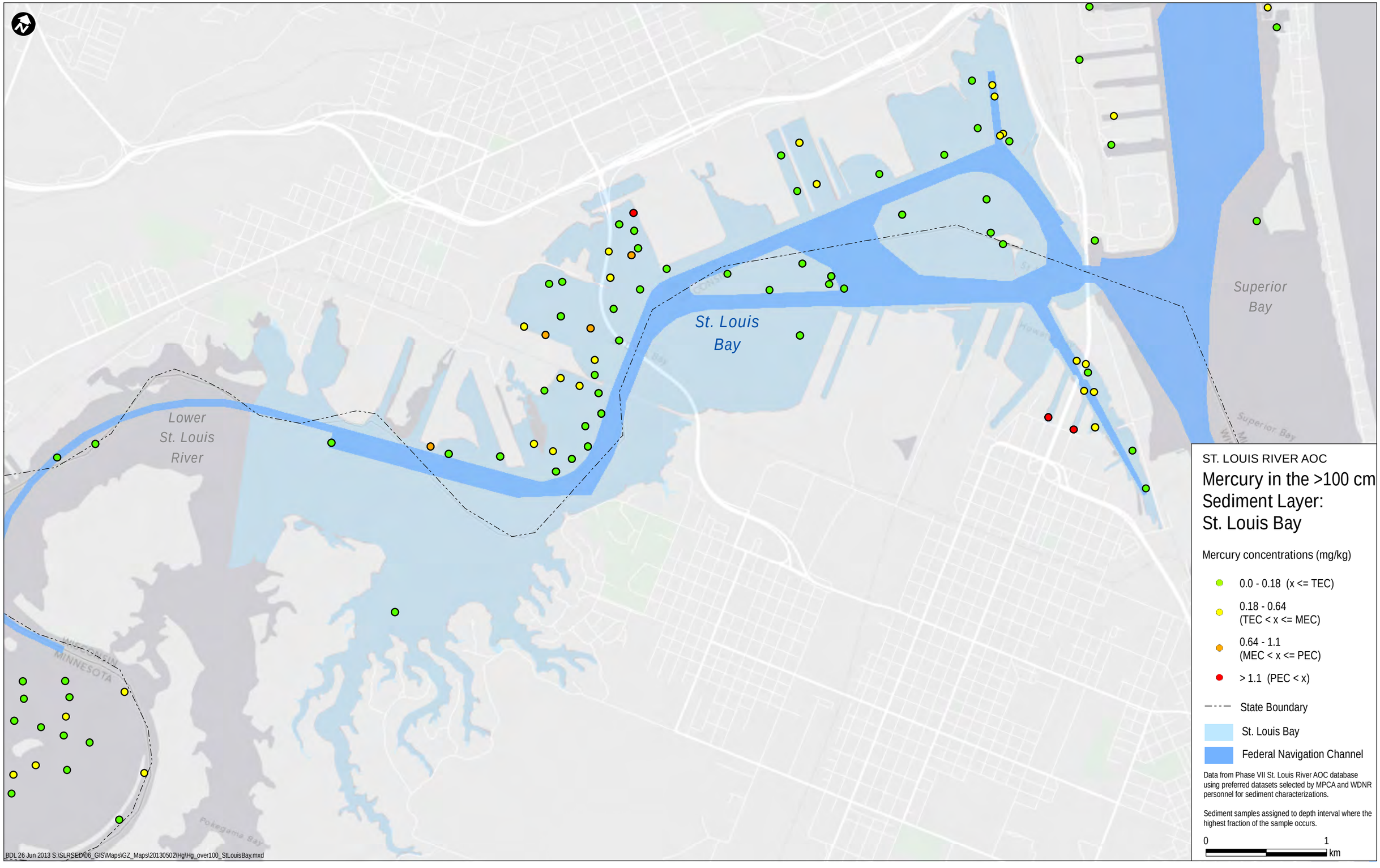
Federal Navigation Channel

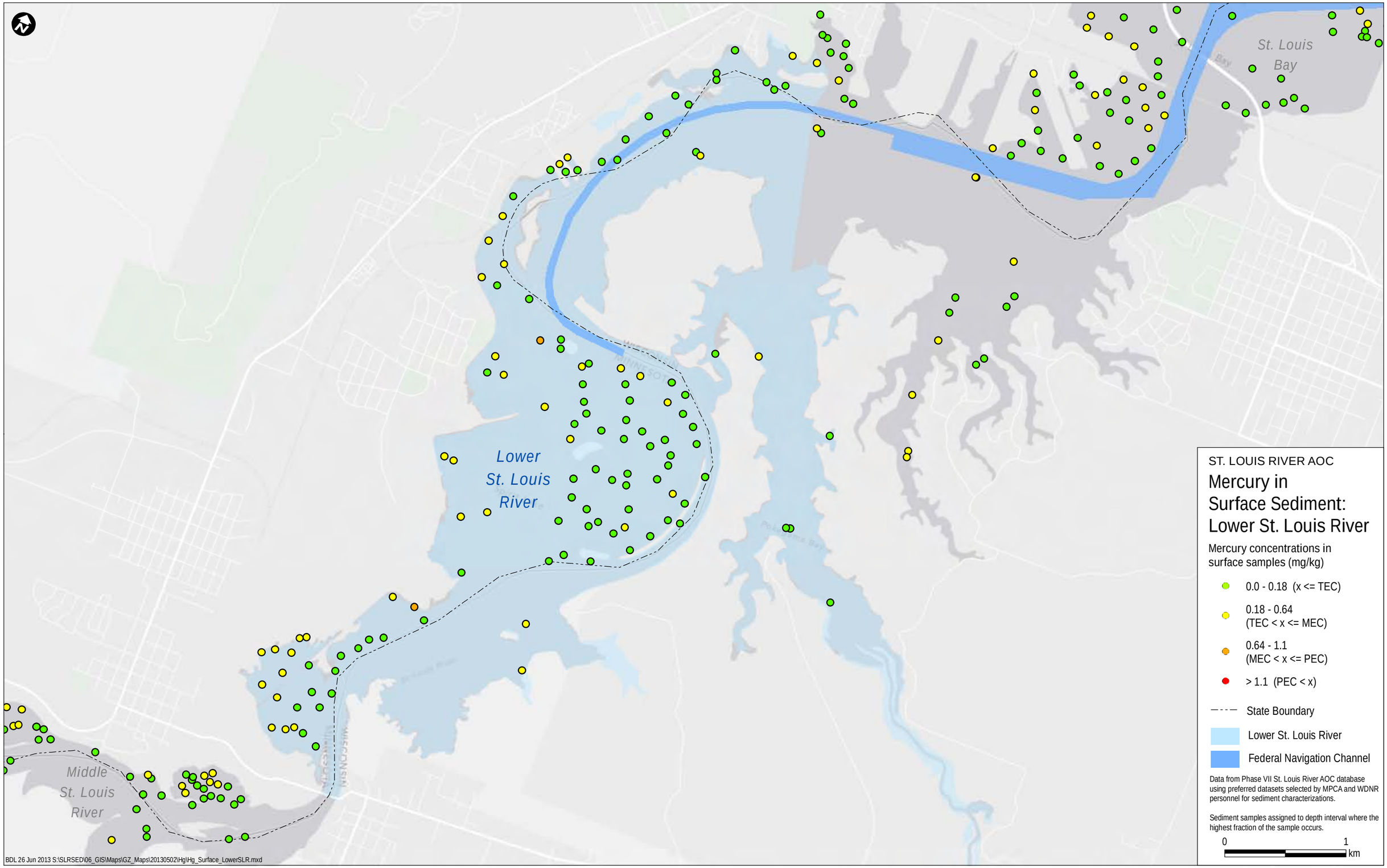
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

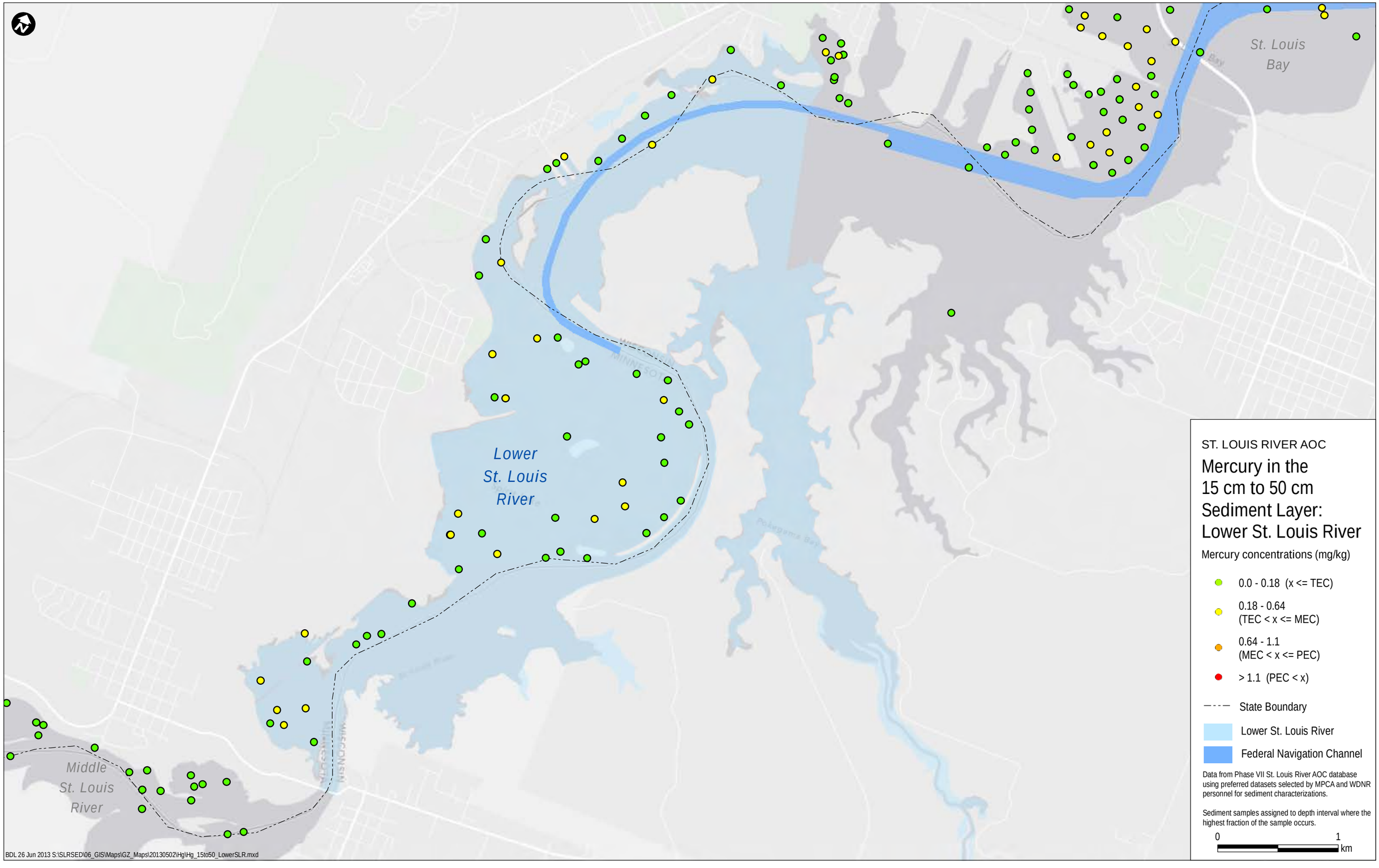
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

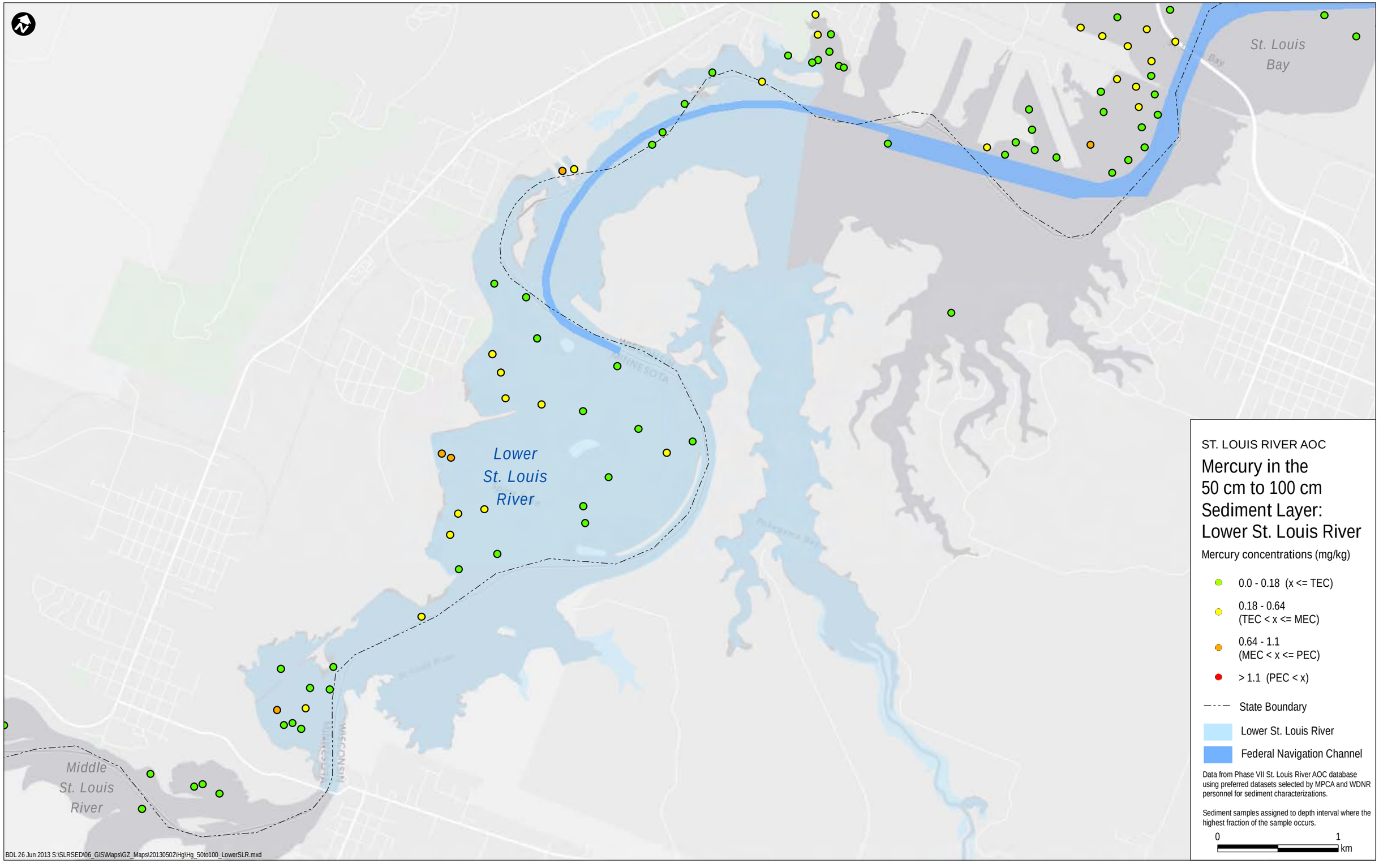
0 1 km

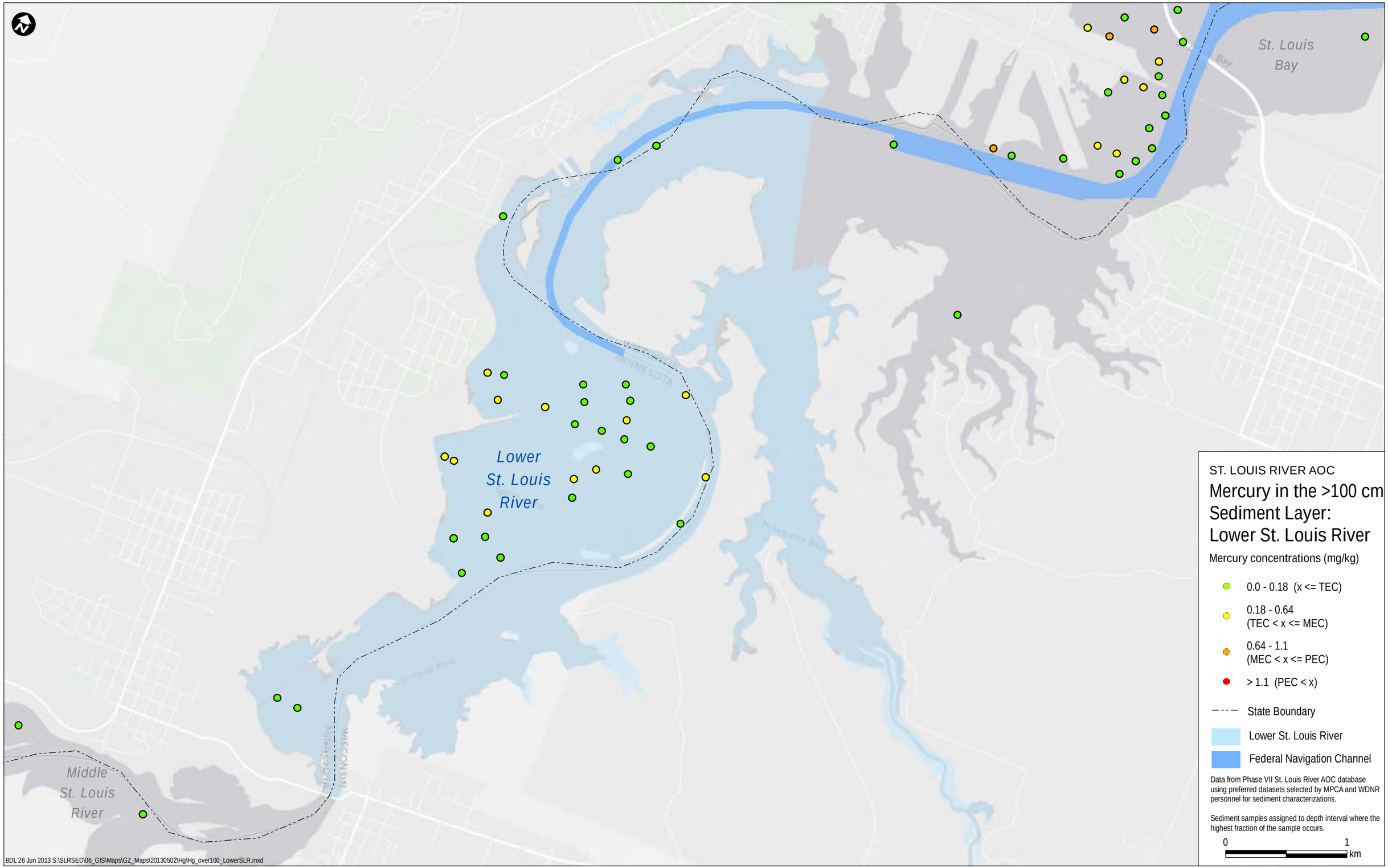

St. Louis Bay
Superior Bay
Lower St. Louis River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Mercury in the 50 cm to 100 cm Sediment Layer: St. Louis Bay
Mercury concentrations (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64 (TEC < x <= MEC)
0.64 - 1.1 (MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_50to100_StLouisBay.mxd

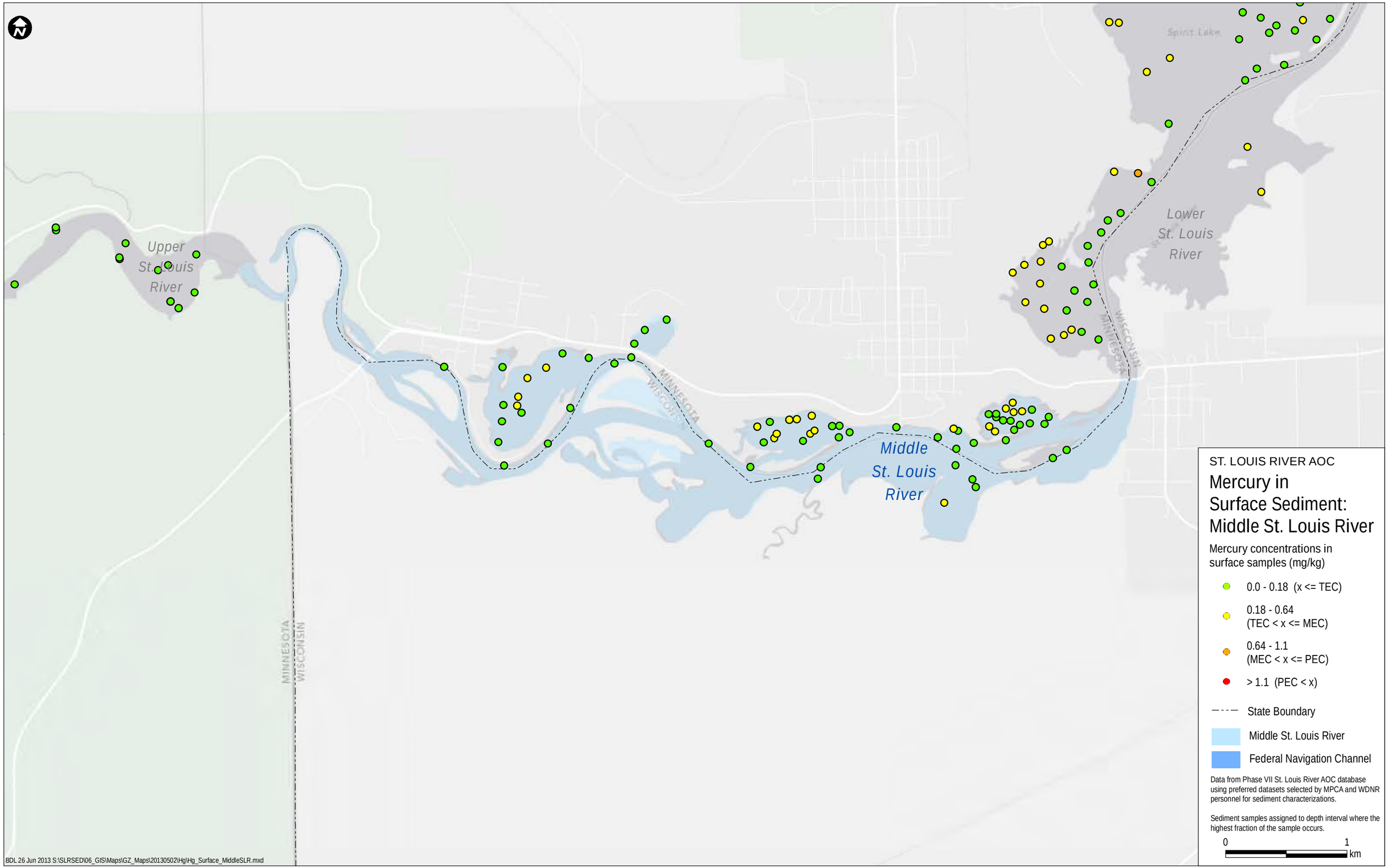

St. Louis Bay
Superior Bay
Lower St. Louis River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Mercury in the >100 cm Sediment Layer: St. Louis Bay
Mercury concentrations (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64 (TEC < x <= MEC)
0.64 - 1.1 (MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\LSRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_over100_StLouisBay.mxd

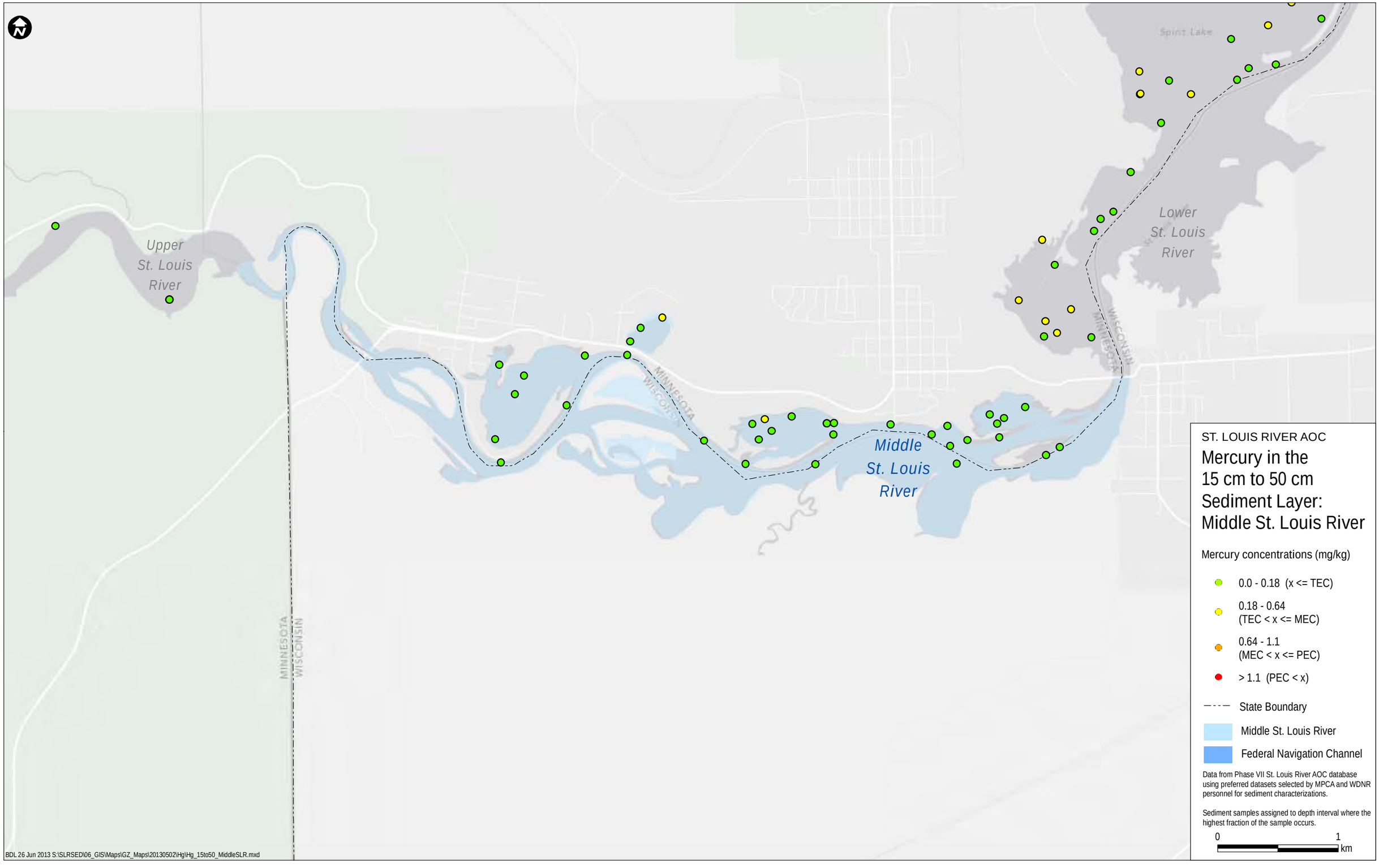

St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mercury in Surface Sediment: Lower St. Louis River
Mercury concentrations in surface samples (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64 (TEC < x <= MEC)
0.64 - 1.1 (MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_Surface_LowerSLR.mxd

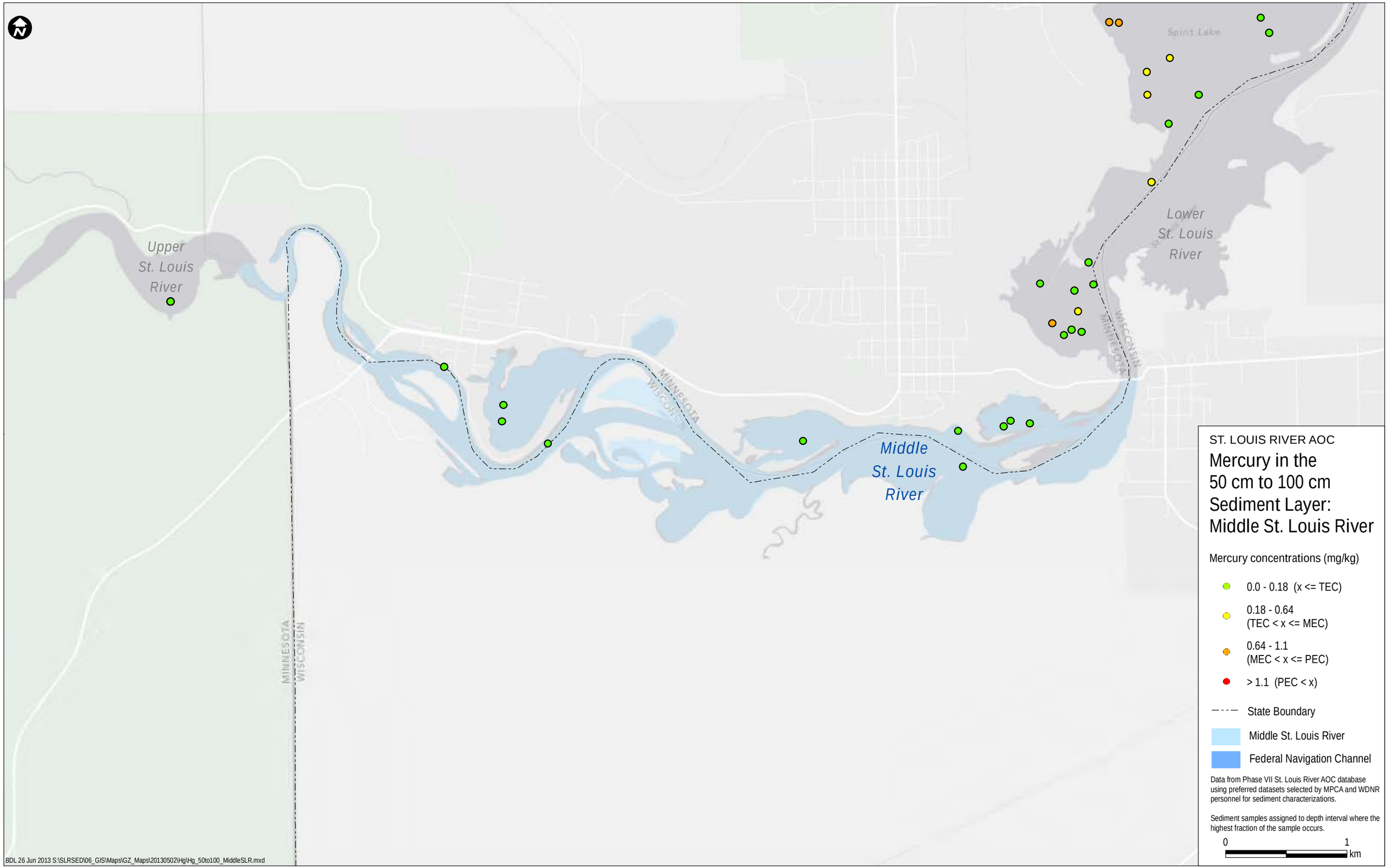

St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mercury in the 15 cm to 50 cm Sediment Layer: Lower St. Louis River
Mercury concentrations (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64 (TEC < x <= MEC)
0.64 - 1.1 (MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_15to50_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mercury in the 50 cm to 100 cm Sediment Layer: Lower St. Louis River
Mercury concentrations (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64 (TEC < x <= MEC)
0.64 - 1.1 (MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_50to100_LowerSLR.mxd


St. Louis
Bay
Lower
St. Louis
River
Middle
St. Louis
River
Pokegama Bay
WISCONSIN
MINNESOTA
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_over100_LowerSLR.mxd
ST. LOUIS RIVER AOC
Mercury in the >100 cm
Sediment Layer:
Lower St. Louis River
Mercury concentrations (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64
(TEC < x <= MEC)
0.64 - 1.1
(MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km


Upper
St. Louis
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mercury in
Surface Sediment:
Middle St. Louis River
Mercury concentrations in
surface samples (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64
(TEC < x <= MEC)
0.64 - 1.1
(MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_Surface_MiddleSLR.mxd


Upper
St. Louis
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mercury in the
15 cm to 50 cm
Sediment Layer:
Middle St. Louis River
Mercury concentrations (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64
(TEC < x <= MEC)
0.64 - 1.1
(MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_15to50_MiddleSLR.mxd


Upper
St. Louis
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Mercury in the
50 cm to 100 cm
Sediment Layer:
Middle St. Louis River
Mercury concentrations (mg/kg)
0.0 - 0.18 (x <= TEC)
0.18 - 0.64
(TEC < x <= MEC)
0.64 - 1.1
(MEC < x <= PEC)
> 1.1 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_50to100_MiddleSLR.mxd

Upper
St. Louis
River

Lower
St. Louis
River

Spirit Lake

Middle
St. Louis
River

MINNESOTA
WISCONSIN

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Mercury in the >100 cm Sediment Layer: Middle St. Louis River

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Middle St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_over100_MiddleSLR.mxd

ST. LOUIS RIVER AOC

# Mercury in Surface Sediment: Upper St. Louis River

Mercury concentrations in surface samples (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_Surface_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Mercury in the 15 cm to 50 cm Sediment Layer: Upper St. Louis River

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_15to50_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Mercury in the 50 cm to 100 cm Sediment Layer: Upper St. Louis River

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

Upper St. Louis River

Middle St. Louis River

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_50to100_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Mercury in the >100 cm Sediment Layer: Upper St. Louis River

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

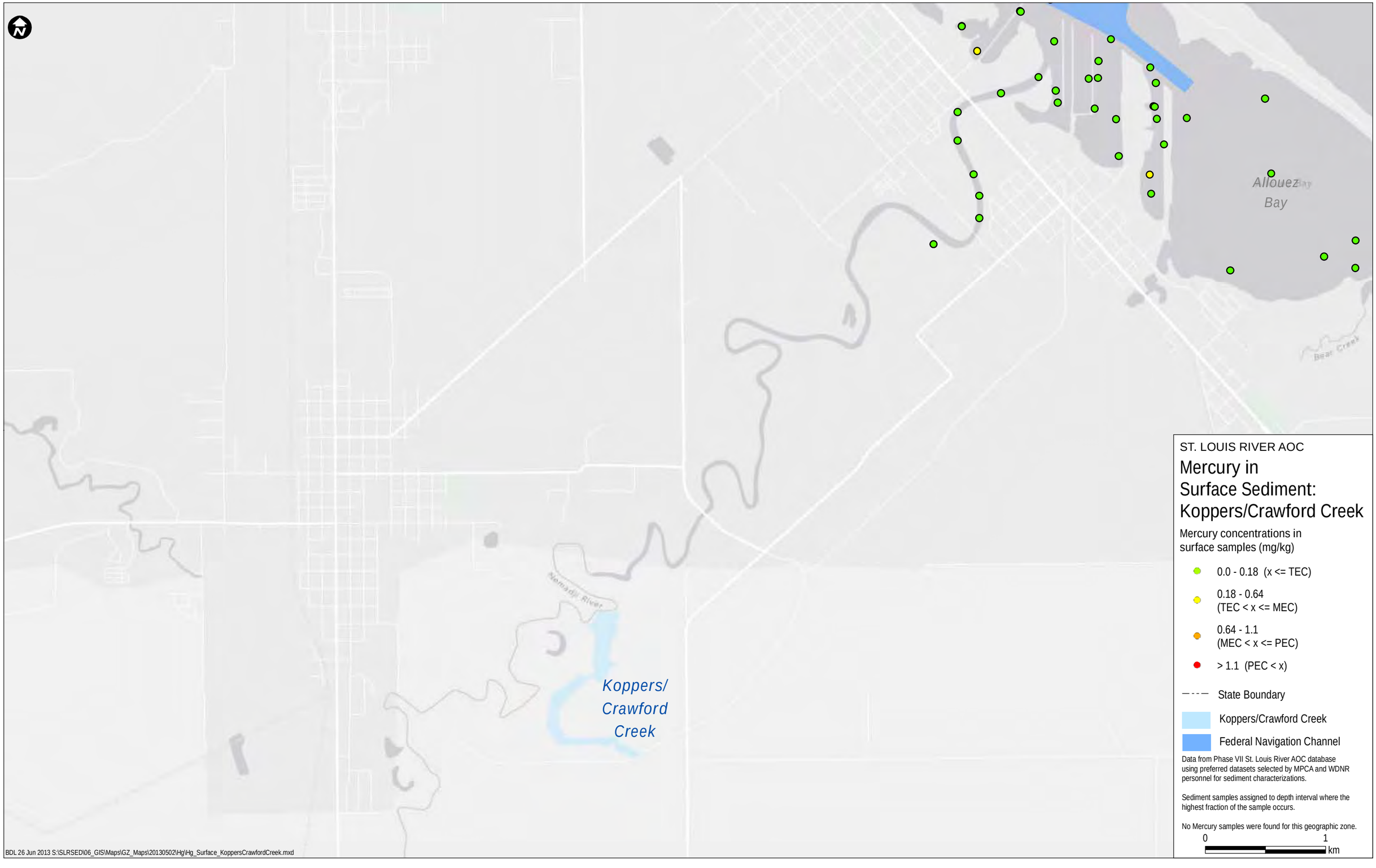
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

Upper St. Louis River

Middle St. Louis River

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_over100_UpperSLR.mxd




ST. LOUIS RIVER AOC

# Mercury in Surface Sediment: Koppers/Crawford Creek

Mercury concentrations in surface samples (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

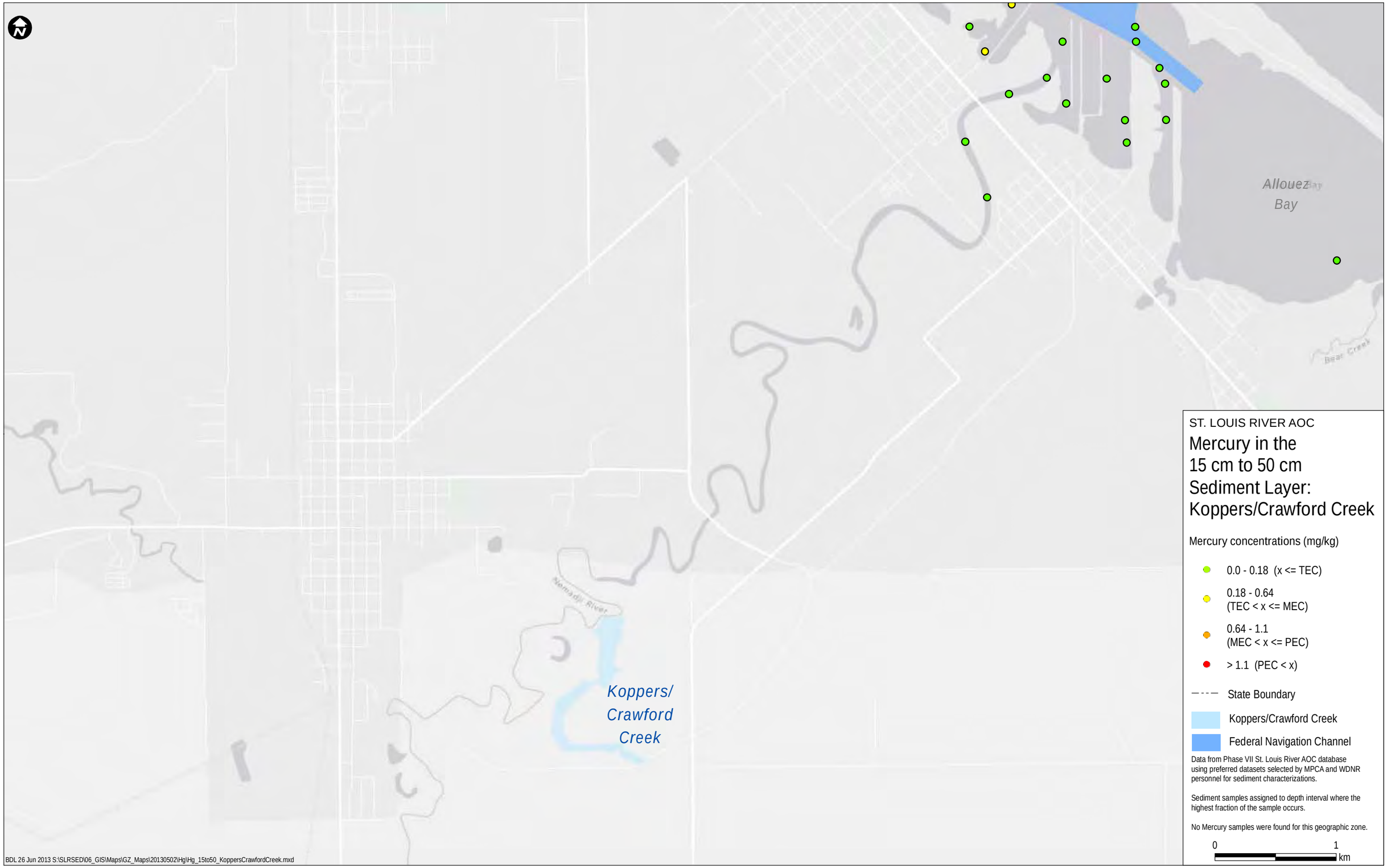
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mercury samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_Surface_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

# Mercury in the 15 cm to 50 cm Sediment Layer: Koppers/Crawford Creek

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

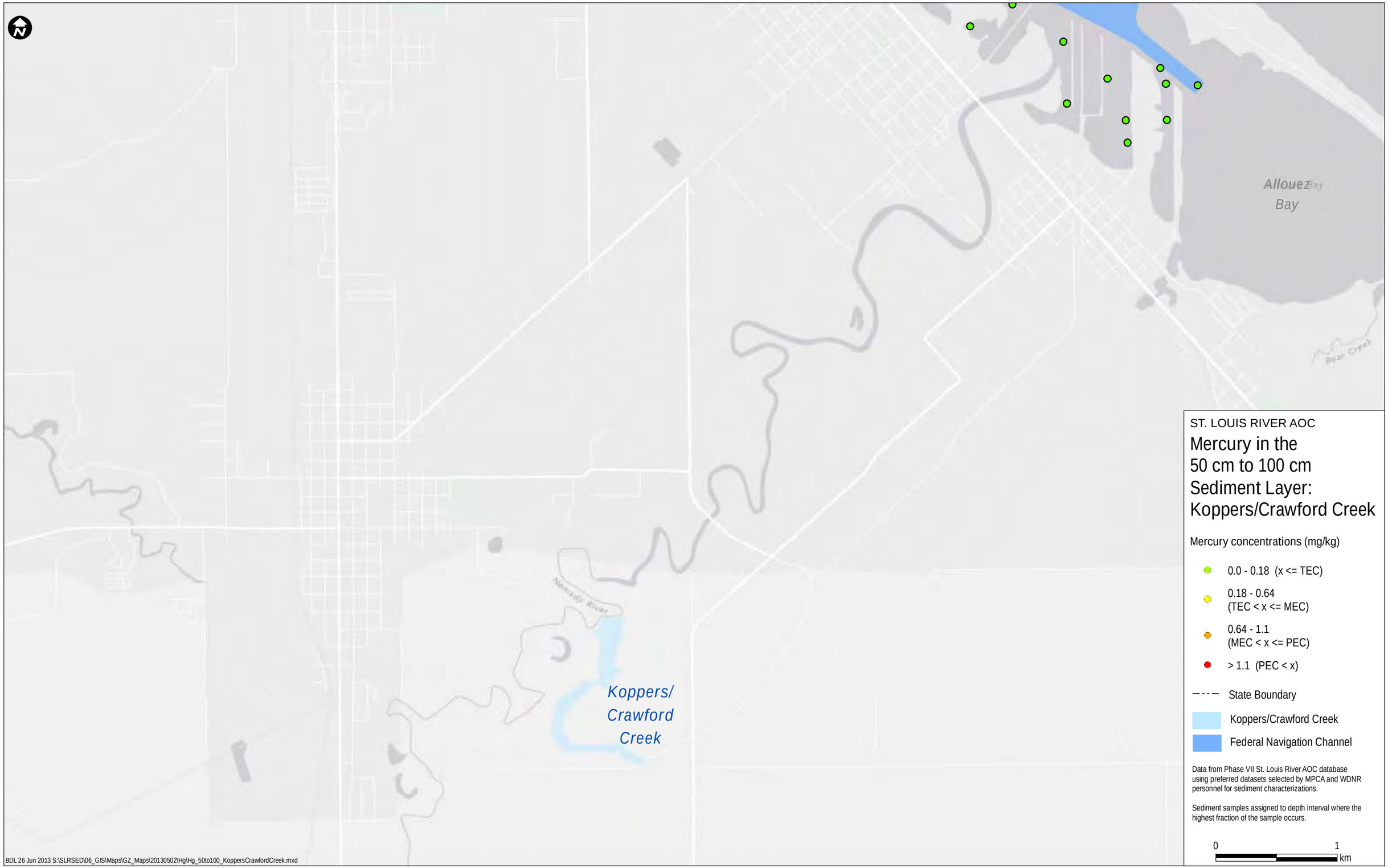
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Mercury samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_15to50_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

# Mercury in the 50 cm to 100 cm Sediment Layer: Koppers/Crawford Creek

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Koppers/Crawford Creek

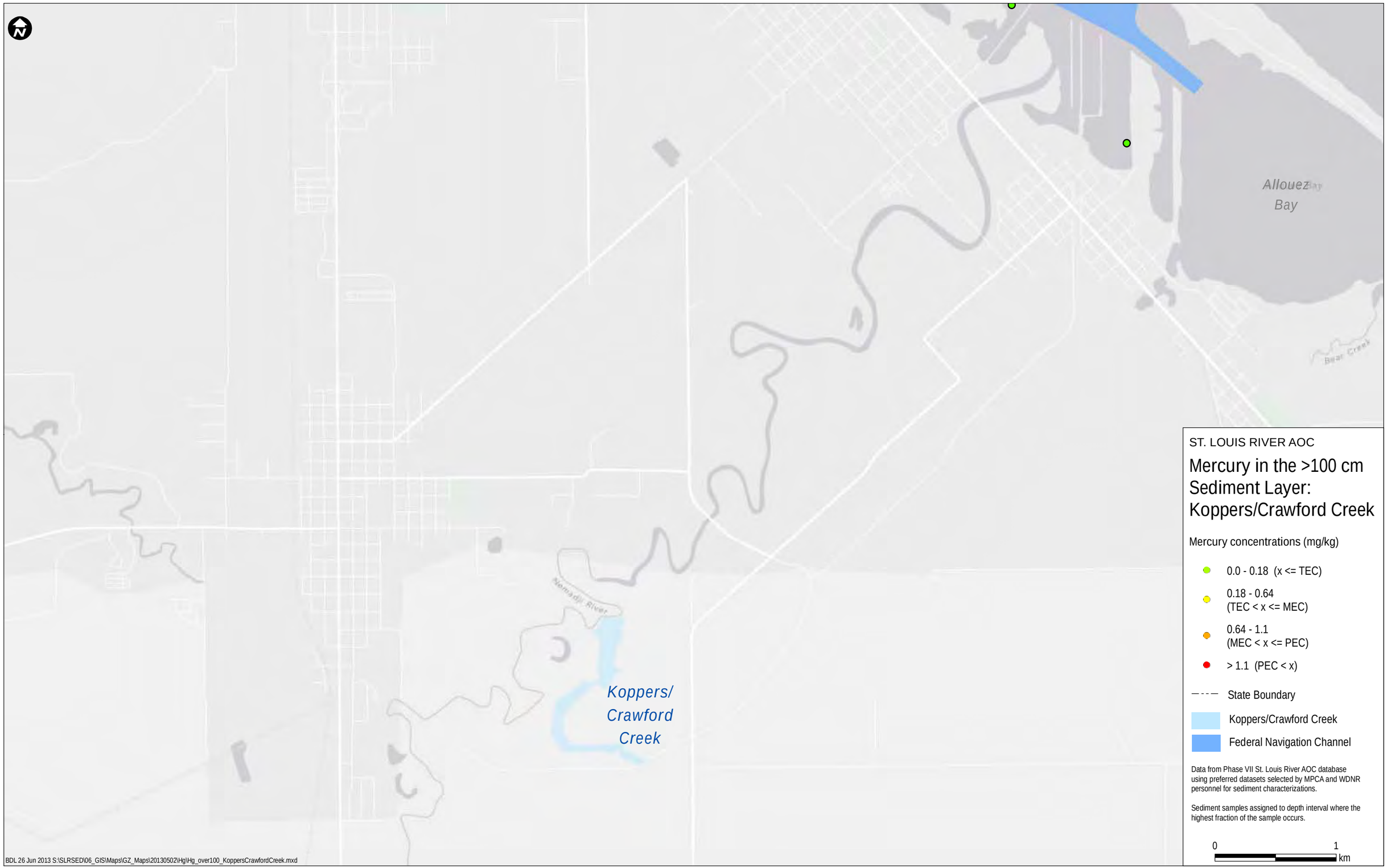
Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_50to100_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

## Mercury in the >100 cm Sediment Layer: Koppers/Crawford Creek

Mercury concentrations (mg/kg)

- 0.0 - 0.18 (x <= TEC)
- 0.18 - 0.64 (TEC < x <= MEC)
- 0.64 - 1.1 (MEC < x <= PEC)
- > 1.1 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Hg\Hg_over100_KoppersCrawfordCreek.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

ST. LOUIS RIVER AOC

## Total PAHs in Surface Sediment: Geographic Zones

Total PAH concentrations in surface samples (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 2 3 km

MINNESOTA WISCONSIN



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Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Total PAHs in the 15 cm to 50 cm Sediment Layer: Geographic Zones

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 2 3 km

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Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

# Total PAHs in the 50 cm to 100 cm Sediment Layer: Geographic Zones

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

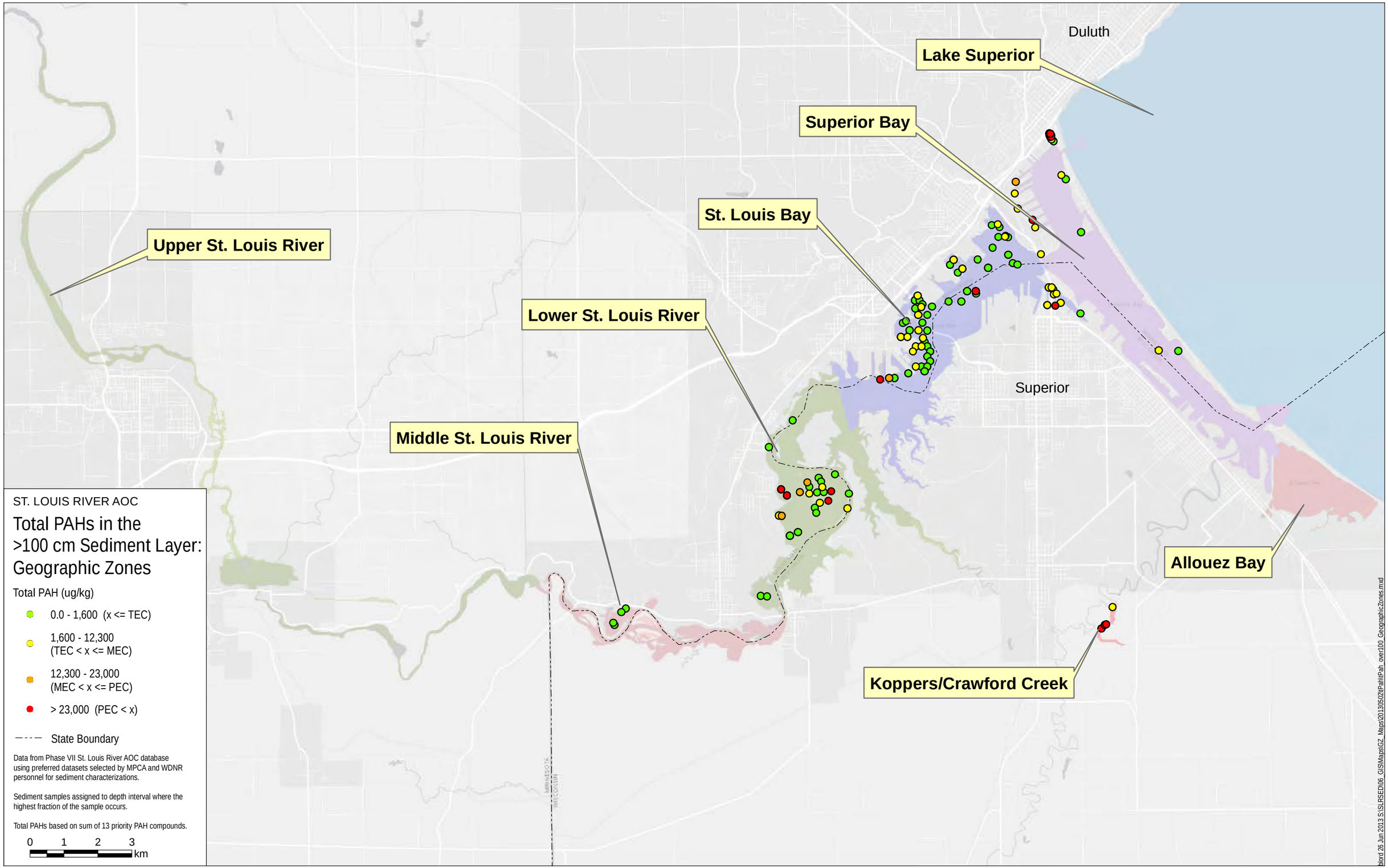
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 2 3 km



mxd 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\PahtPah_50to100_GeographicZones.mxd


Duluth
Lake Superior
Superior Bay
St. Louis Bay
Upper St. Louis River
Lower St. Louis River
Middle St. Louis River
Superior
Allouez Bay
Koppers/Crawford Creek
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Total PAHs in the
>100 cm Sediment Layer:
Geographic Zones
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300
(TEC < x <= MEC)
12,300 - 23,000
(MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0 1 2 3
km
bord 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\PahtPah_over100_GeographicZones.mxd

ST. LOUIS RIVER AOC

# Total PAHs in Surface Sediment: Allouez Bay

Total PAH concentrations in surface samples (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 km

Superior Bay

Lake Superior

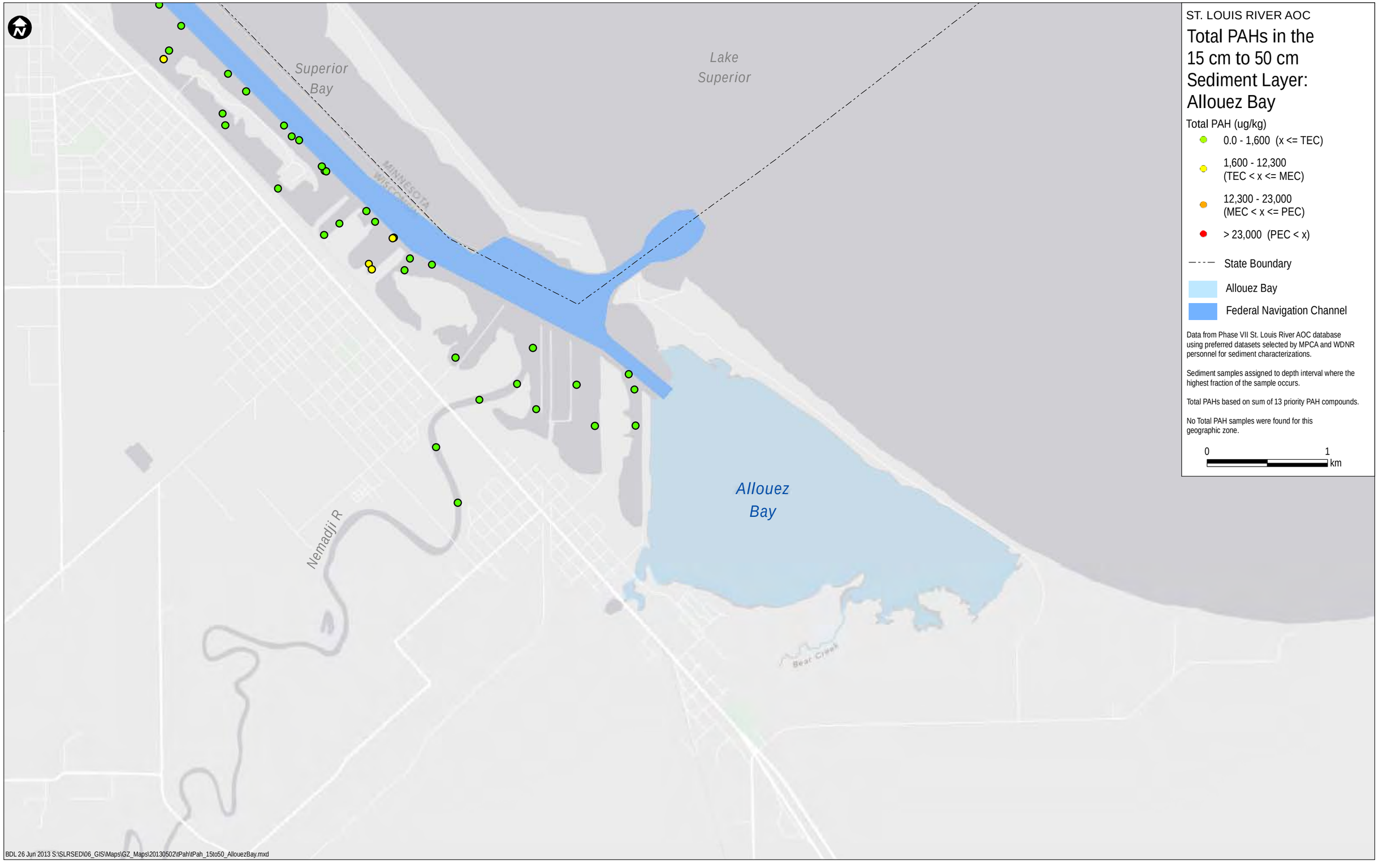
MINNESOTA WISCONSIN

Allouez Bay

Nemadji R

Bear Creek

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_Surface_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Total PAHs in the 15 cm to 50 cm Sediment Layer: Allouez Bay

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Allouez Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

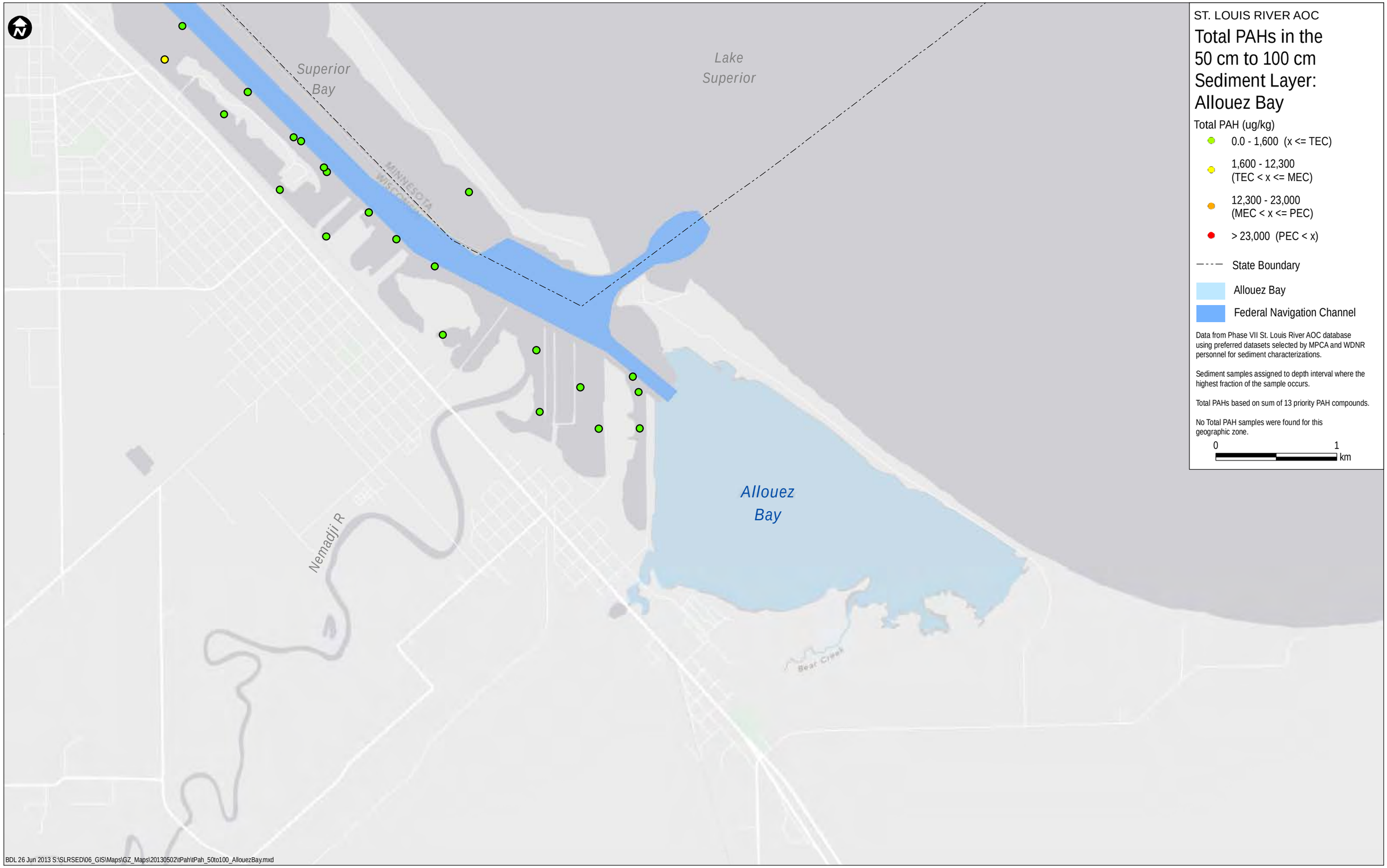
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

No Total PAH samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_15to50_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Total PAHs in the 50 cm to 100 cm Sediment Layer: Allouez Bay

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Allouez Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

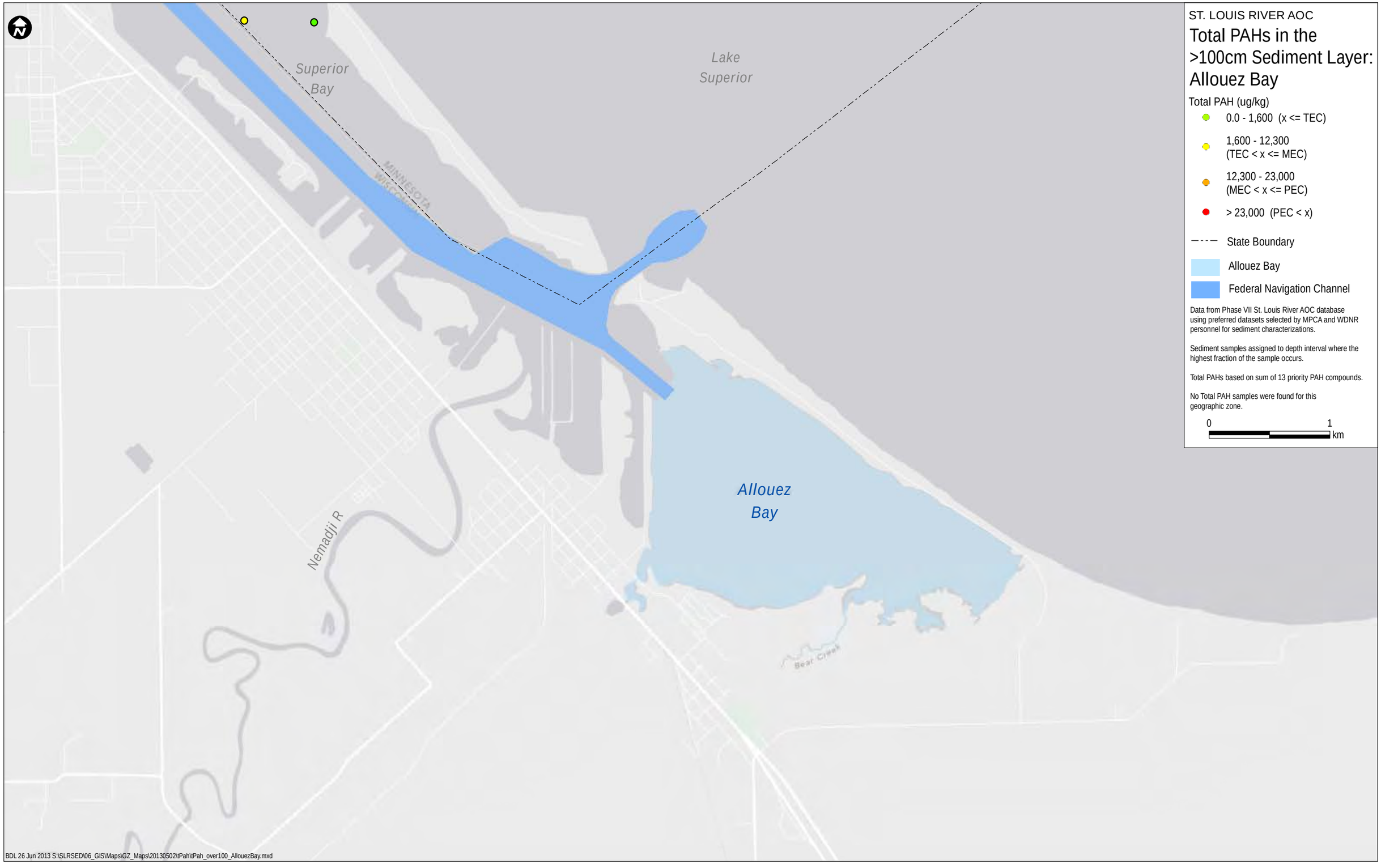
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

No Total PAH samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_50to100_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Total PAHs in the >100cm Sediment Layer: Allouez Bay

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

No Total PAH samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_over100_AllouezBay.mxd

ST. LOUIS RIVER AOC

# Total PAHs in Surface Sediment: Superior Bay

Total PAH concentrations in surface samples (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)
- State Boundary
- Superior Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 km

Lake Superior

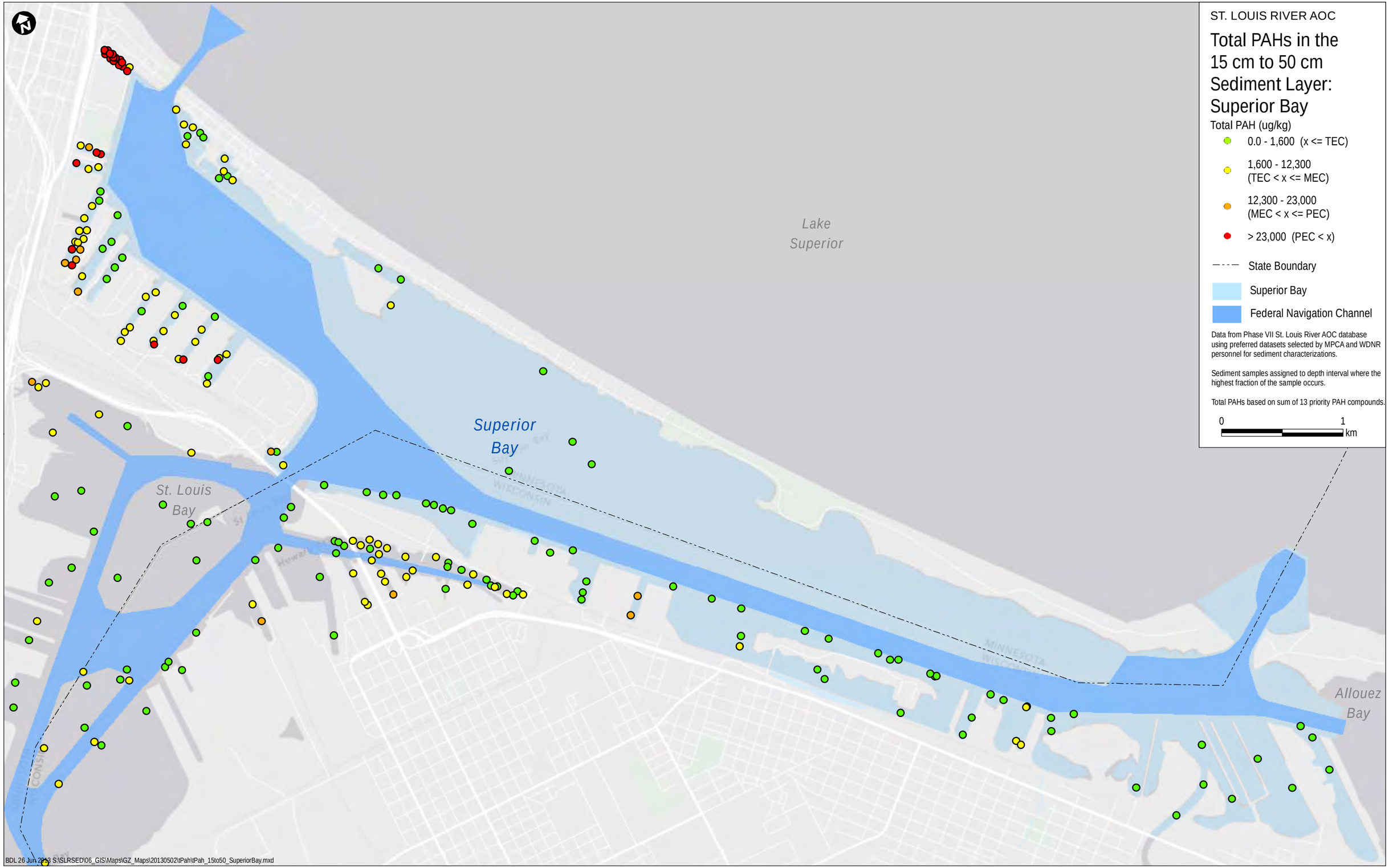
Superior Bay

St. Louis Bay

Allouez Bay

MINNESOTA WISCONSIN

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_Surface_SuperiorBay.mxd




ST. LOUIS RIVER AOC

# Total PAHs in the 15 cm to 50 cm Sediment Layer: Superior Bay

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_15to50_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Total PAHs in the 50 cm to 100 cm Sediment Layer: Superior Bay

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 km

Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_50to100_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Total PAHs in the >100 cm Sediment Layer: Superior Bay

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 km

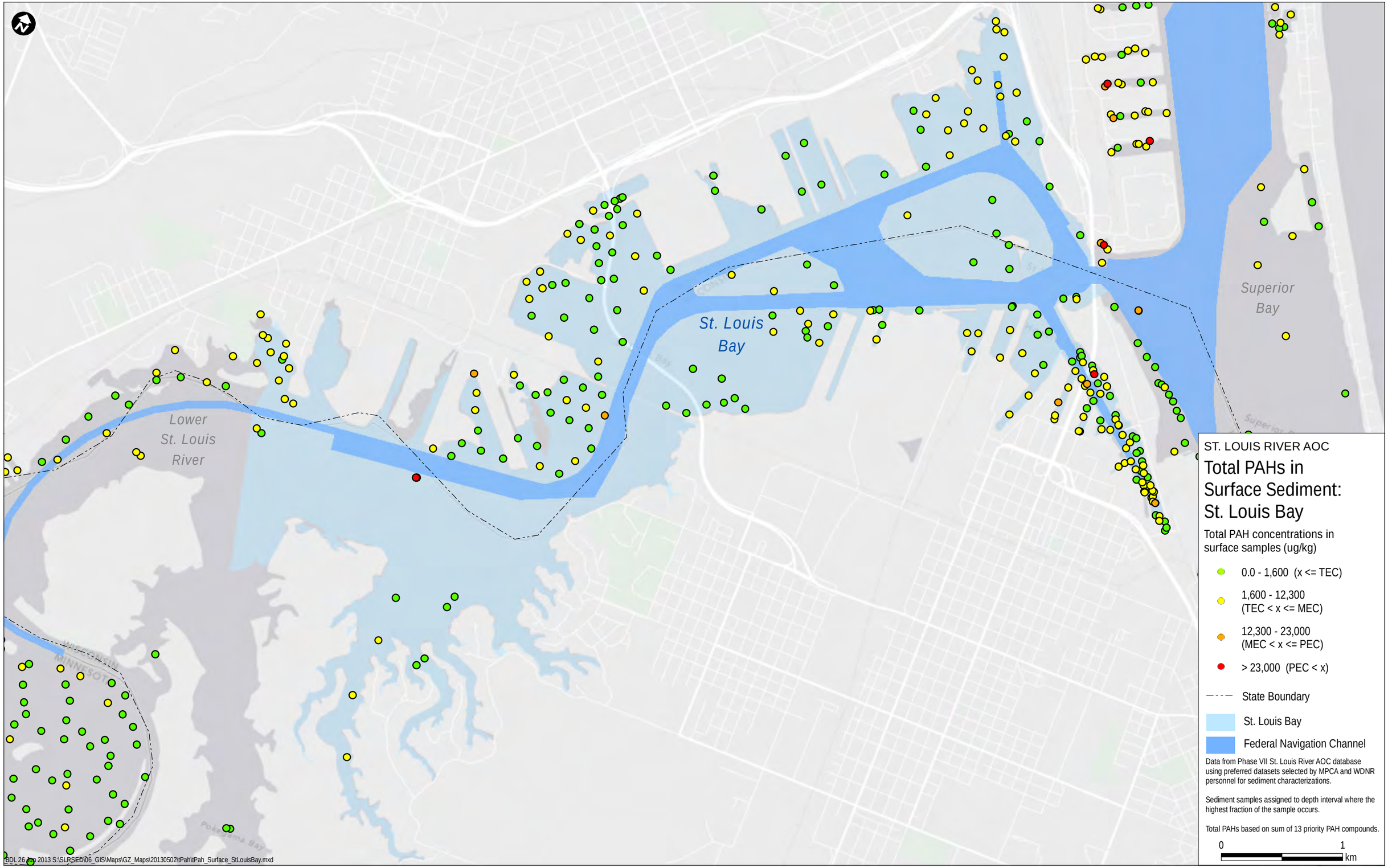
Lake Superior

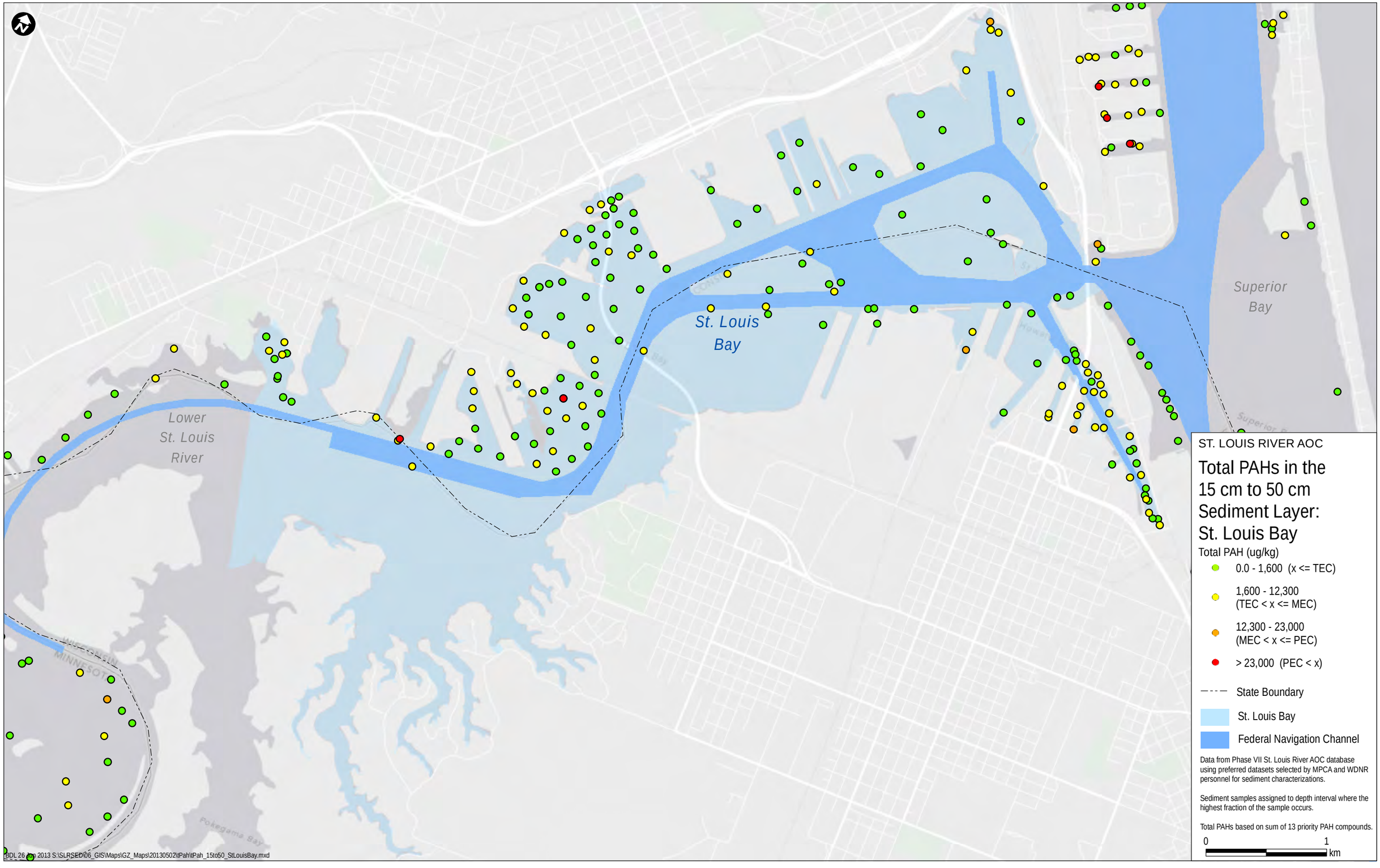
Superior Bay

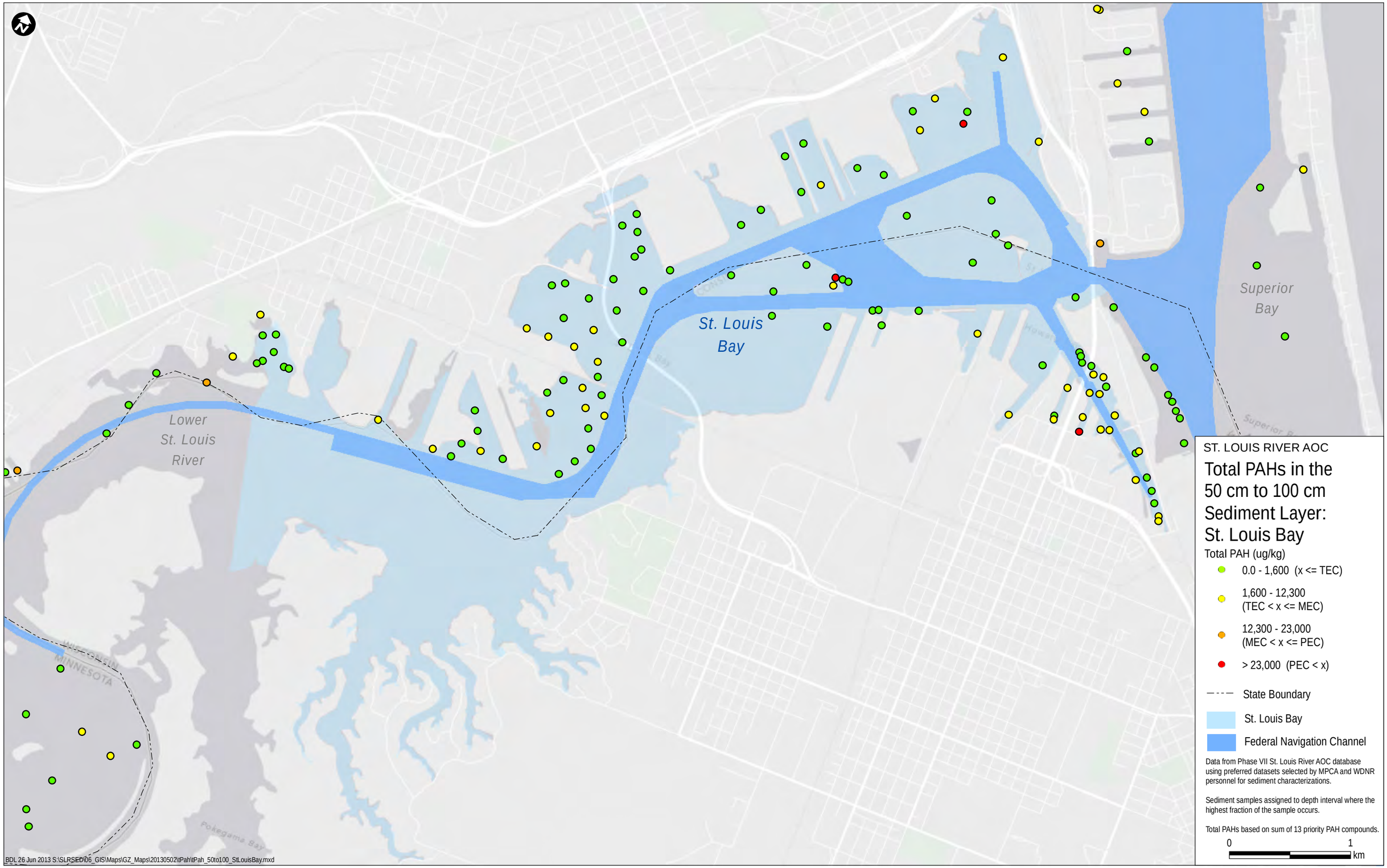
St. Louis Bay

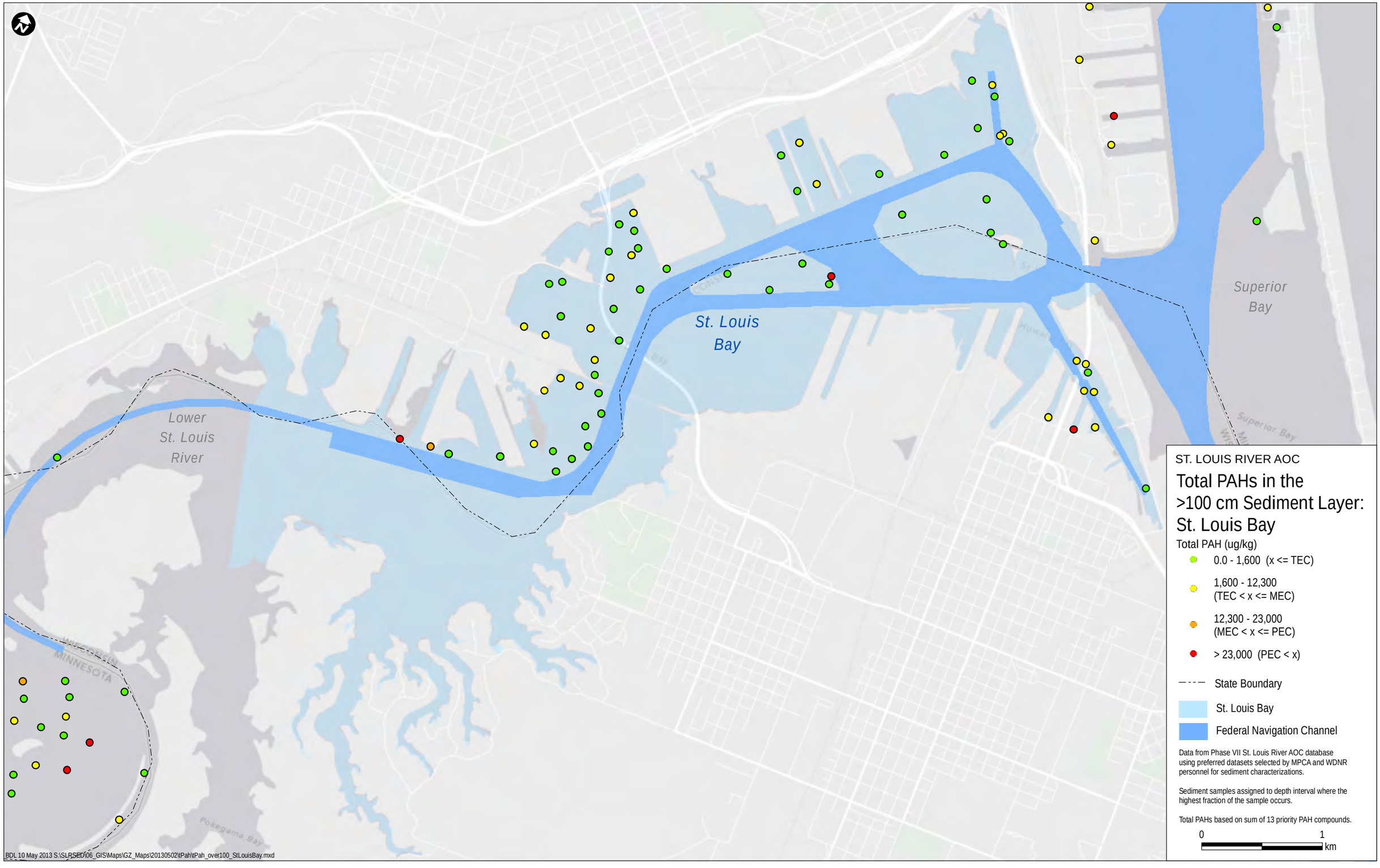
Allouez Bay

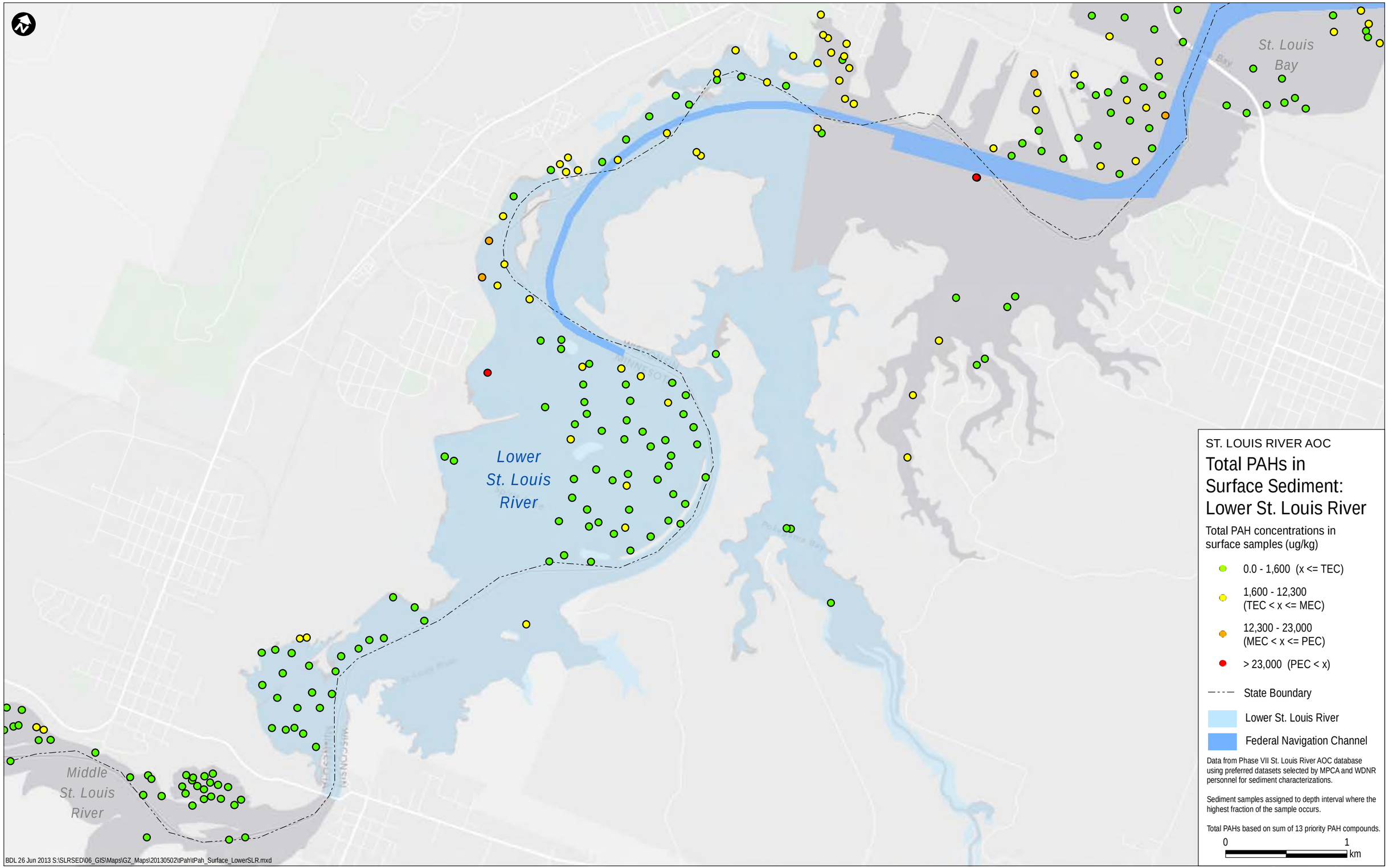
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_over100_SuperiorBay.mxd


Lower
St. Louis
River
St. Louis
Bay
Superior
Bay
Pokegama Bay
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PAHs in
Surface Sediment:
St. Louis Bay
Total PAH concentrations in
surface samples (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300
(TEC < x <= MEC)
12,300 - 23,000
(MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
GDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_Surface_StLouisBay.mxd


St. Louis
Bay
Superior
Bay
Lower
St. Louis
River
Pokegama Bay
ST. LOUIS RIVER AOC
Total PAHs in the
15 cm to 50 cm
Sediment Layer:
St. Louis Bay
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300
(TEC < x <= MEC)
12,300 - 23,000
(MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_15to50_StLouisBay.mxd


St. Louis Bay
Superior Bay
Lower St. Louis River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Total PAHs in the 50 cm to 100 cm Sediment Layer: St. Louis Bay
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300 (TEC < x <= MEC)
12,300 - 23,000 (MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_50to100_StLouisBay.mxd


St. Louis Bay
Superior Bay
Lower St. Louis River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Total PAHs in the >100 cm Sediment Layer: St. Louis Bay
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300 (TEC < x <= MEC)
12,300 - 23,000 (MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 10 May 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_over100_StLouisBay.mxd




ST. LOUIS RIVER AOC

# Total PAHs in Surface Sediment: Lower St. Louis River

Total PAH concentrations in surface samples (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)
- State Boundary
- Lower St. Louis River
- Federal Navigation Channel

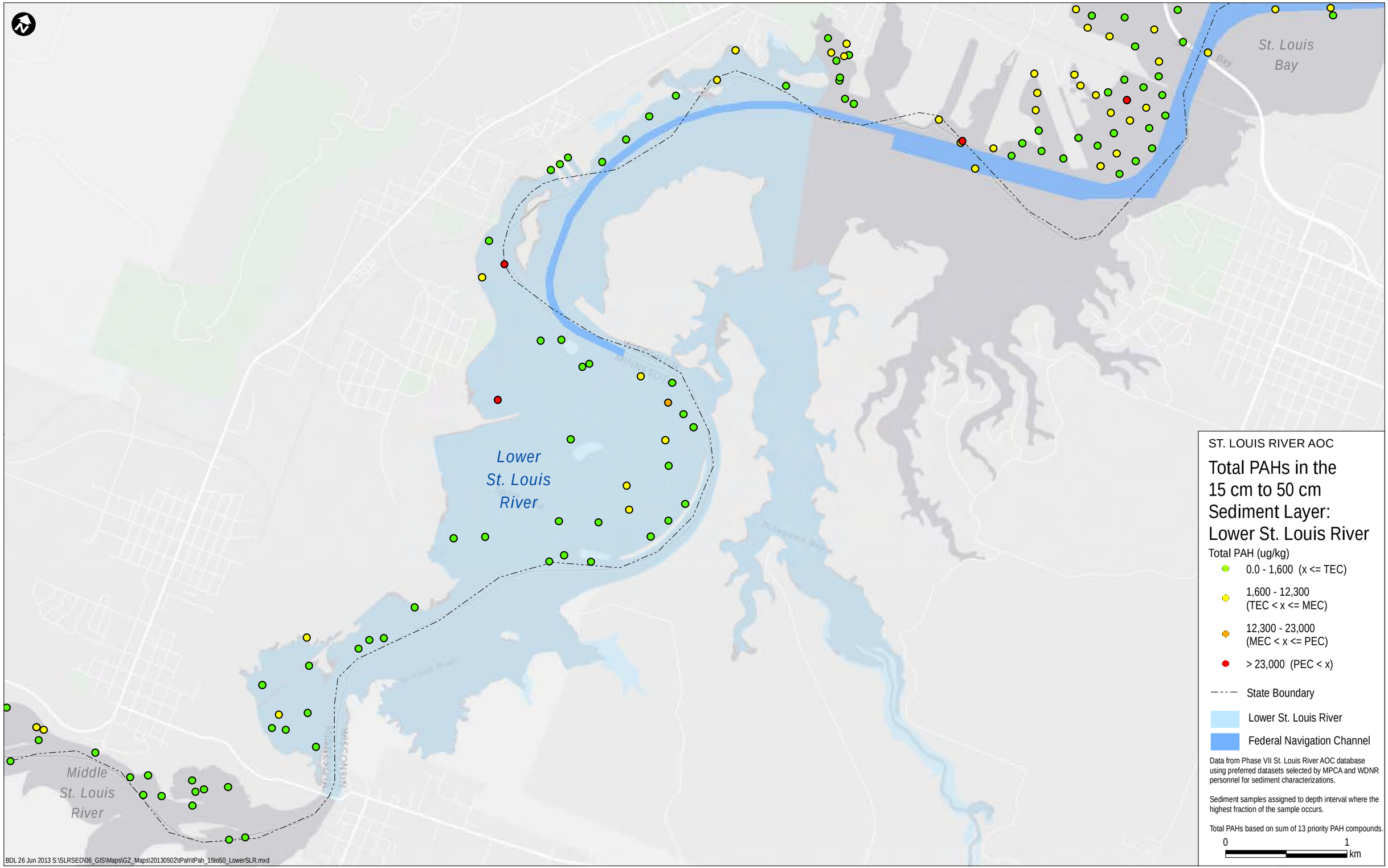
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

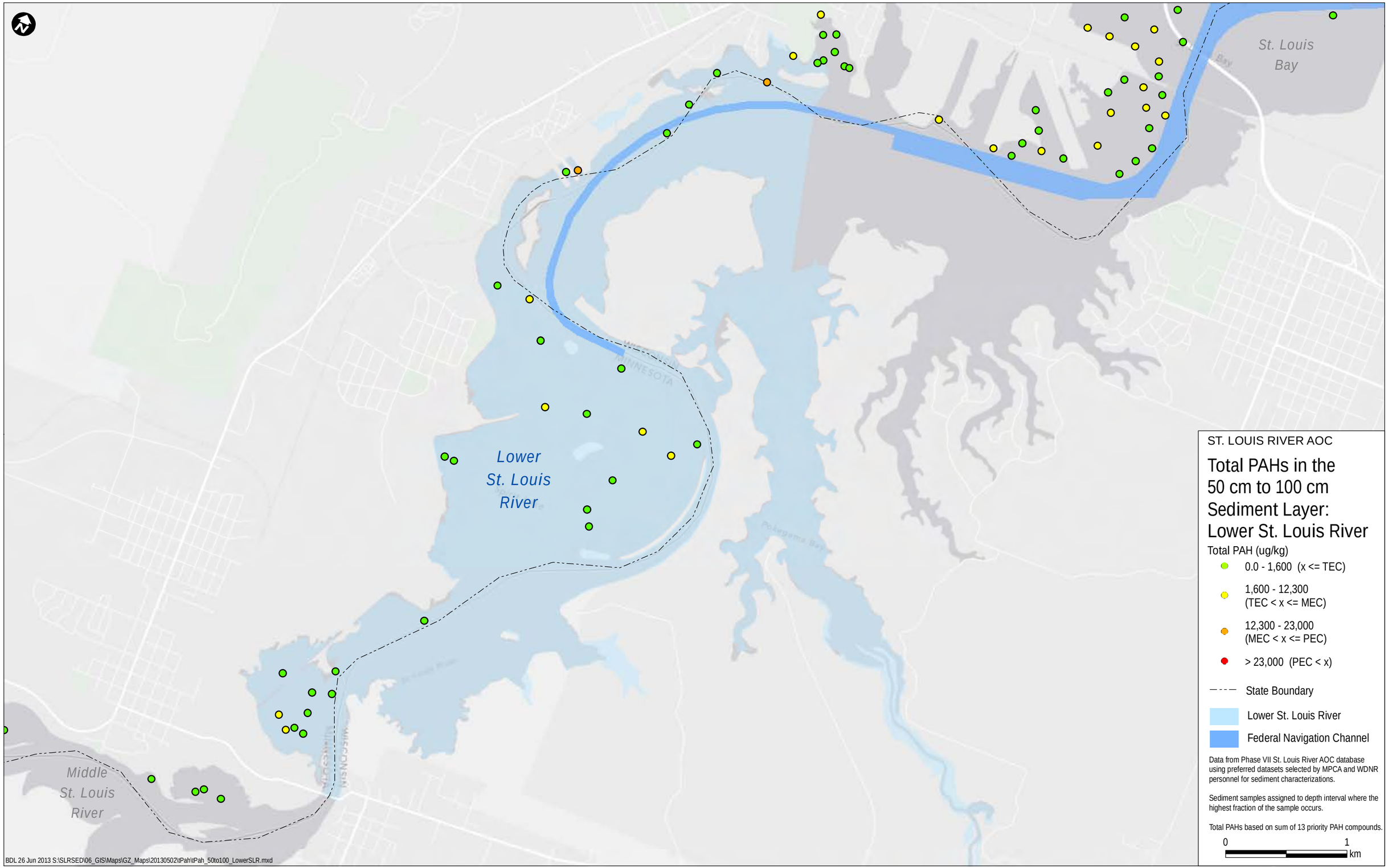
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

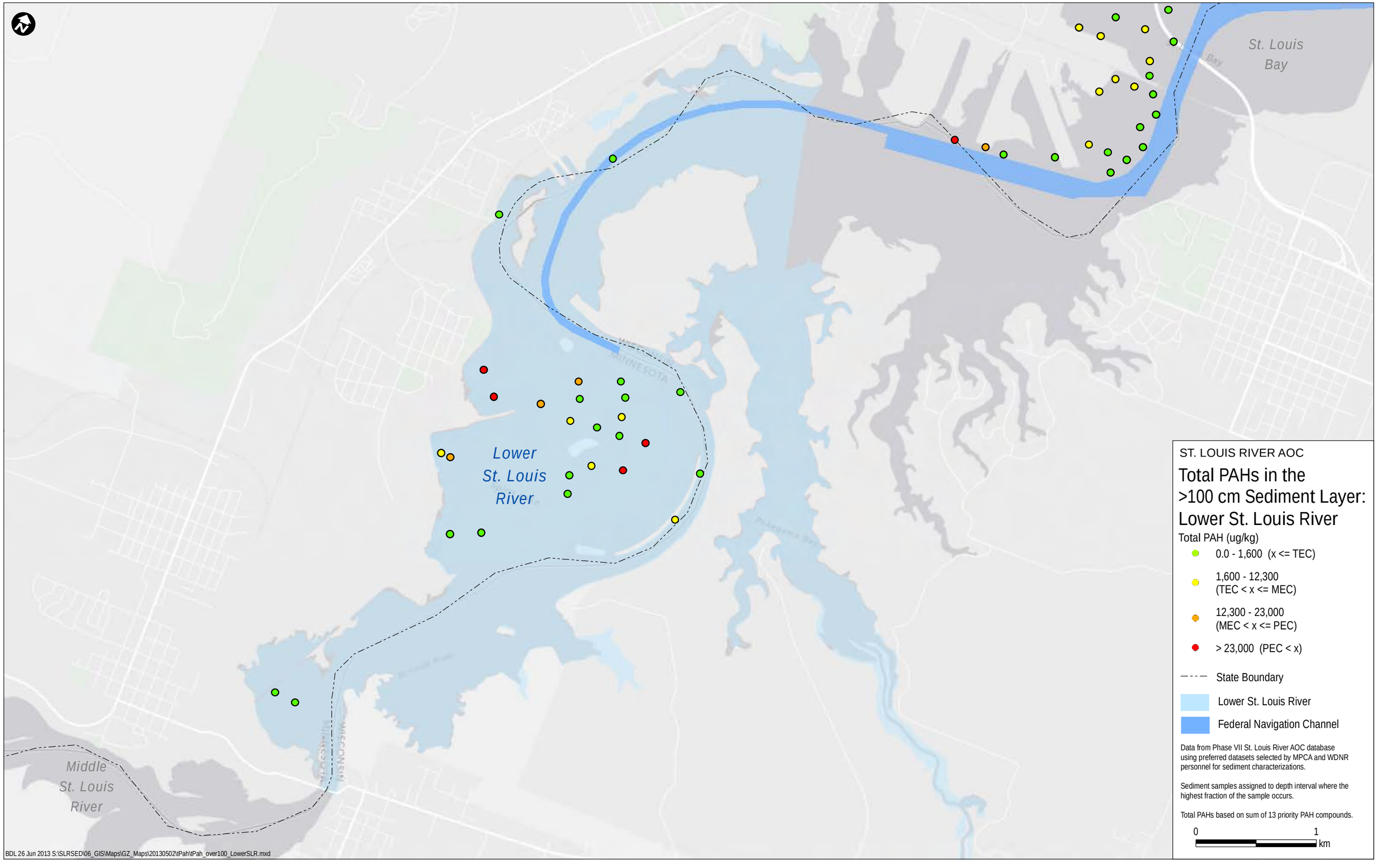
Total PAHs based on sum of 13 priority PAH compounds.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_Surface_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PAHs in the 15 cm to 50 cm Sediment Layer: Lower St. Louis River
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300 (TEC < x <= MEC)
12,300 - 23,000 (MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_15to50_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PAHs in the 50 cm to 100 cm Sediment Layer: Lower St. Louis River
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300 (TEC < x <= MEC)
12,300 - 23,000 (MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_50to100_LowerSLR.mxd




ST. LOUIS RIVER AOC

## Total PAHs in the >100 cm Sediment Layer: Lower St. Louis River

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)
- State Boundary
- Lower St. Louis River
- Federal Navigation Channel

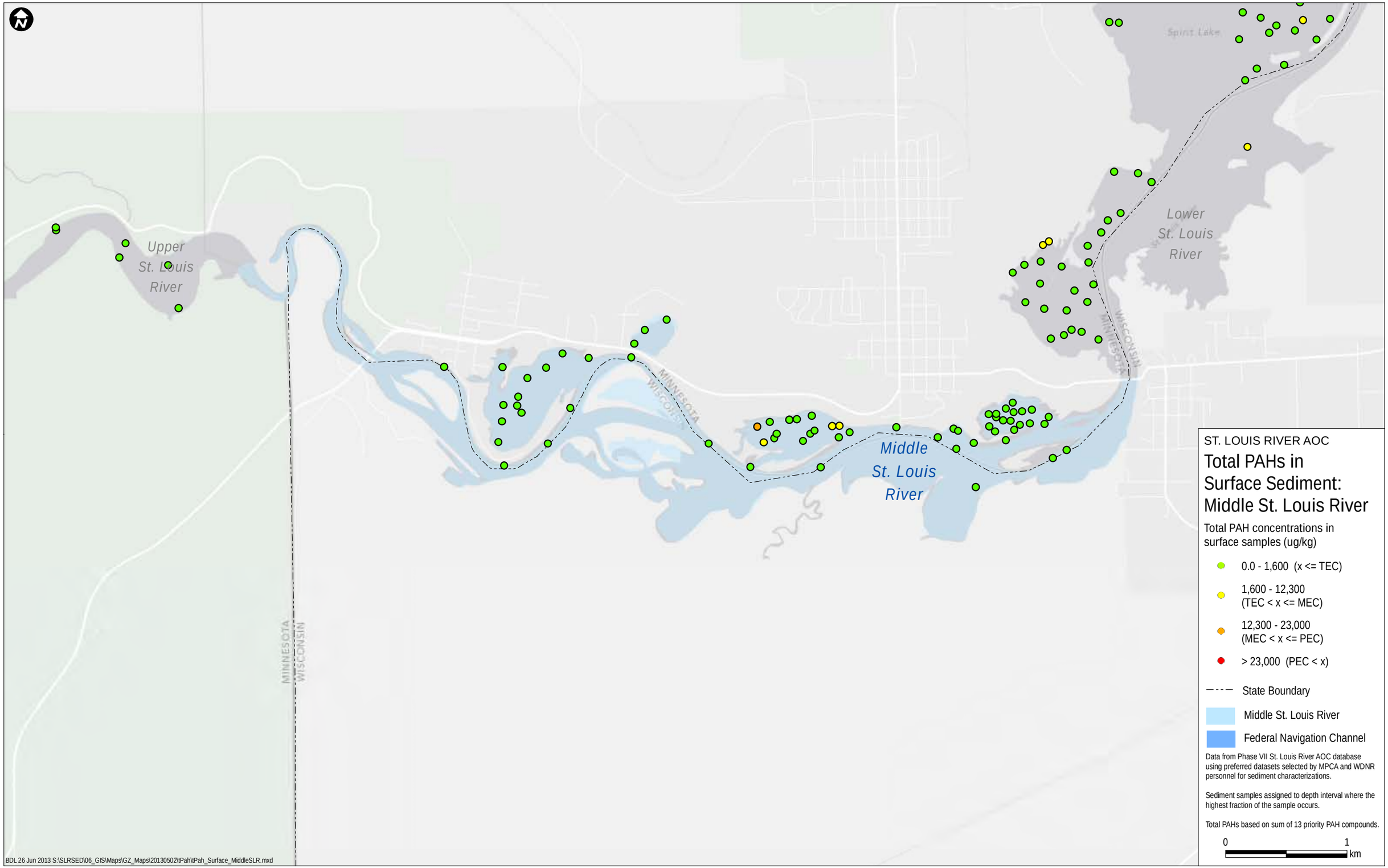
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

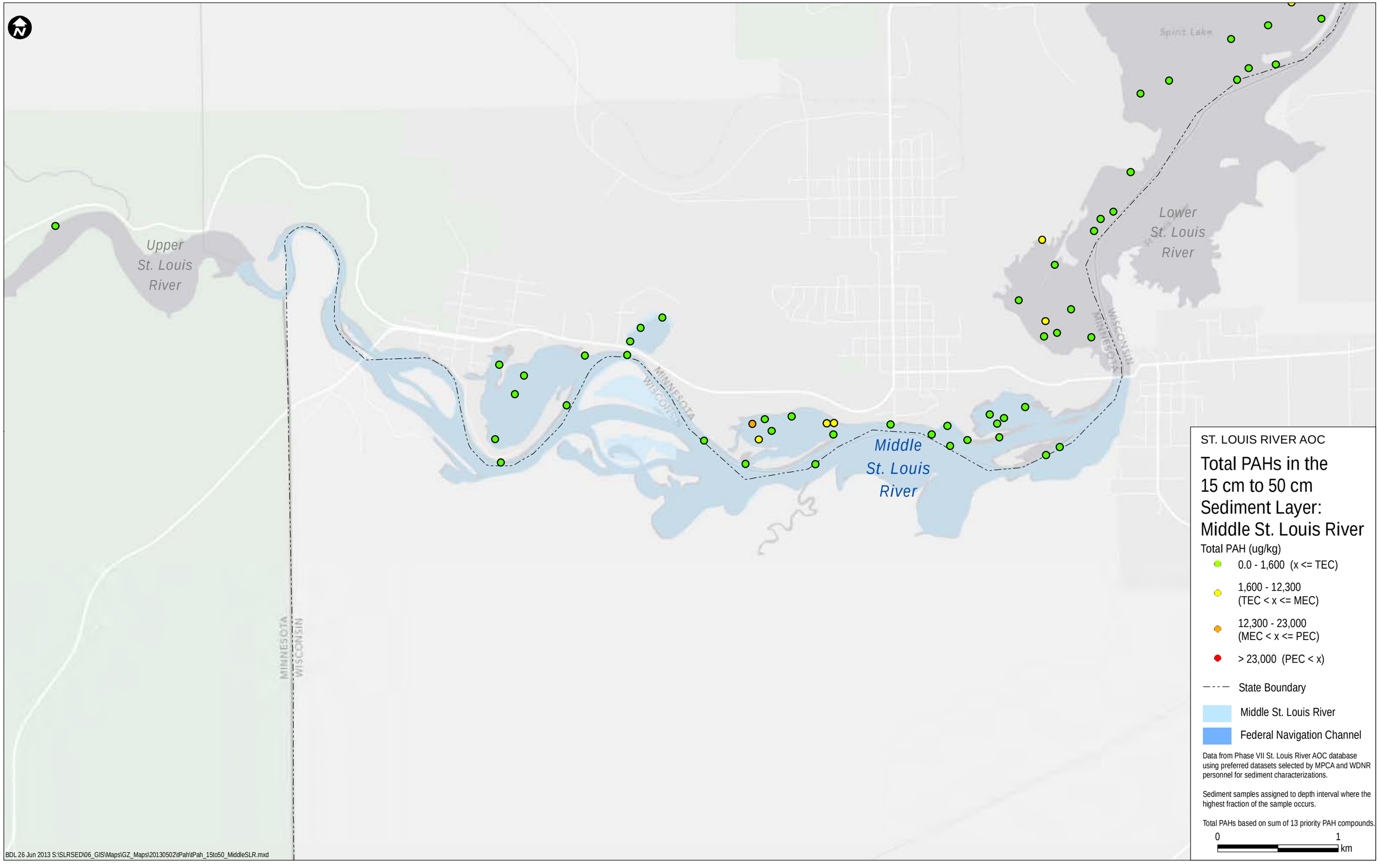
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

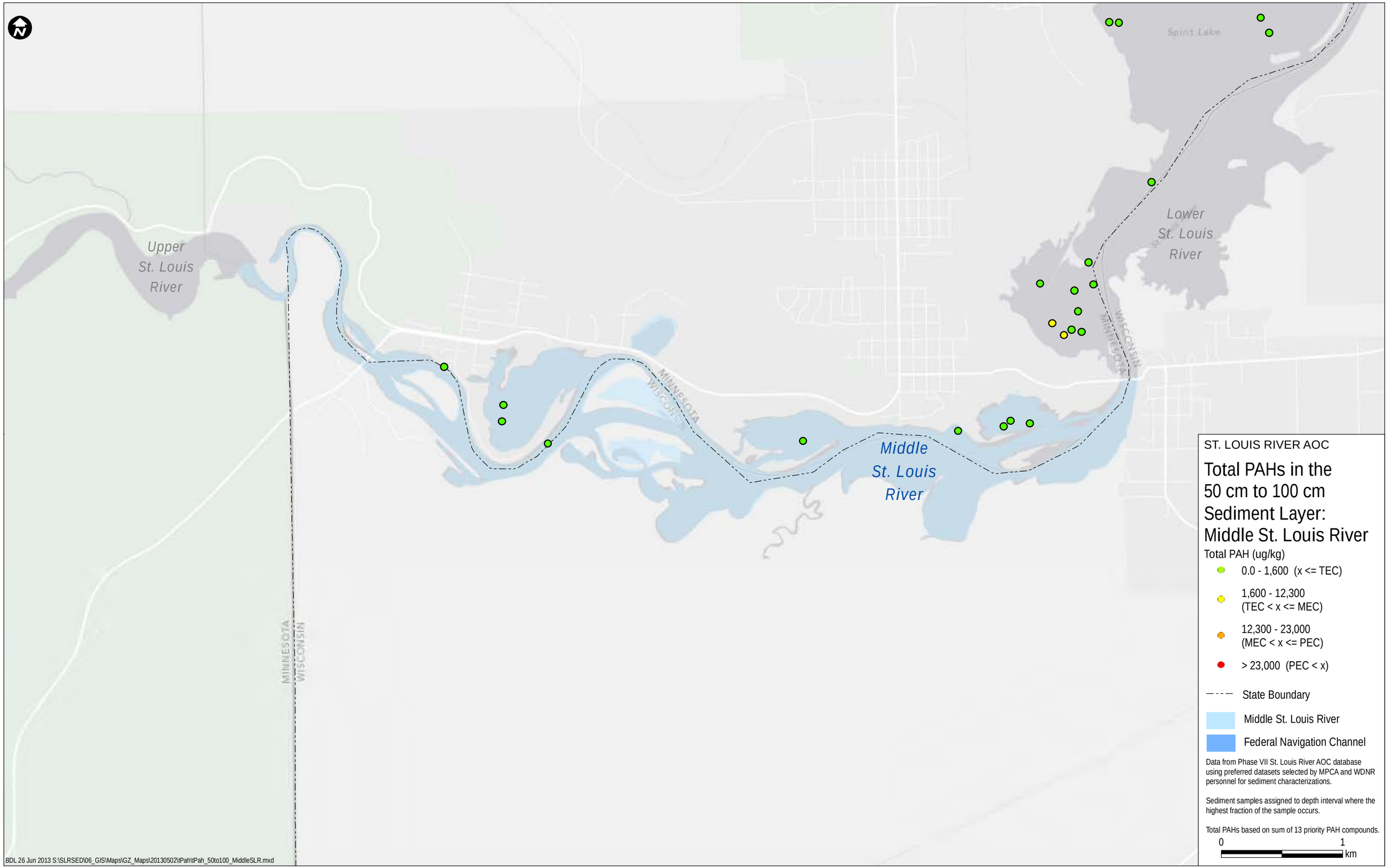
Total PAHs based on sum of 13 priority PAH compounds.

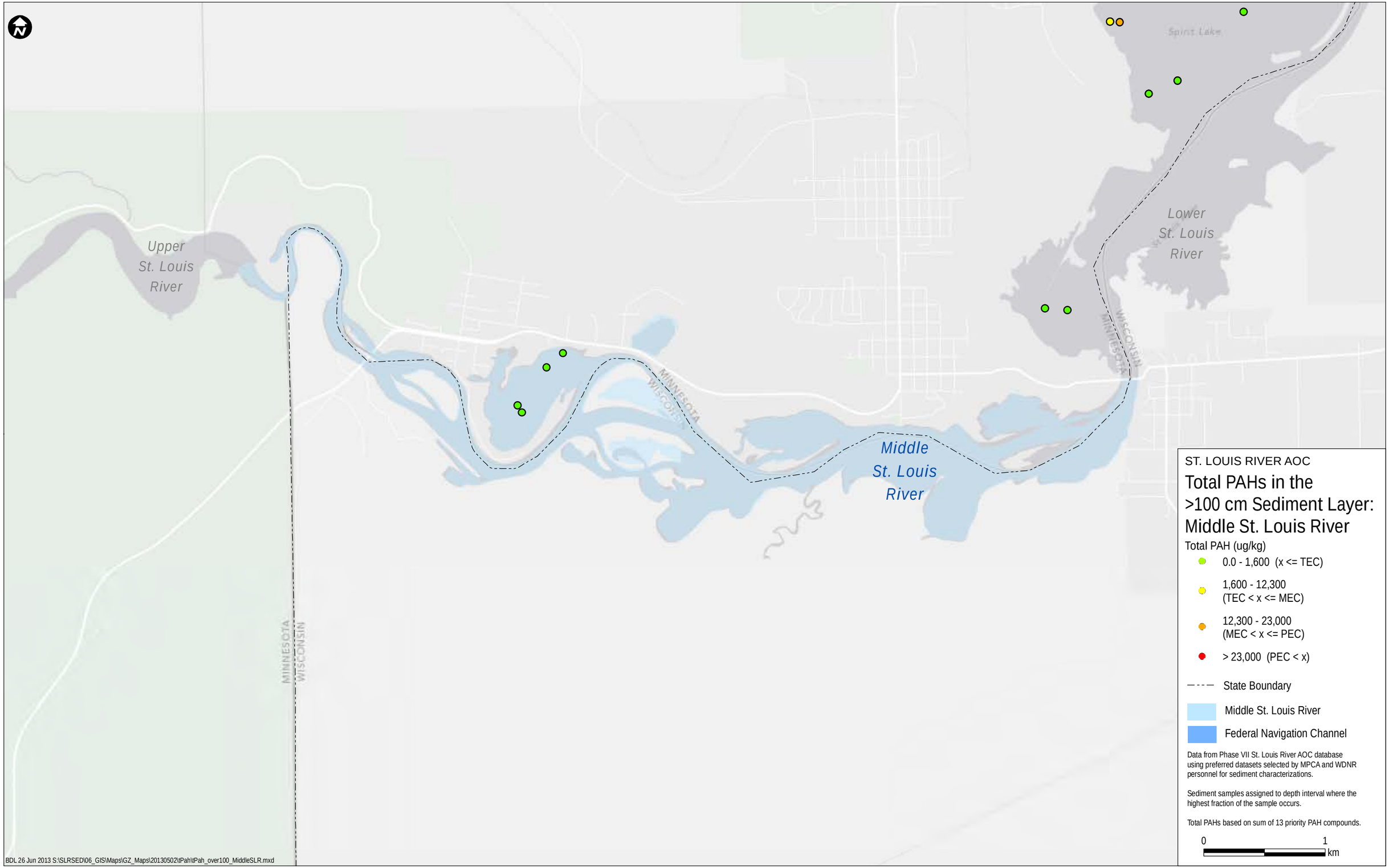
0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_over100_LowerSLR.mxd


Upper
St. Louis
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PAHs in Surface Sediment: Middle St. Louis River
Total PAH concentrations in surface samples (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300 (TEC < x <= MEC)
12,300 - 23,000 (MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_Surface_MiddleSLR.mxd


Upper
St. Louis
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PAHs in the
15 cm to 50 cm
Sediment Layer:
Middle St. Louis River
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300
(TEC < x <= MEC)
12,300 - 23,000
(MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_15to50_MiddleSLR.mxd


Upper
St. Louis
River
Lower
St. Louis
River
Middle
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Total PAHs in the
50 cm to 100 cm
Sediment Layer:
Middle St. Louis River
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300
(TEC < x <= MEC)
12,300 - 23,000
(MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_50to100_MiddleSLR.mxd


Upper
St. Louis
River
Spirit Lake
Lower
St. Louis
River
MINNESOTA
WISCONSIN
Middle
St. Louis
River
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Total PAHs in the
>100 cm Sediment Layer:
Middle St. Louis River
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300
(TEC < x <= MEC)
12,300 - 23,000
(MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database
using preferred datasets selected by MPCA and WDNR
personnel for sediment characterizations.
Sediment samples assigned to depth interval where the
highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_over100_MiddleSLR.mxd

ST. LOUIS RIVER AOC

# Total PAHs in Surface Sediment: Upper St. Louis River

Total PAH concentrations in surface samples (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_Surface_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Total PAHs in the 15 cm to 50 cm Sediment Layer: Upper St. Louis River

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 2 km

Upper St. Louis River

Middle St. Louis River

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_15to50_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Total PAHs in the 50 cm to 100 cm Sediment Layer: Upper St. Louis River

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 2 km

Upper St. Louis River

Middle St. Louis River

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_50to100_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Total PAHs in the >100 cm Sediment Layer: Upper St. Louis River

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

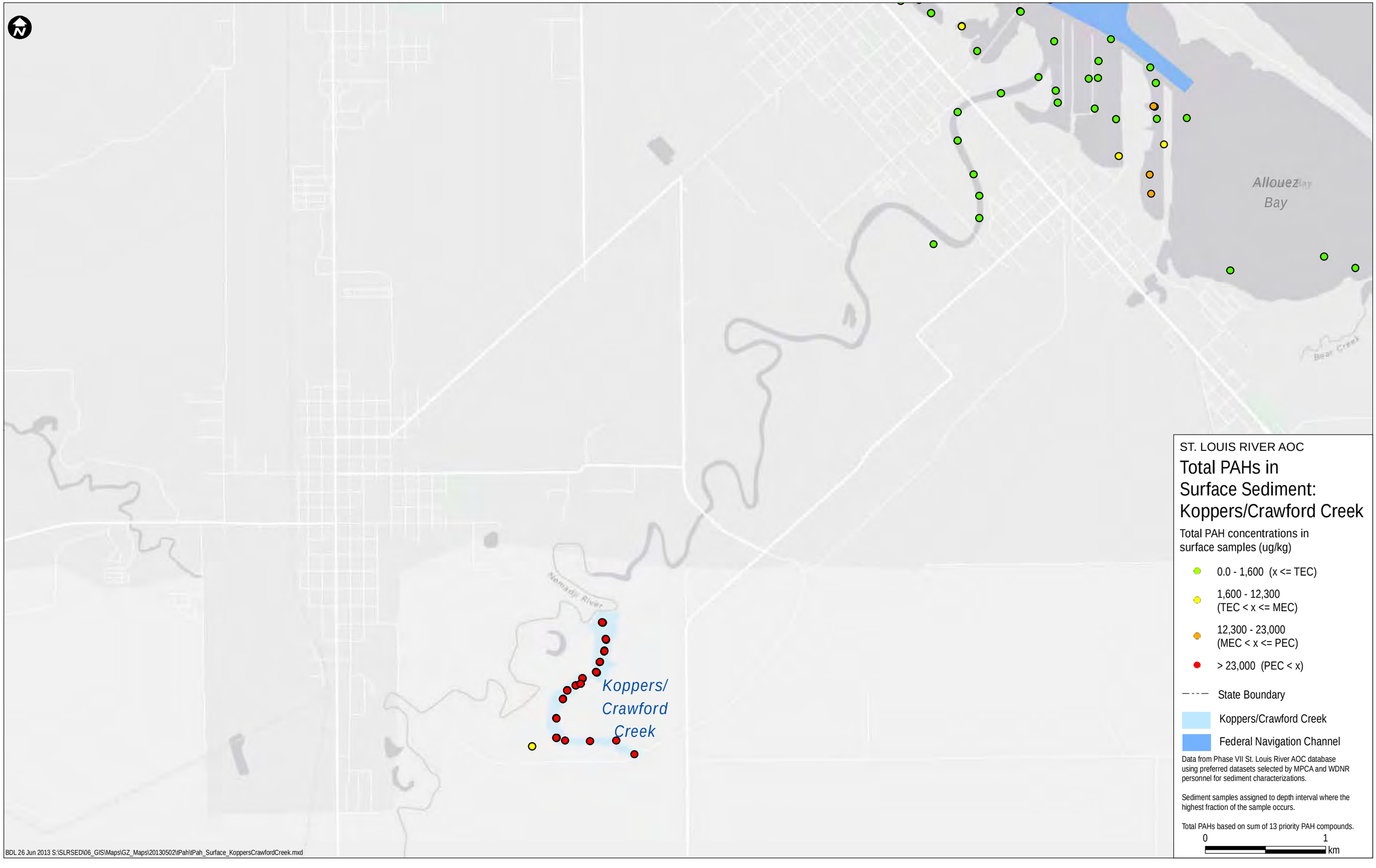
No Total PAH samples were found for this geographic zone.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_over100_UpperSLR.mxd




ST. LOUIS RIVER AOC

# Total PAHs in Surface Sediment: Koppers/Crawford Creek

Total PAH concentrations in surface samples (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

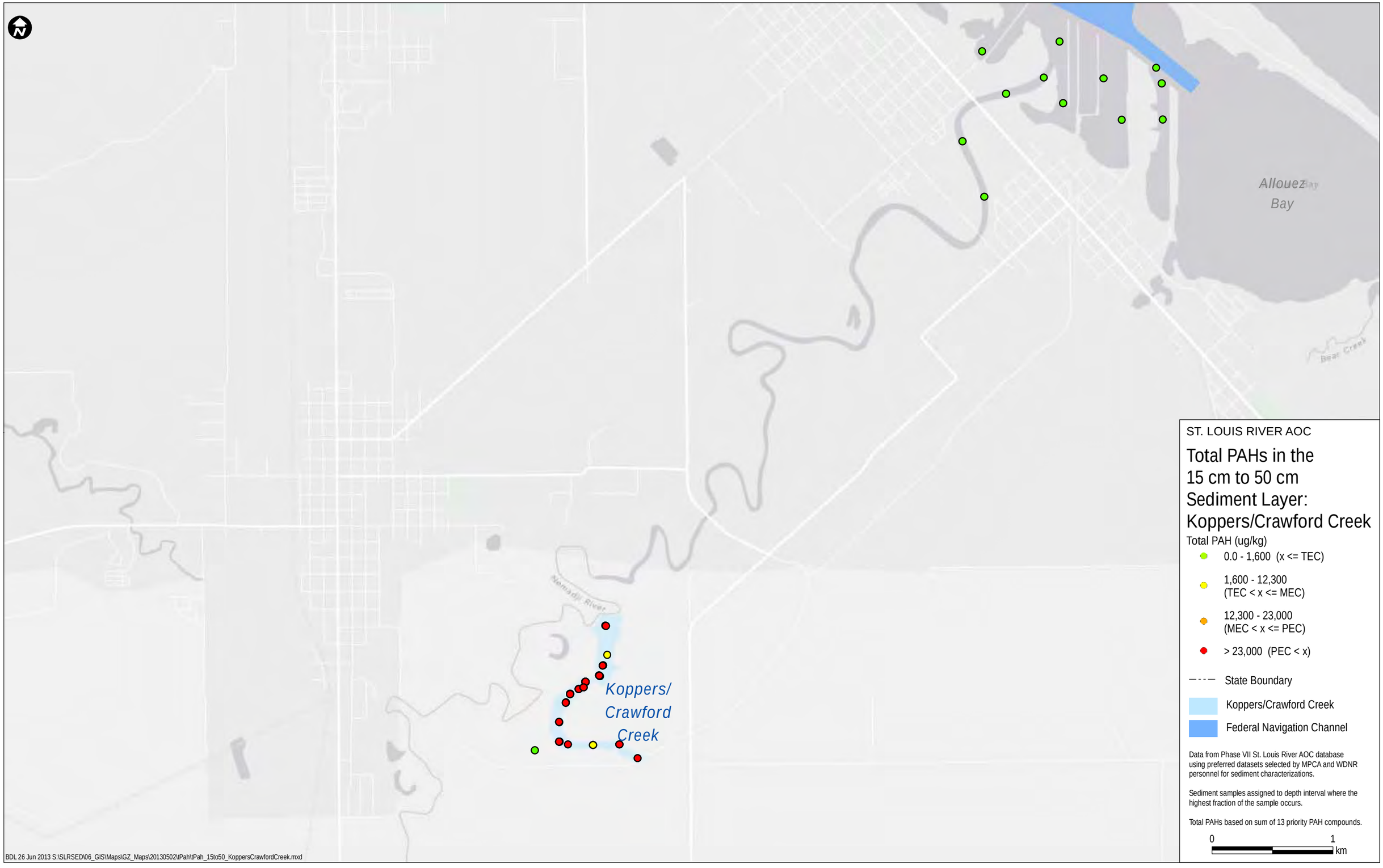
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

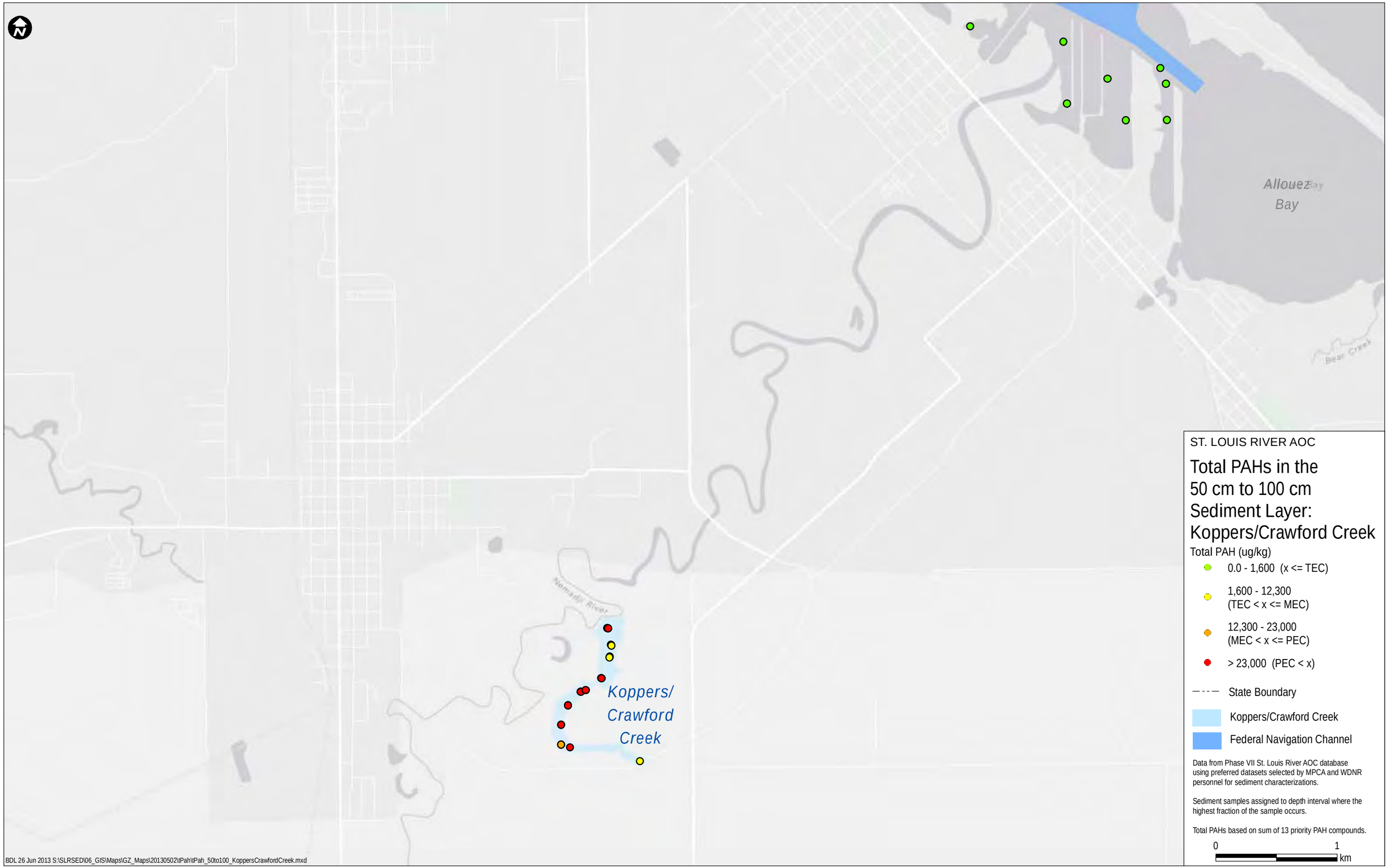
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_Surface_KoppersCrawfordCreek.mxd


Allouez Bay
Bear Creek
Nemadji River
Koppers/
Crawford
Creek
ST. LOUIS RIVER AOC
Total PAHs in the
15 cm to 50 cm
Sediment Layer:
Koppers/Crawford Creek
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300
(TEC < x <= MEC)
12,300 - 23,000
(MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Koppers/Crawford Creek
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_15to50_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

## Total PAHs in the 50 cm to 100 cm Sediment Layer: Koppers/Crawford Creek

Total PAH (ug/kg)

- 0.0 - 1,600 (x <= TEC)
- 1,600 - 12,300 (TEC < x <= MEC)
- 12,300 - 23,000 (MEC < x <= PEC)
- > 23,000 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

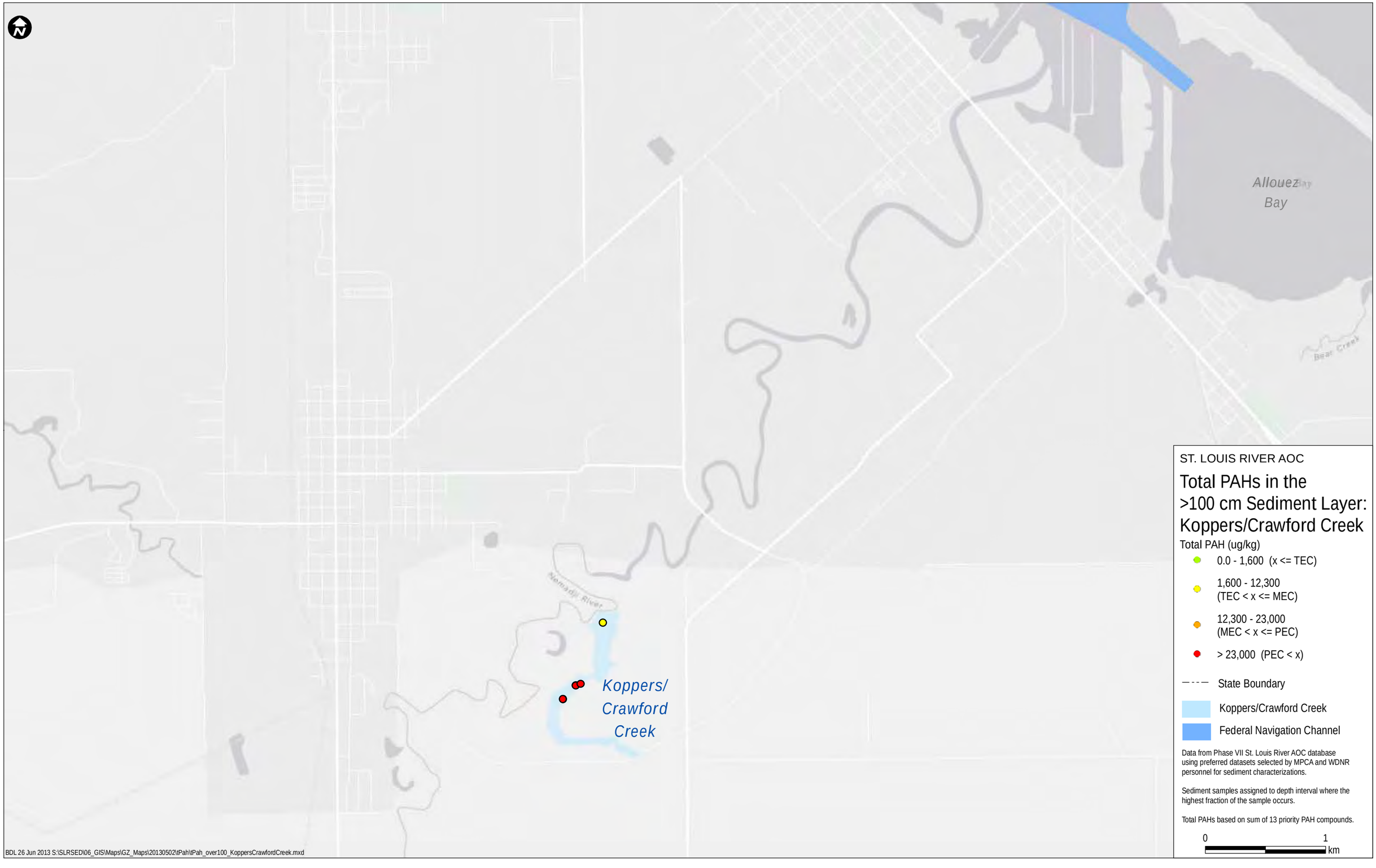
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

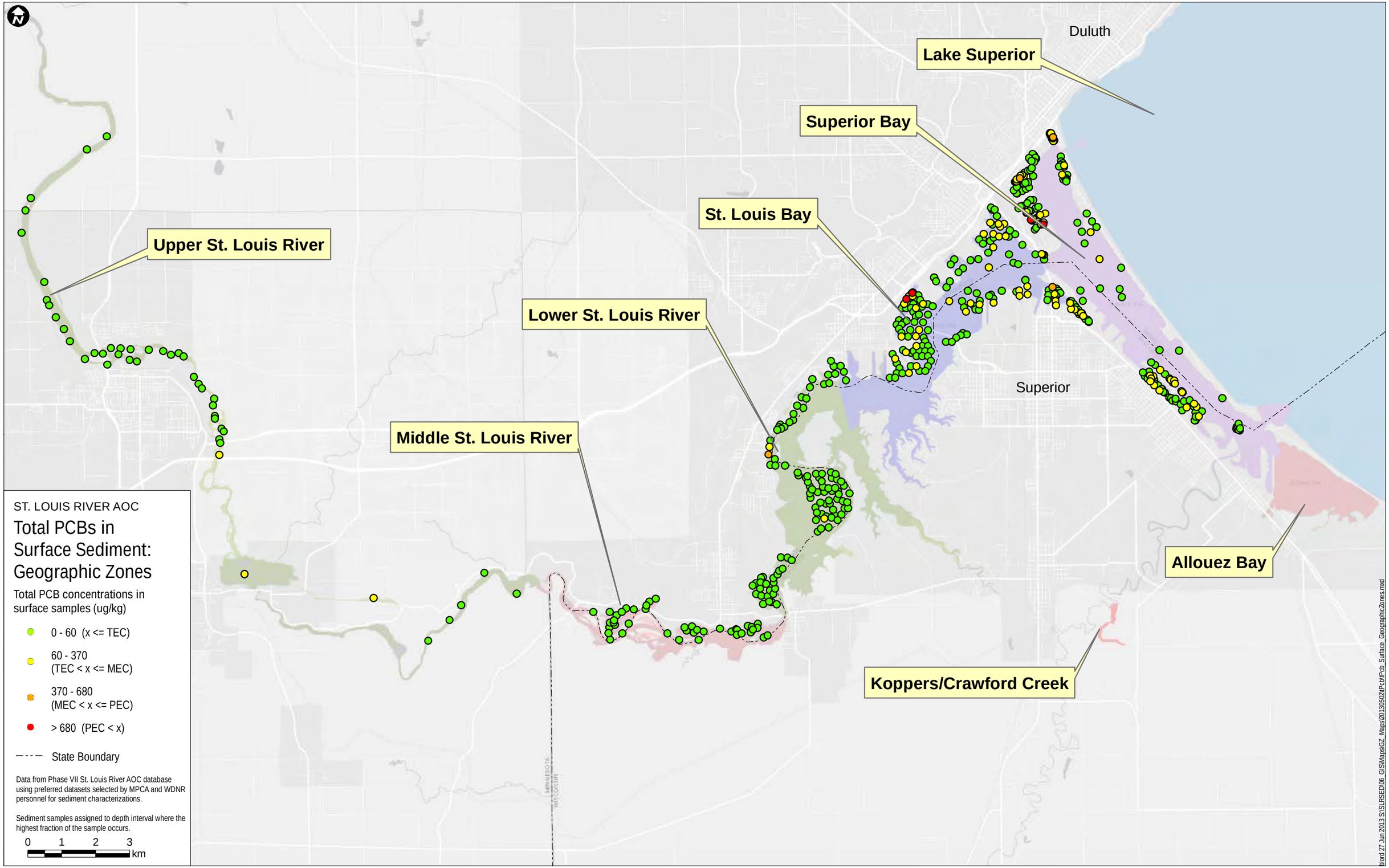
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Total PAHs based on sum of 13 priority PAH compounds.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_50to100_KoppersCrawfordCreek.mxd


Allouez Bay
Bear Creek
Kenwood River
Koppers/
Crawford
Creek
ST. LOUIS RIVER AOC
Total PAHs in the
>100 cm Sediment Layer:
Koppers/Crawford Creek
Total PAH (ug/kg)
0.0 - 1,600 (x <= TEC)
1,600 - 12,300
(TEC < x <= MEC)
12,300 - 23,000
(MEC < x <= PEC)
> 23,000 (PEC < x)
State Boundary
Koppers/Crawford Creek
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Total PAHs based on sum of 13 priority PAH compounds.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPah\tPah_over100_KoppersCrawfordCreek.mxd


Duluth
Lake Superior
Superior Bay
St. Louis Bay
Upper St. Louis River
Lower St. Louis River
Middle St. Louis River
Superior
Allouez Bay
Koppers/Crawford Creek
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Total PCBs in Surface Sediment: Geographic Zones
Total PCB concentrations in surface samples (ug/kg)
0 - 60 (x <= TEC)
60 - 370 (TEC < x <= MEC)
370 - 680 (MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0 1 2 3
km
bford 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130602\PcbNPcb_Surface_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Total PCBs in the 15 cm to 50 cm Sediment Layer: Geographic Zones

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

bford 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\NPcb\NPcb_15to50_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Total PCBs in the 50 cm to 100 cm Sediment Layer: Geographic Zones

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

bford 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\PcbPcb_50to100_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Total PCBs in the >100 cm Sediment Layer: Geographic Zones

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

bord 27 Jun 2013 S:\SLR\SED\06_GIS\Maps\GZ_Maps\20130502\PctlPcb_over100_GeographicZones.mxd

ST. LOUIS RIVER AOC

# Total PCBs in Surface Sediment: Allouez Bay

Total PCB concentrations in surface samples (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Total PCB samples were found for this geographic zone.

0 1 km

Superior Bay

Lake Superior

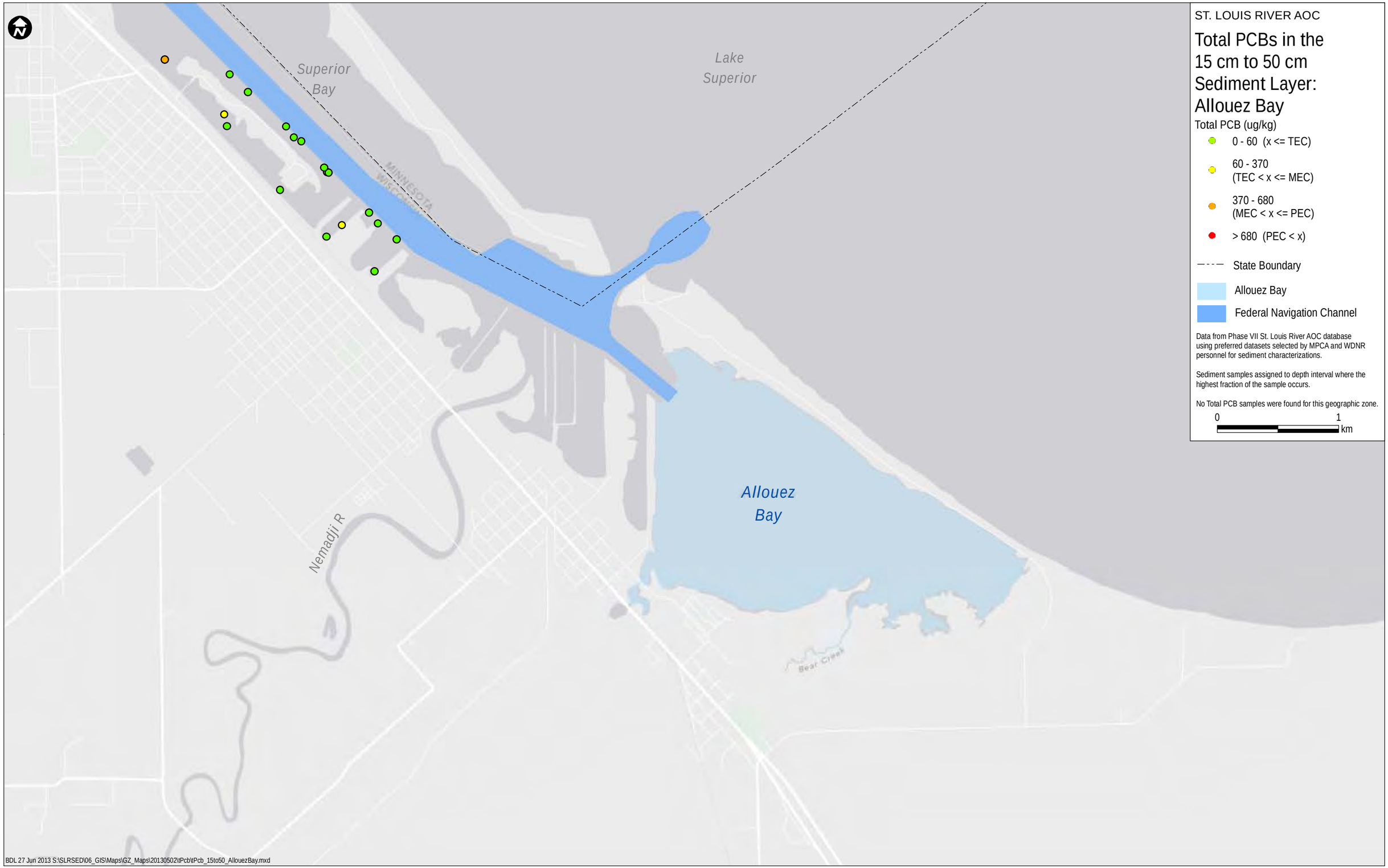
MINNESOTA WISCONSIN

Allouez Bay

Nemadji R

Bear Creek

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_Surface_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Total PCBs in the 15 cm to 50 cm Sediment Layer: Allouez Bay

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

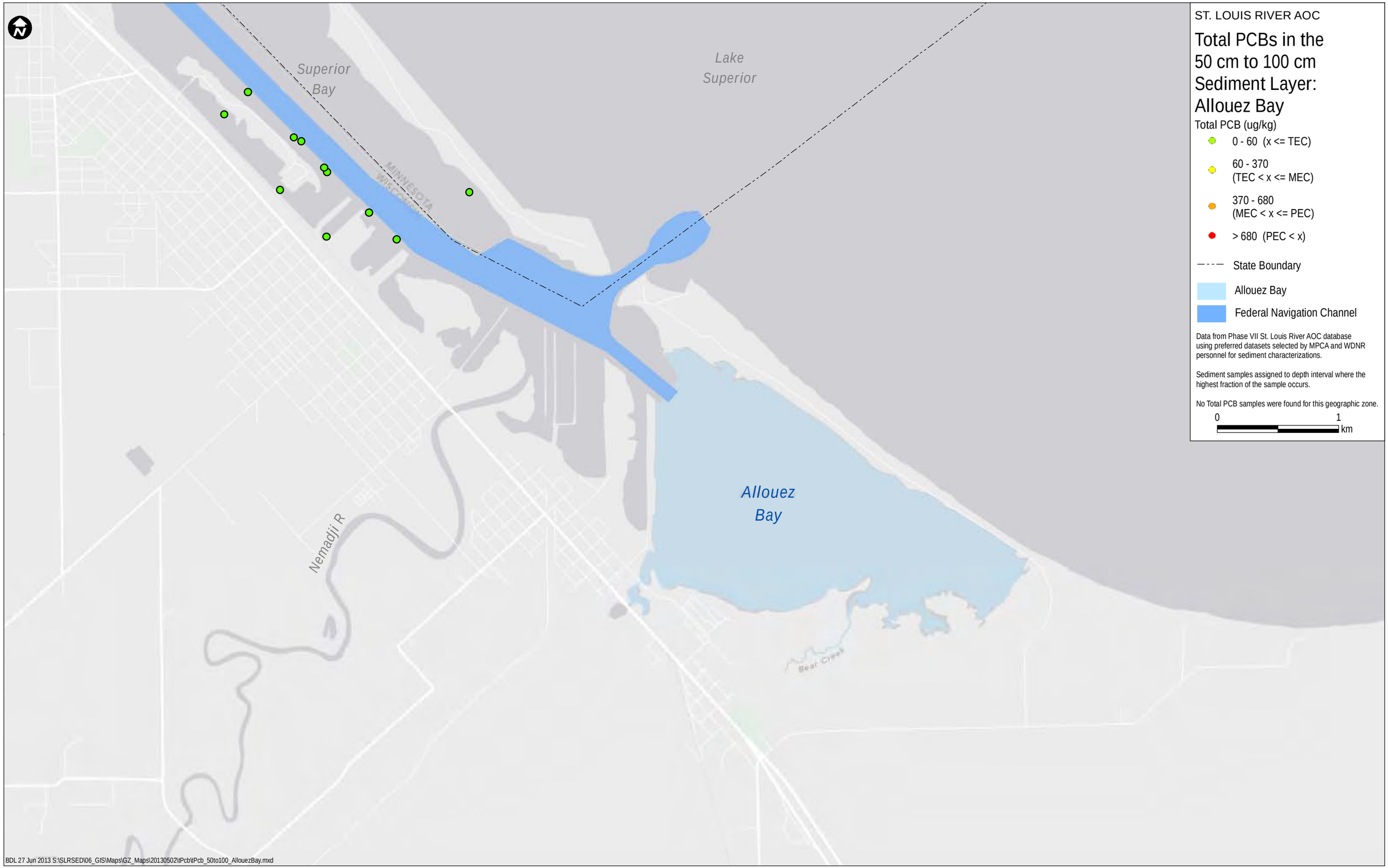
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Total PCB samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_15to50_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Total PCBs in the 50 cm to 100 cm Sediment Layer: Allouez Bay

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

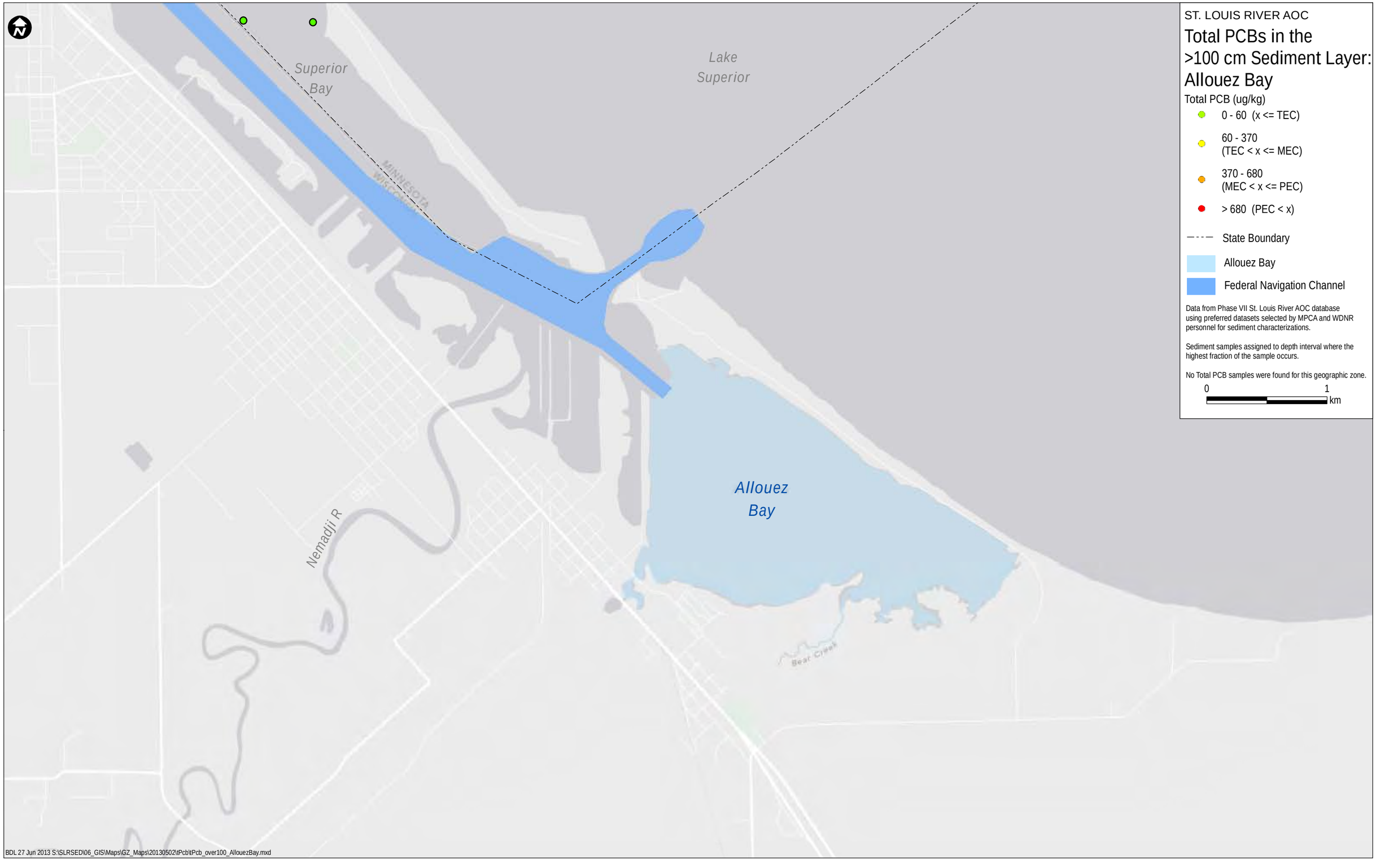
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Total PCB samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_50to100_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Total PCBs in the >100 cm Sediment Layer: Allouez Bay

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Total PCB samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_over100_AllouezBay.mxd

ST. LOUIS RIVER AOC

# Total PCBs in Surface Sediment: Superior Bay

Total PCB concentrations in surface samples (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)
- State Boundary
- Superior Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_Surface_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Total PCBs in the 15 cm to 50 cm Sediment Layer: Superior Bay

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_15to50_SuperiorBay.mxd


Lake
Superior
Superior
Bay
St. Louis
Bay
Allouez
Bay
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Total PCBs in the
50 cm to 100 cm
Sediment Layer:
Superior Bay
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Superior Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_50to100_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Total PCBs in the >100 cm Sediment Layer: Superior Bay

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

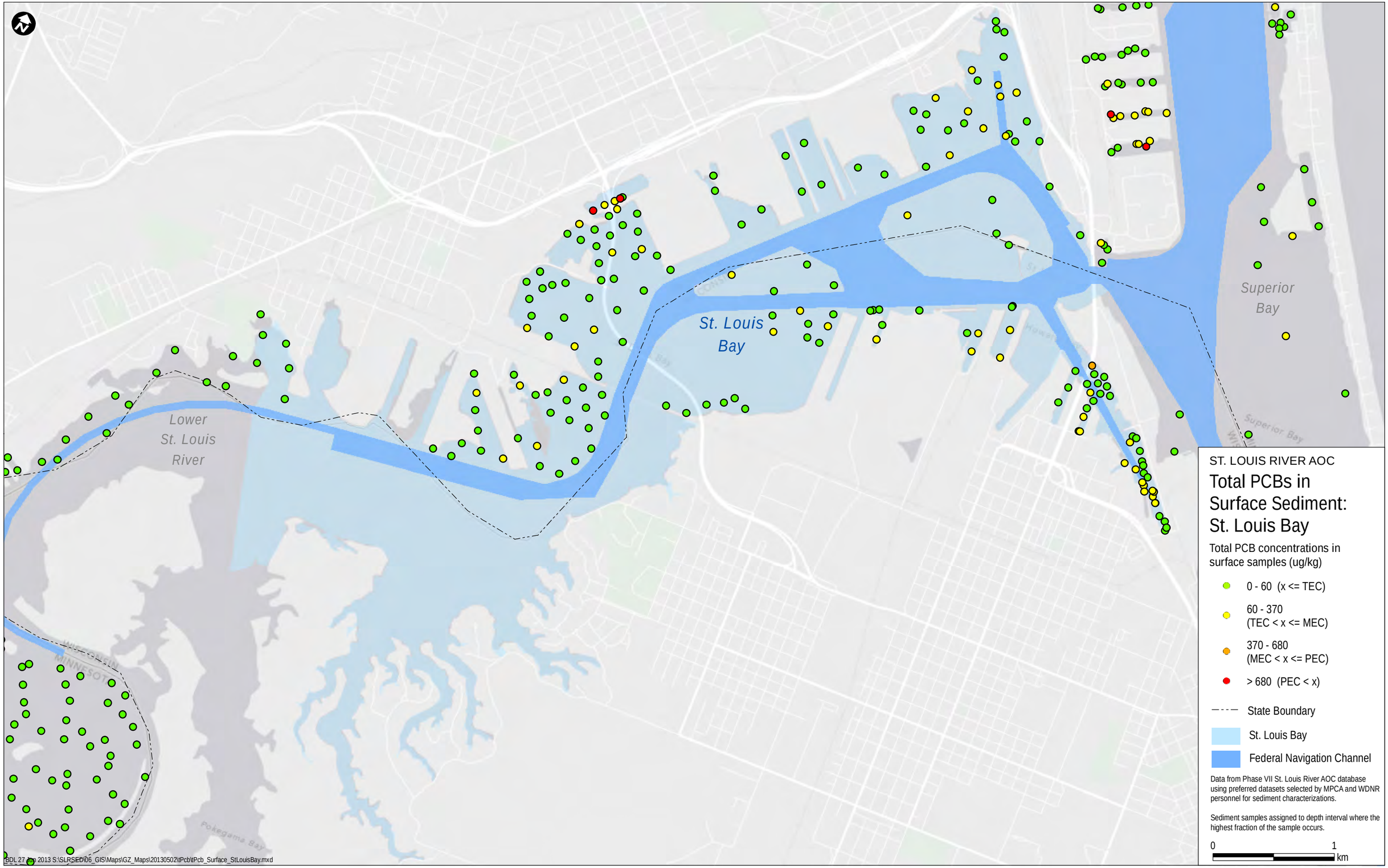
Lake Superior

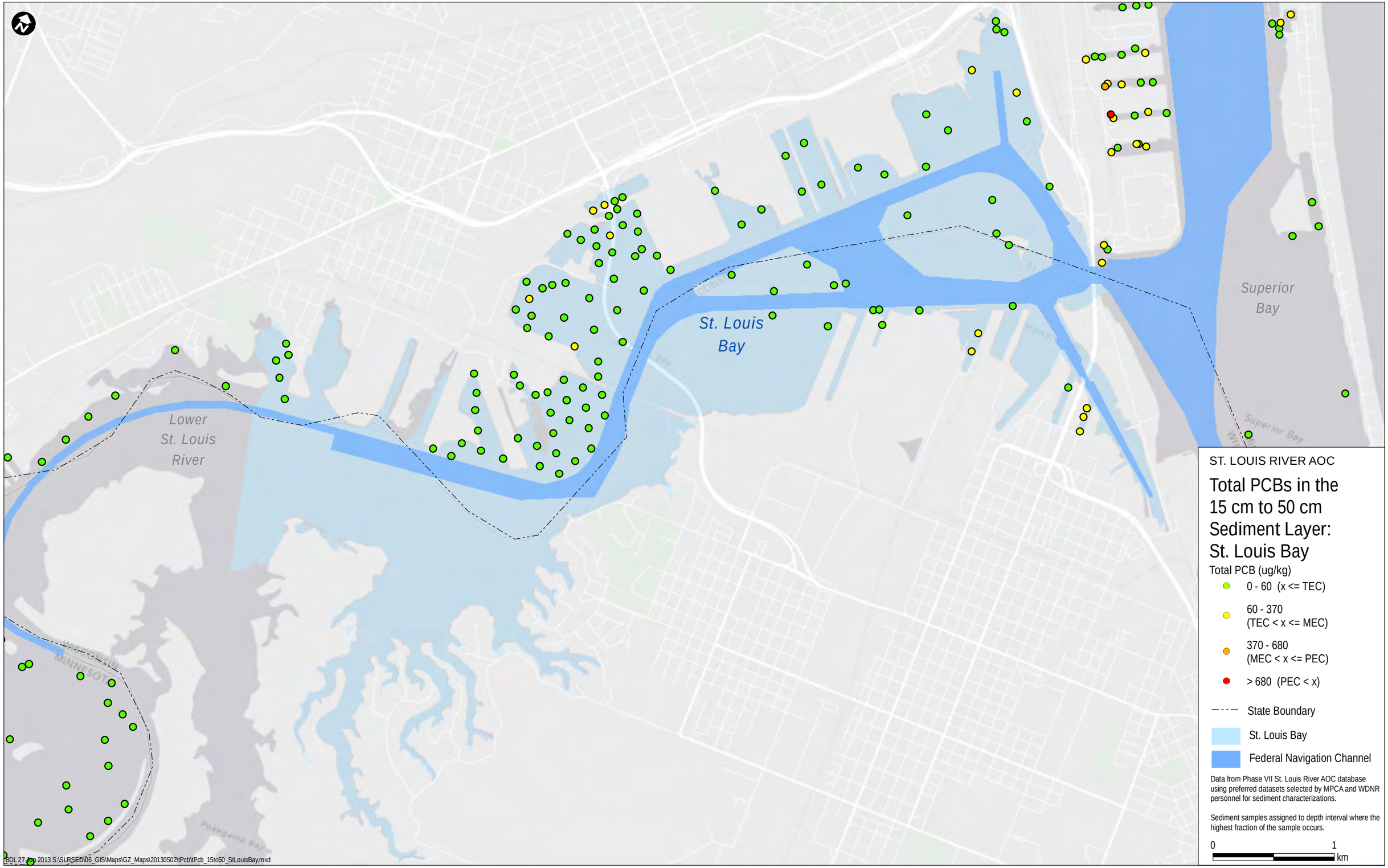
Superior Bay

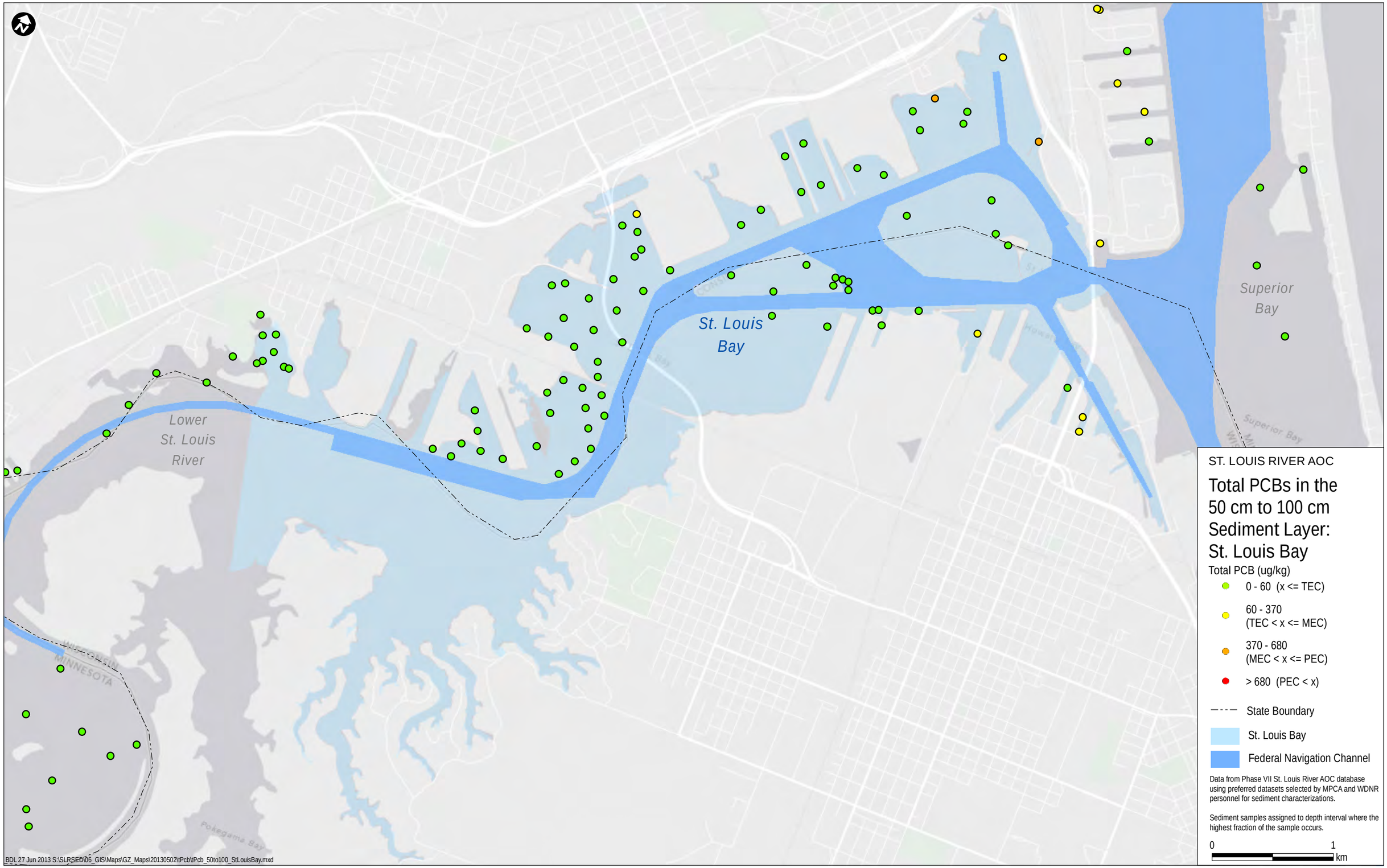
St. Louis Bay

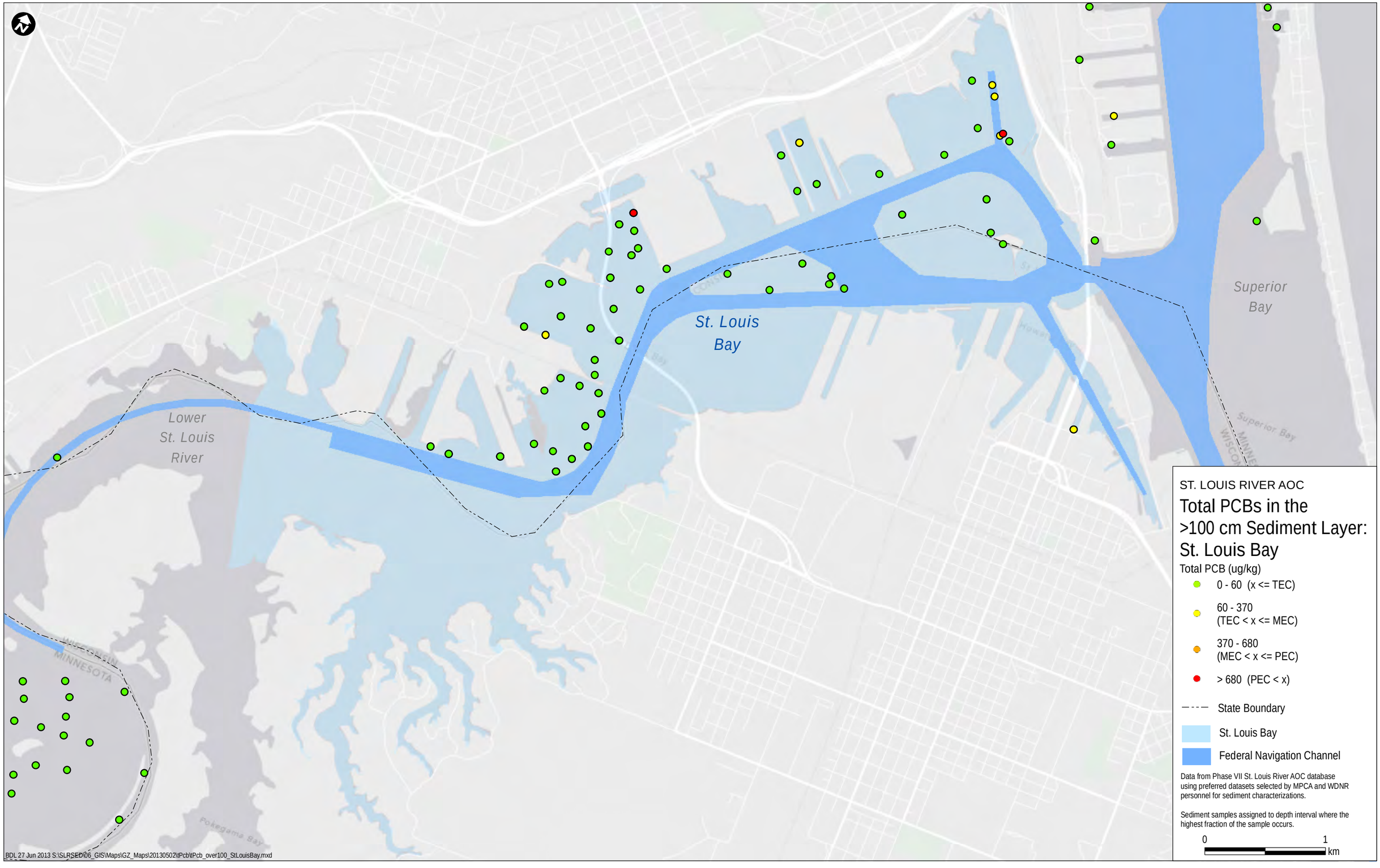
Allouez Bay

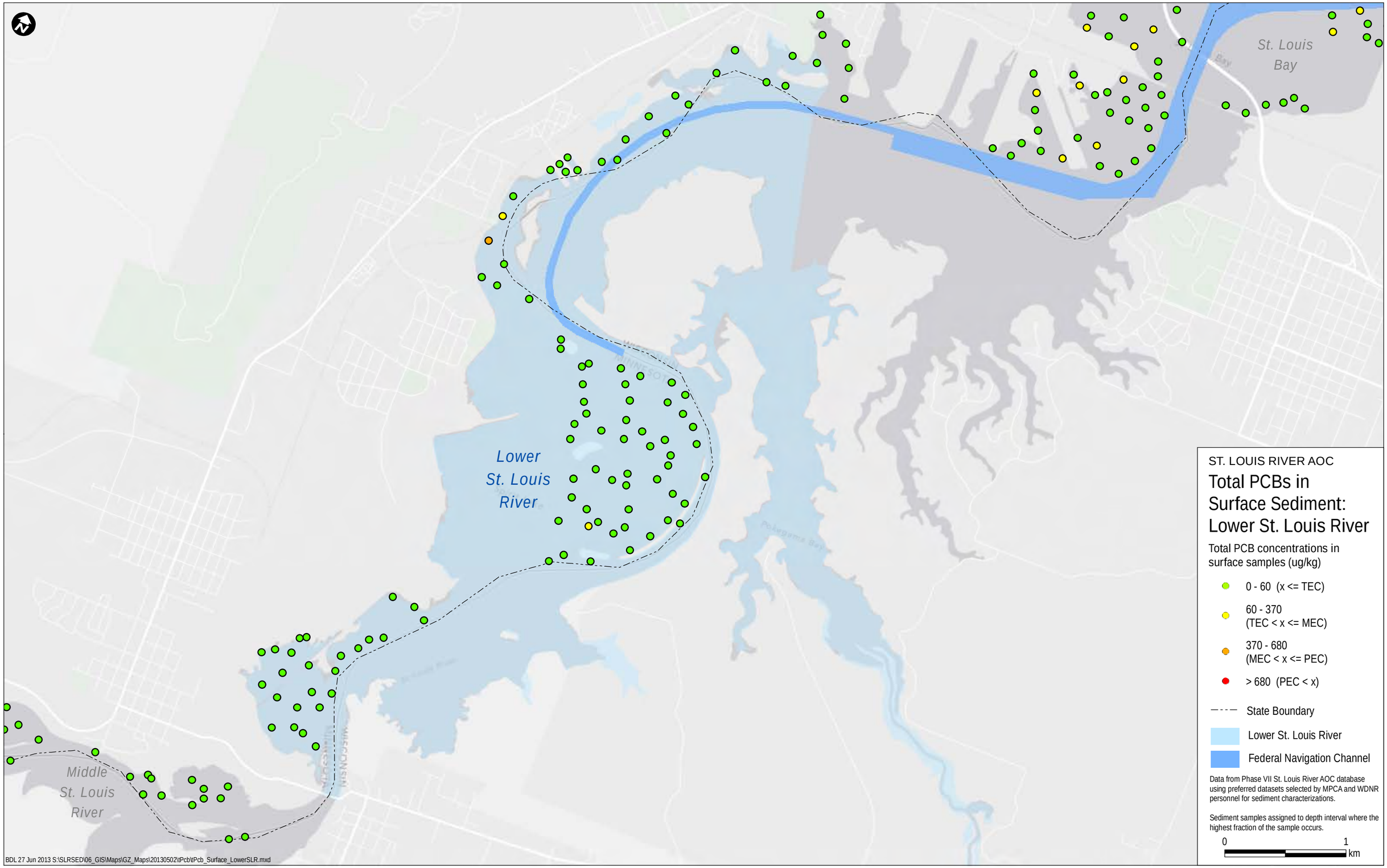
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_over100_SuperiorBay.mxd

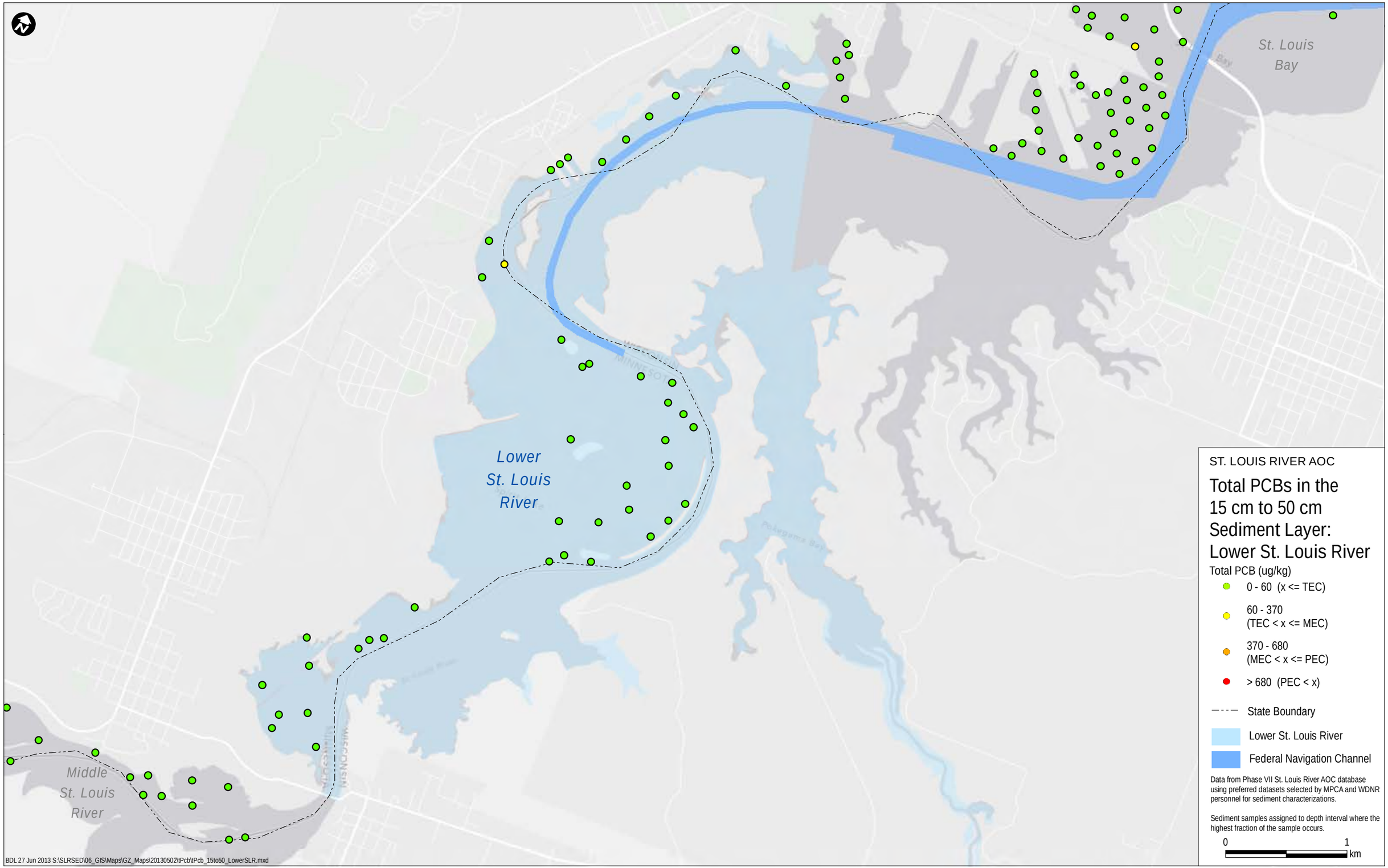

Lower
St. Louis
River
St. Louis
Bay
Superior
Bay
Superior Bay
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Total PCBs in
Surface Sediment:
St. Louis Bay
Total PCB concentrations in
surface samples (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
GDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_Surface_StLouisBay.mxd

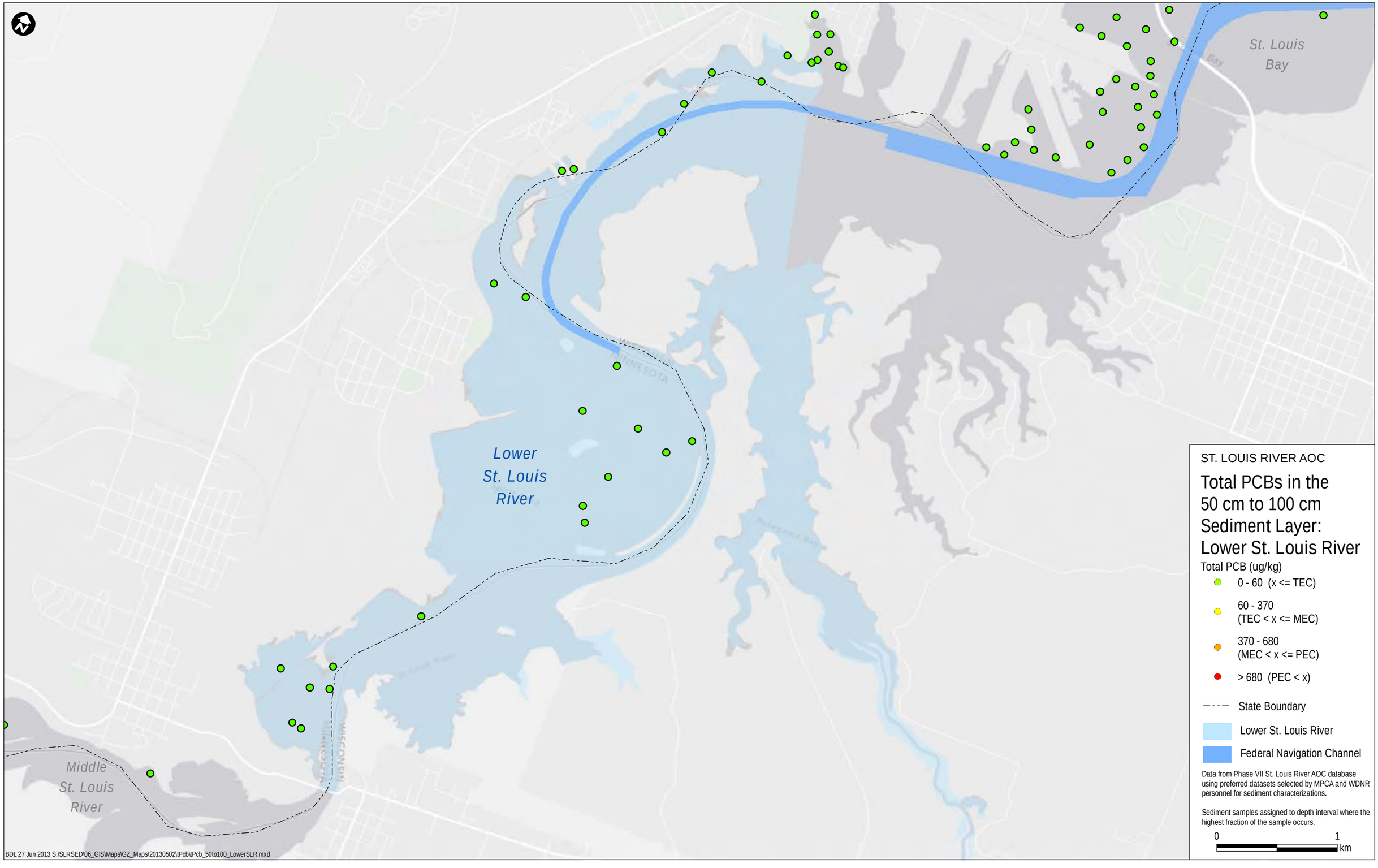

Lower
St. Louis
River
St. Louis
Bay
Superior
Bay
Superior Bay
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Total PCBs in the
15 cm to 50 cm
Sediment Layer:
St. Louis Bay
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_15to50_StLouisBay.mxd

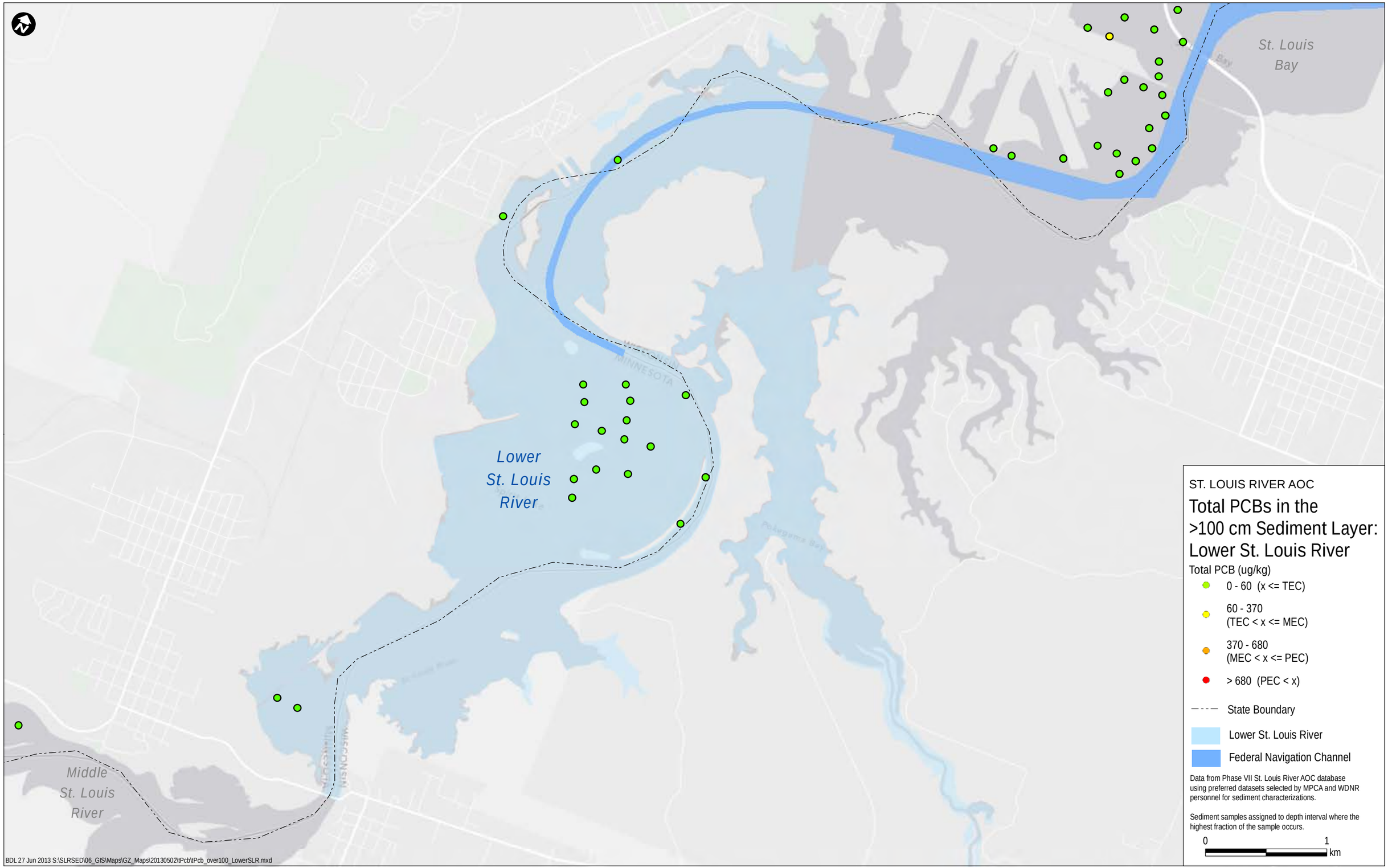

St. Louis Bay
Superior Bay
Lower St. Louis River
Pokegama Bay
ST. LOUIS RIVER AOC
Total PCBs in the 50 cm to 100 cm Sediment Layer: St. Louis Bay
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370 (TEC < x <= MEC)
370 - 680 (MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_50to100_StLouisBay.mxd

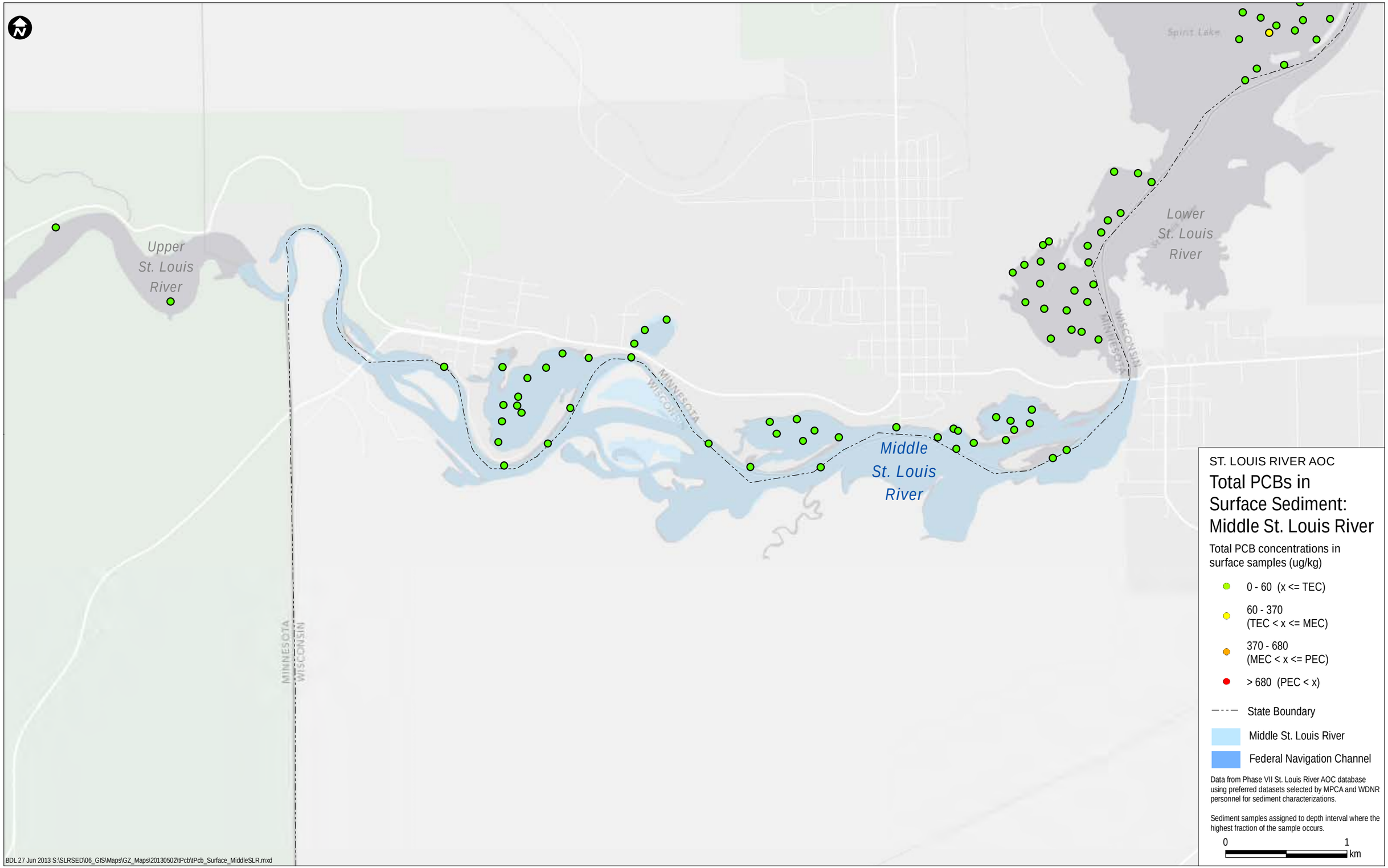

St. Louis
Bay
Superior
Bay
Lower
St. Louis
River
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Total PCBs in the
>100 cm Sediment Layer:
St. Louis Bay
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_over100_StLouisBay.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PCBs in Surface Sediment: Lower St. Louis River
Total PCB concentrations in surface samples (ug/kg)
0 - 60 (x <= TEC)
60 - 370 (TEC < x <= MEC)
370 - 680 (MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_Surface_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PCBs in the 15 cm to 50 cm Sediment Layer: Lower St. Louis River
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370 (TEC < x <= MEC)
370 - 680 (MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_15to50_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PCBs in the 50 cm to 100 cm Sediment Layer: Lower St. Louis River
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370 (TEC < x <= MEC)
370 - 680 (MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_50to100_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PCBs in the >100 cm Sediment Layer: Lower St. Louis River
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370 (TEC < x <= MEC)
370 - 680 (MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_over100_LowerSLR.mxd


Upper
St. Louis
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Total PCBs in Surface Sediment: Middle St. Louis River
Total PCB concentrations in surface samples (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_Surface_MiddleSLR.mxd

Upper
St. Louis
River

Lower
St. Louis
River

Middle
St. Louis
River

Spirit Lake

MINNESOTA
WISCONSIN

MINNESOTA
WISCONSIN

BDL 27 Jun 2013 S:\SLRSED\I06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_15to50_MiddleSLR.mxd

ST. LOUIS RIVER AOC

# Total PCBs in the 15 cm to 50 cm Sediment Layer: Middle St. Louis River

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

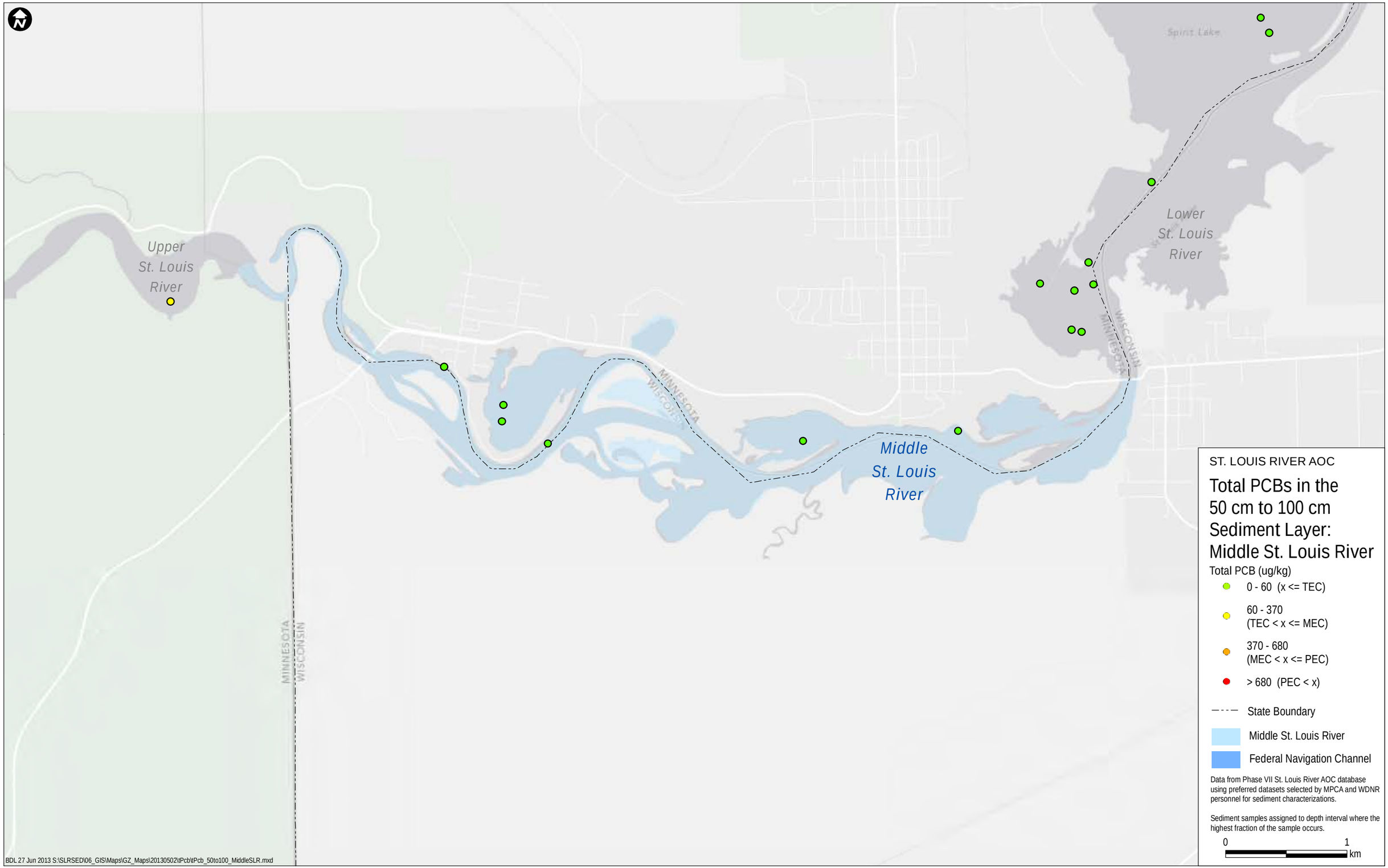
Middle St. Louis River

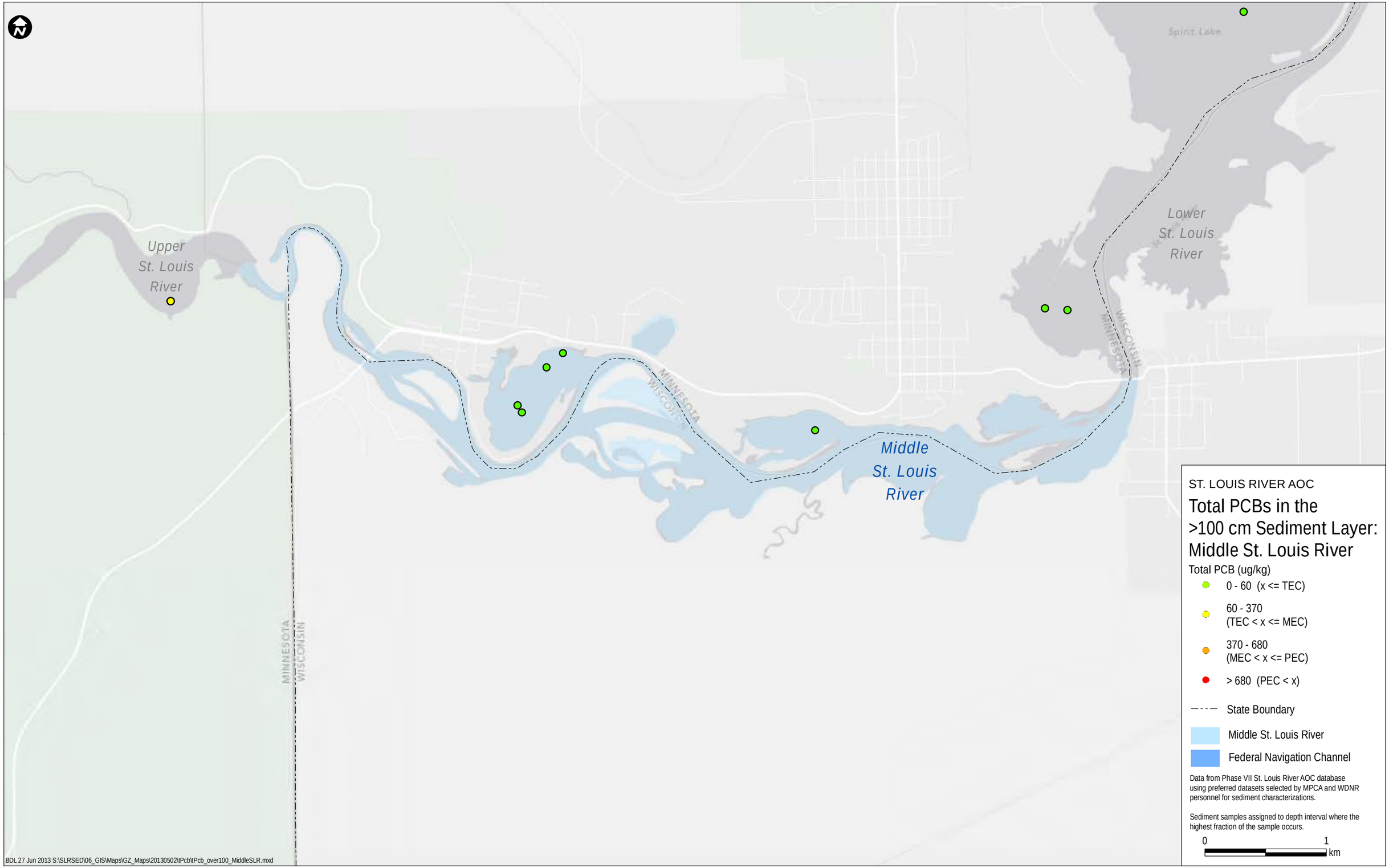
Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km


Spirit Lake
Upper
St. Louis
River
Lower
St. Louis
River
Middle
St. Louis
River
MINNESOTA
WISCONSIN
MINNESOTA
WISCONSIN
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Total PCBs in the
50 cm to 100 cm
Sediment Layer:
Middle St. Louis River
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_50to100_MiddleSLR.mxd


Spirit Lake
Upper
St. Louis
River
Lower
St. Louis
River
MINNESOTA
WISCONSIN
Middle
St. Louis
River
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Total PCBs in the
>100 cm Sediment Layer:
Middle St. Louis River
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_over100_MiddleSLR.mxd

ST. LOUIS RIVER AOC

# Total PCBs in Surface Sediment: Upper St. Louis River

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)
- State Boundary
- Upper St. Louis River
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_Surface_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Total PCBs in the 15 cm to 50 cm Sediment Layer: Upper St. Louis River

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

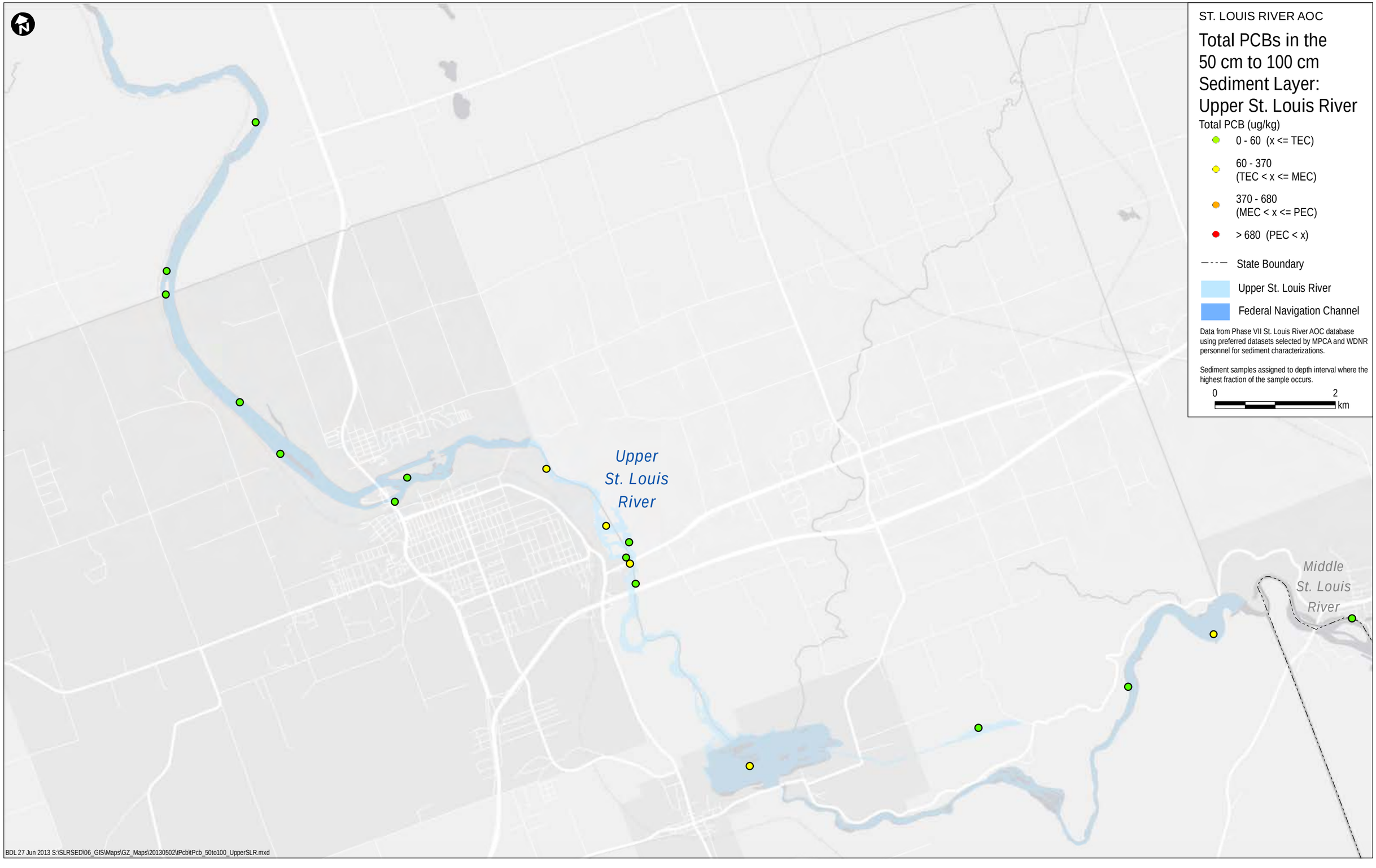
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_15to50_UpperSLR.mxd




ST. LOUIS RIVER AOC

# Total PCBs in the 50 cm to 100 cm Sediment Layer: Upper St. Louis River

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_50to100_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Total PCBs in the >100 cm Sediment Layer: Upper St. Louis River

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

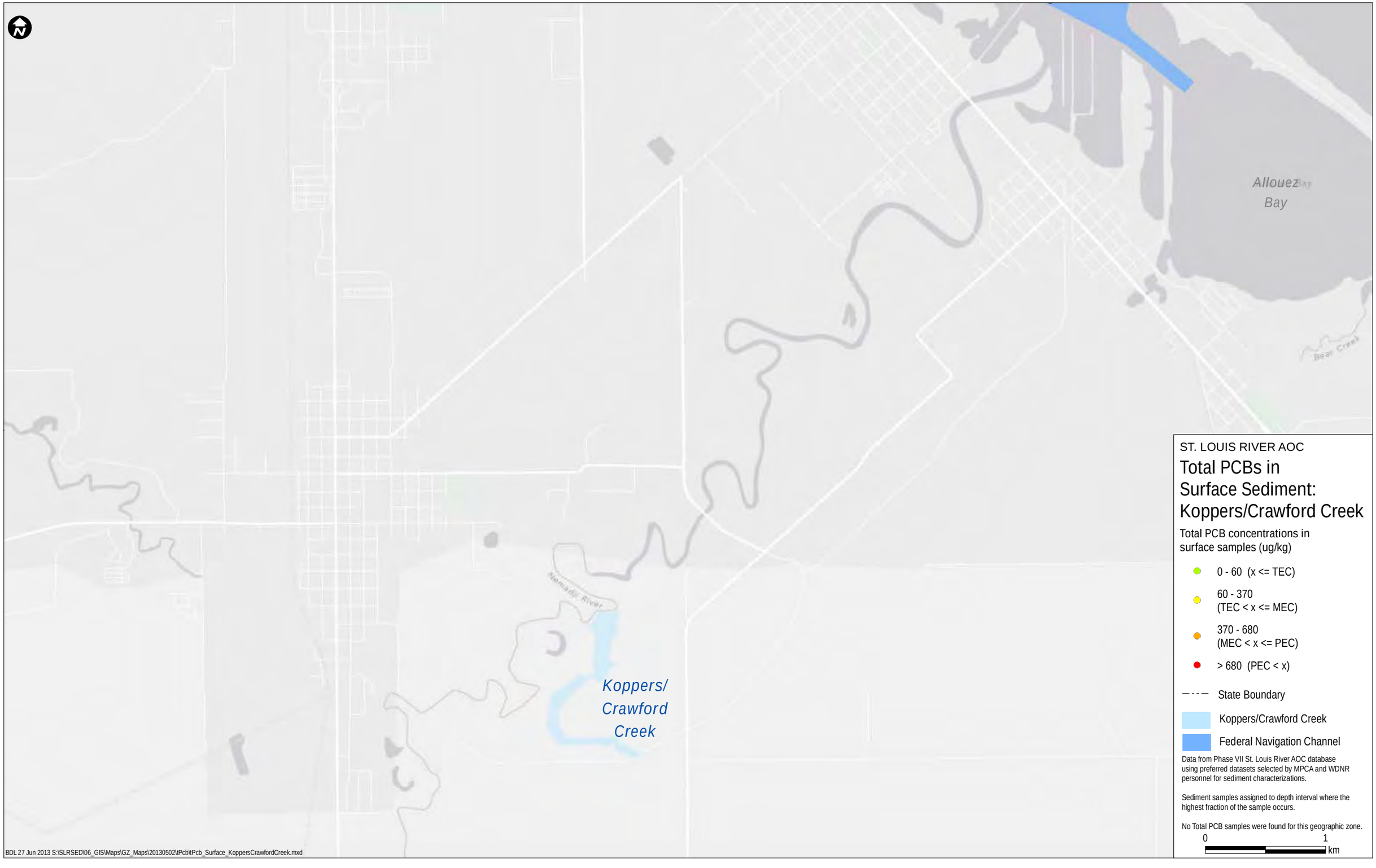
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_over100_UpperSLR.mxd




ST. LOUIS RIVER AOC

## Total PCBs in Surface Sediment: Koppers/Crawford Creek

Total PCB concentrations in surface samples (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

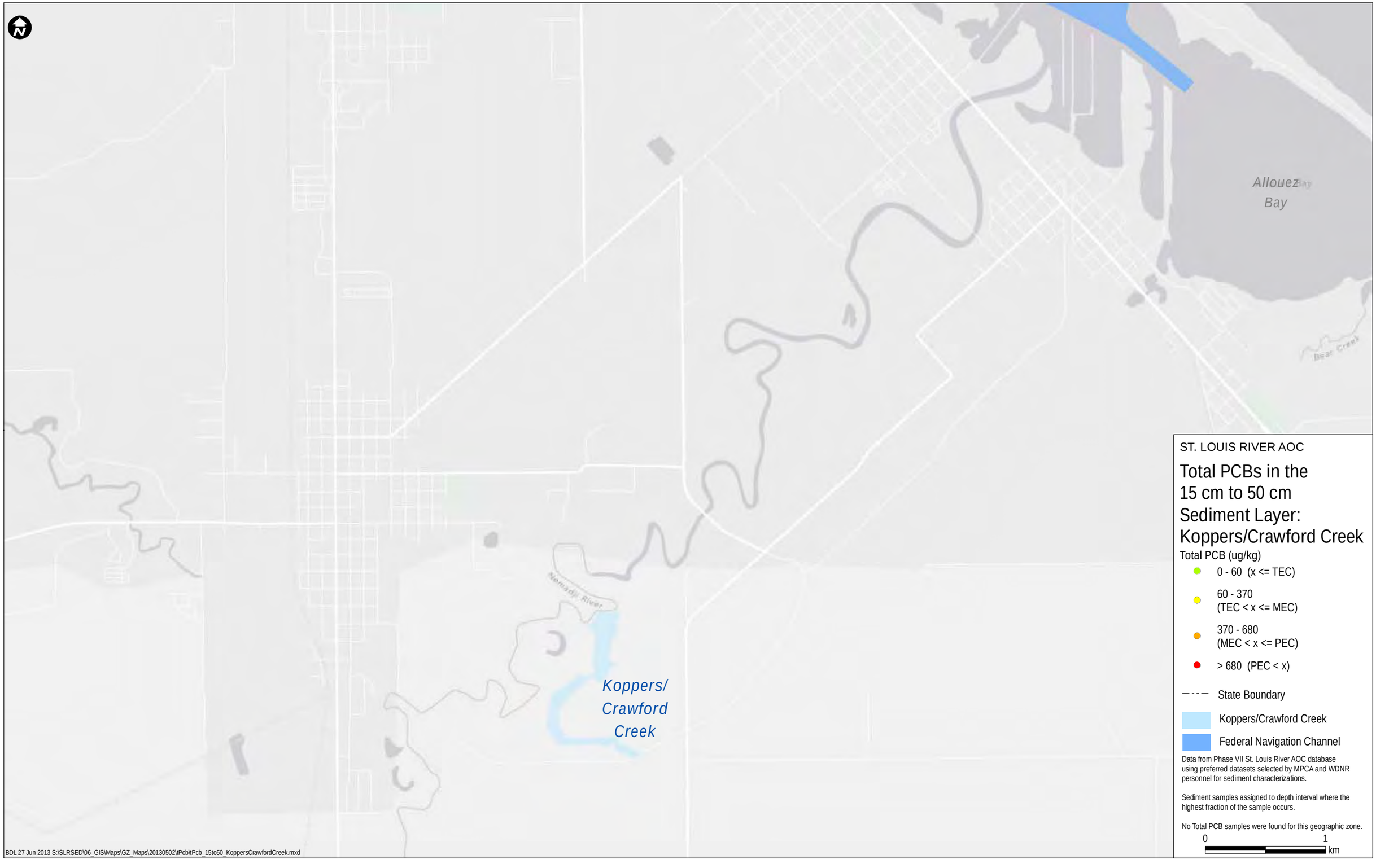
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

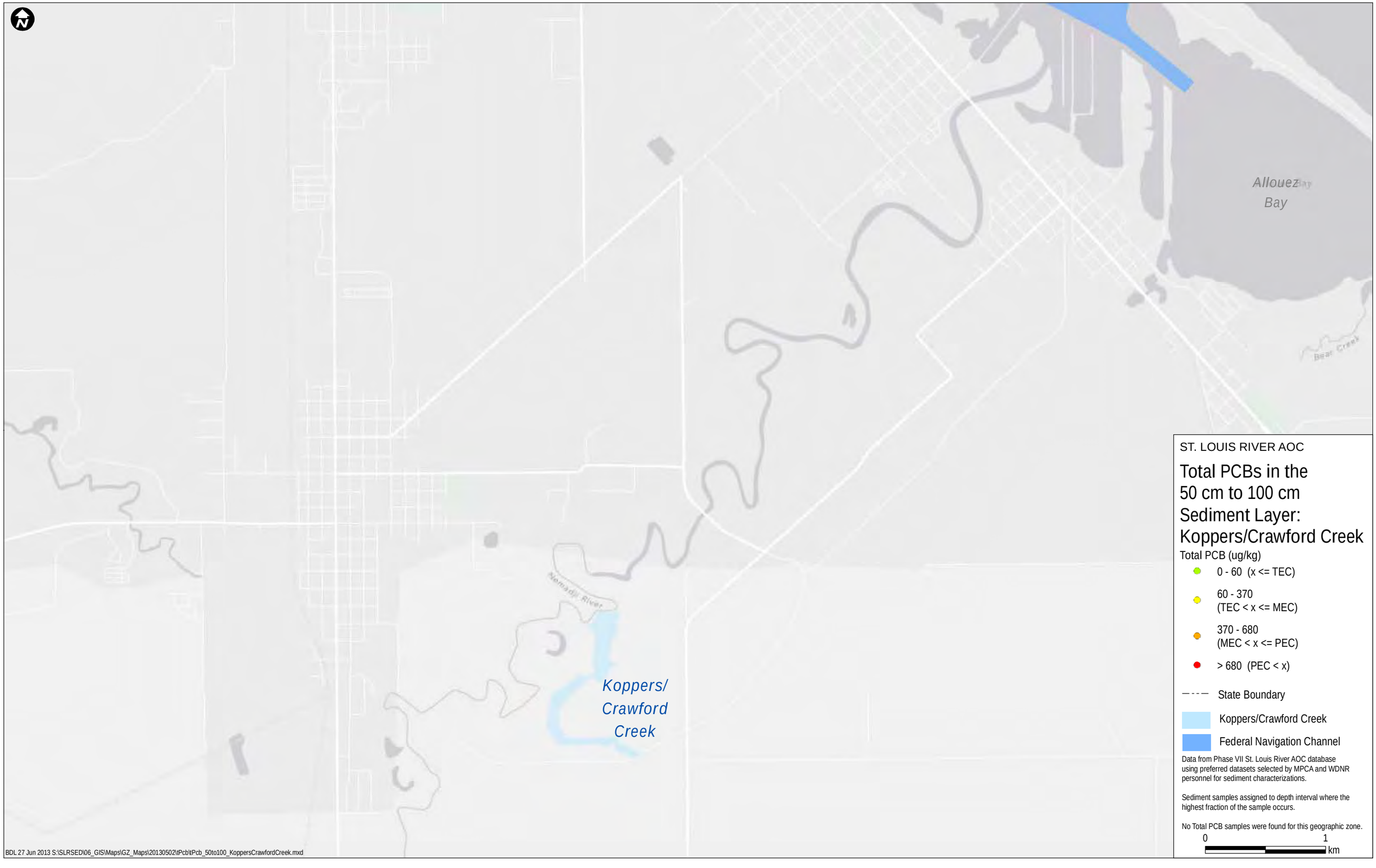
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

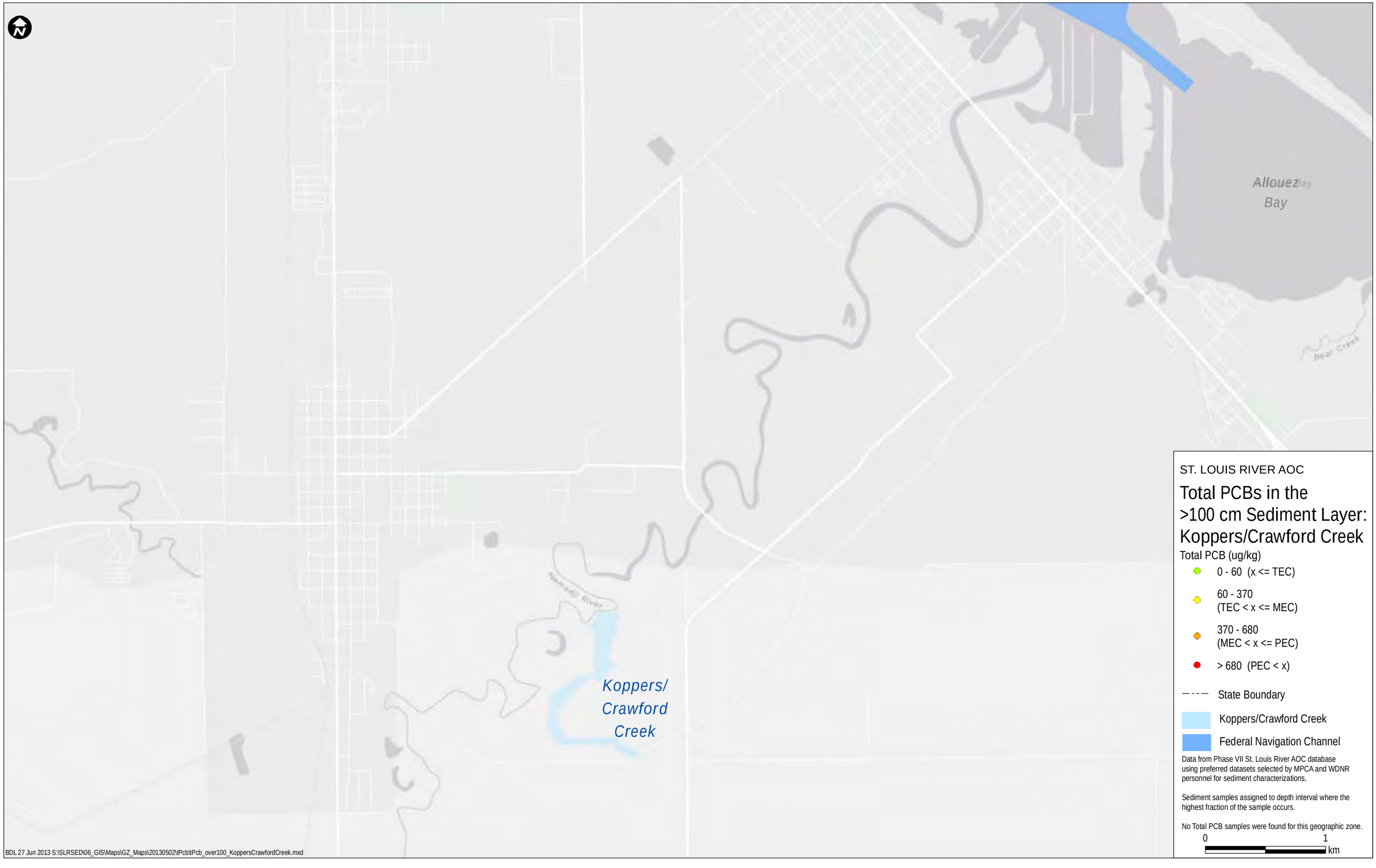
No Total PCB samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_Surface_KoppersCrawfordCreek.mxd


Allouez Bay
Bear Creek
Kenwood River
Koppers/
Crawford
Creek
ST. LOUIS RIVER AOC
Total PCBs in the
15 cm to 50 cm
Sediment Layer:
Koppers/Crawford Creek
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Koppers/Crawford Creek
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
No Total PCB samples were found for this geographic zone.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_15to50_KoppersCrawfordCreek.mxd


Allouez Bay
Bear Creek
Nemadji River
Koppers/
Crawford
Creek
ST. LOUIS RIVER AOC
Total PCBs in the
50 cm to 100 cm
Sediment Layer:
Koppers/Crawford Creek
Total PCB (ug/kg)
0 - 60 (x <= TEC)
60 - 370
(TEC < x <= MEC)
370 - 680
(MEC < x <= PEC)
> 680 (PEC < x)
State Boundary
Koppers/Crawford Creek
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
No Total PCB samples were found for this geographic zone.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_50to100_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

## Total PCBs in the >100 cm Sediment Layer: Koppers/Crawford Creek

Total PCB (ug/kg)

- 0 - 60 (x <= TEC)
- 60 - 370 (TEC < x <= MEC)
- 370 - 680 (MEC < x <= PEC)
- > 680 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Total PCB samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\tPcb\tPcb_over100_KoppersCrawfordCreek.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## PCDD/F $TEQ_{WHO98\text{-}Fish}$ in Surface Sediment: Geographic Zones

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ in surface samples (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 2 3 km

bford 27 Jun 2013 S:\SLR\SED\06_GIS\Maps\GZ_Maps\20130502\TEQfishTEQfish_Surface_Geographic2zones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 15 cm to 50 cm Sediment Layer: Geographic Zones

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 2 3 km

bord 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_15to50_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 50 cm to 100 cm Sediment Layer: Geographic Zones

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 2 3 km

bford 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfishTEQfish_50to100_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Superior

Middle St. Louis River

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the >100 cm Sediment Layer: Geographic Zones

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

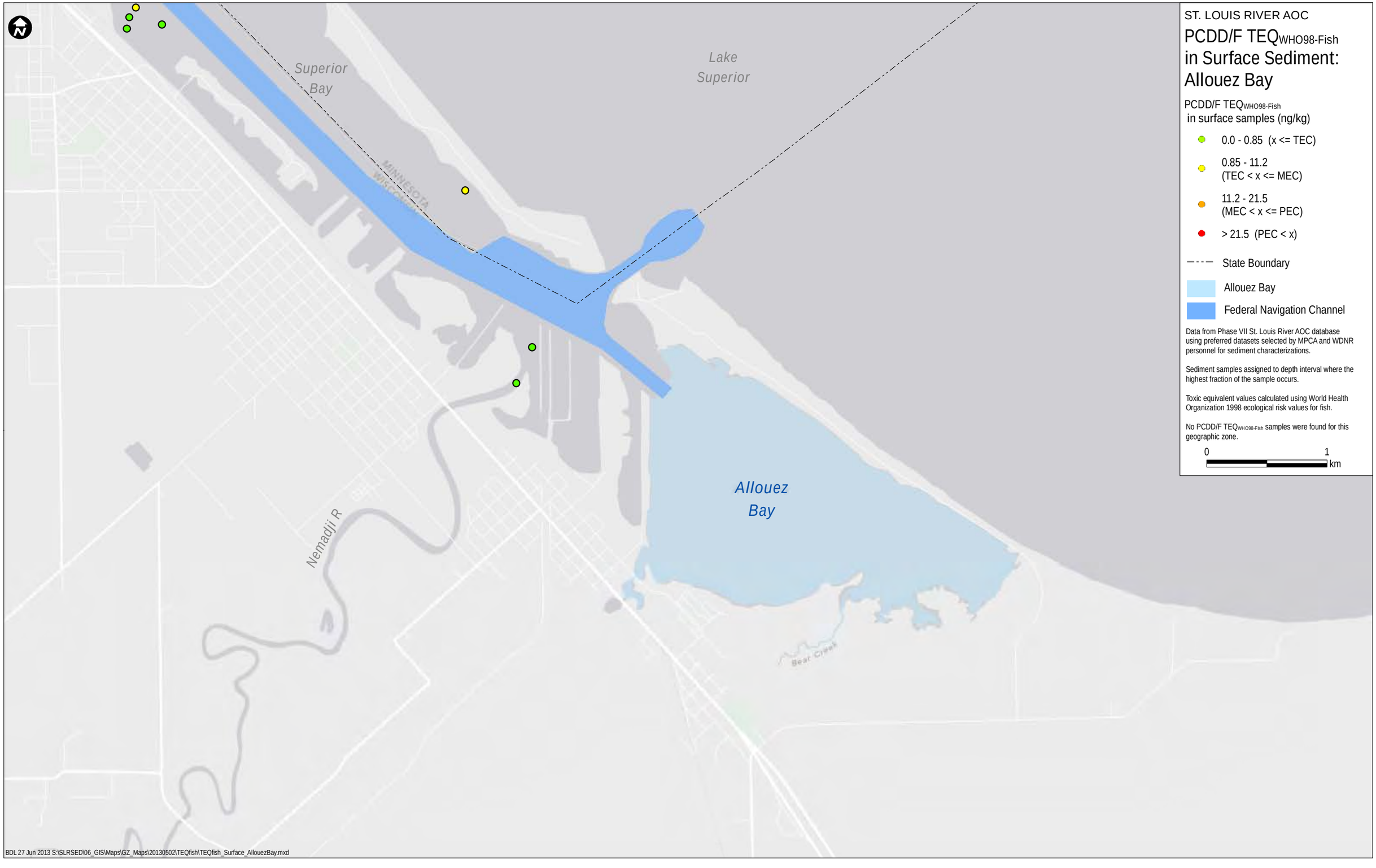
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 2 3 km

bord 27 Jun 2013 S:\SLR\SED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_over100_Geographic2zones.mxd




ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in Surface Sediment: Allouez Bay

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in surface samples (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Allouez Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

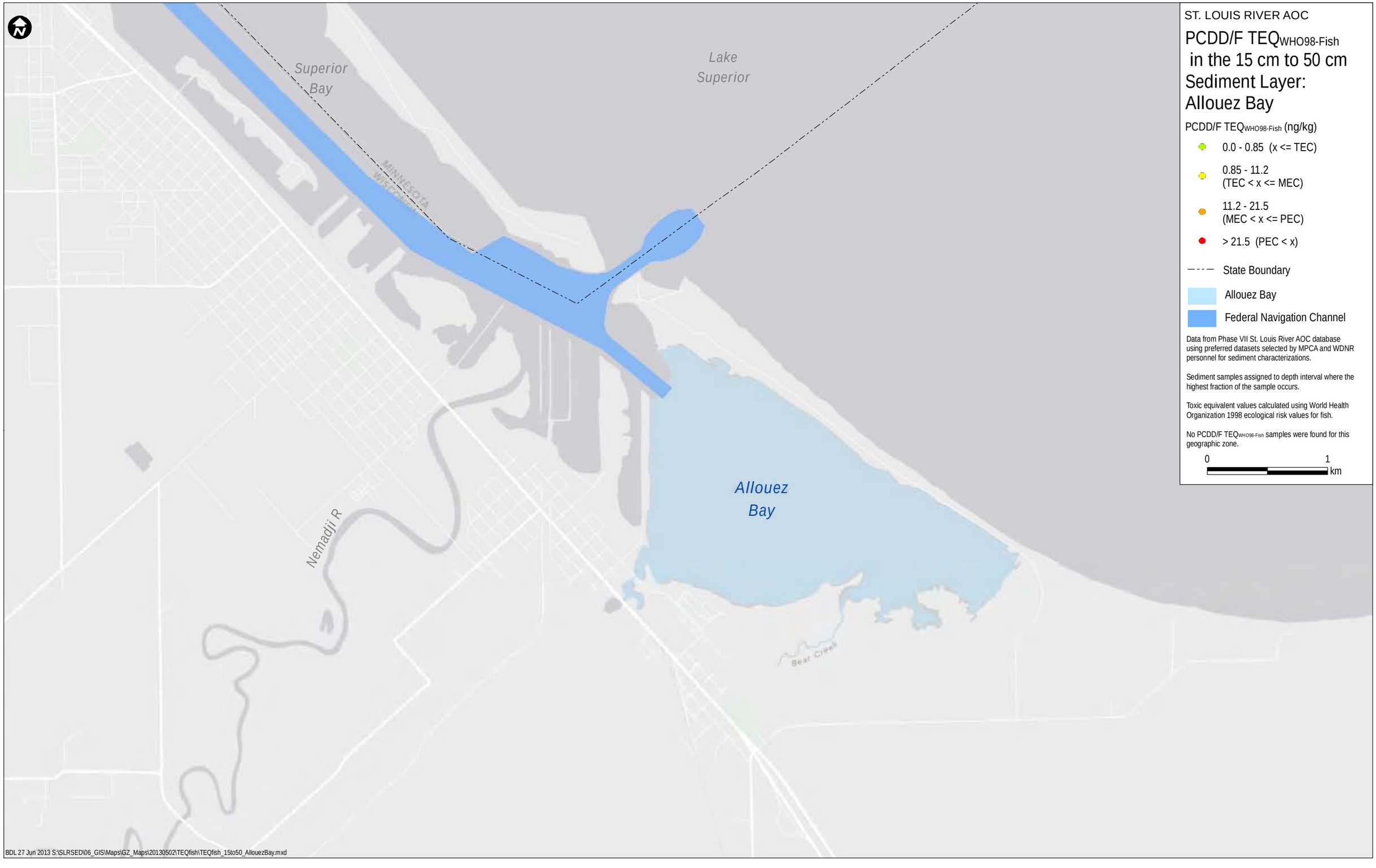
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

No PCDD/F $TEQ_{WHO98\text{-}Fish}$ samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_Surface_AllouezBay.mxd




ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 15 cm to 50 cm Sediment Layer: Allouez Bay

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Allouez Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

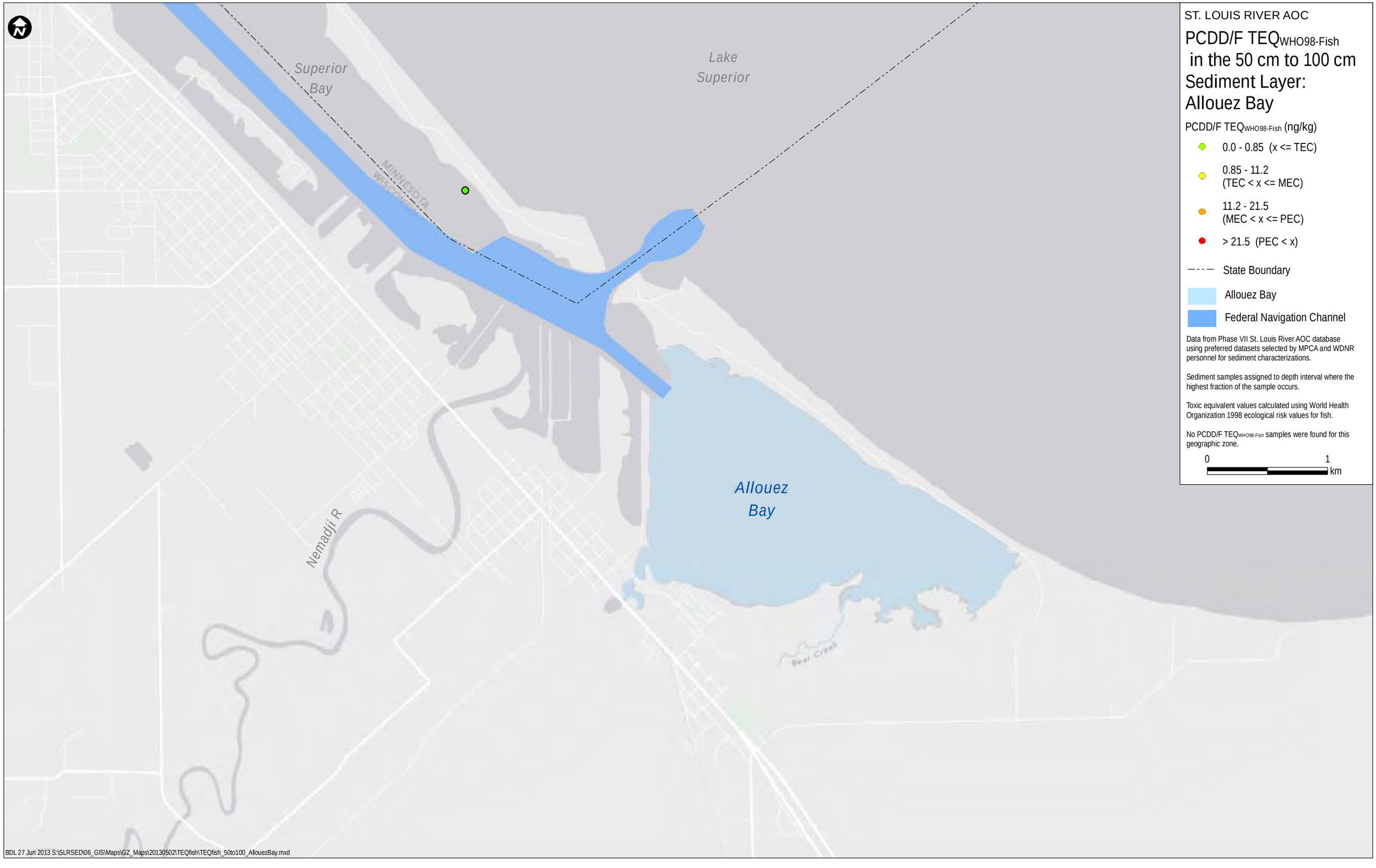
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

No $PCDD/F\ TEQ_{WHO98\text{-}Fish}$ samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_15to50_AllouezBay.mxd




ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 50 cm to 100 cm Sediment Layer: Allouez Bay

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Allouez Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

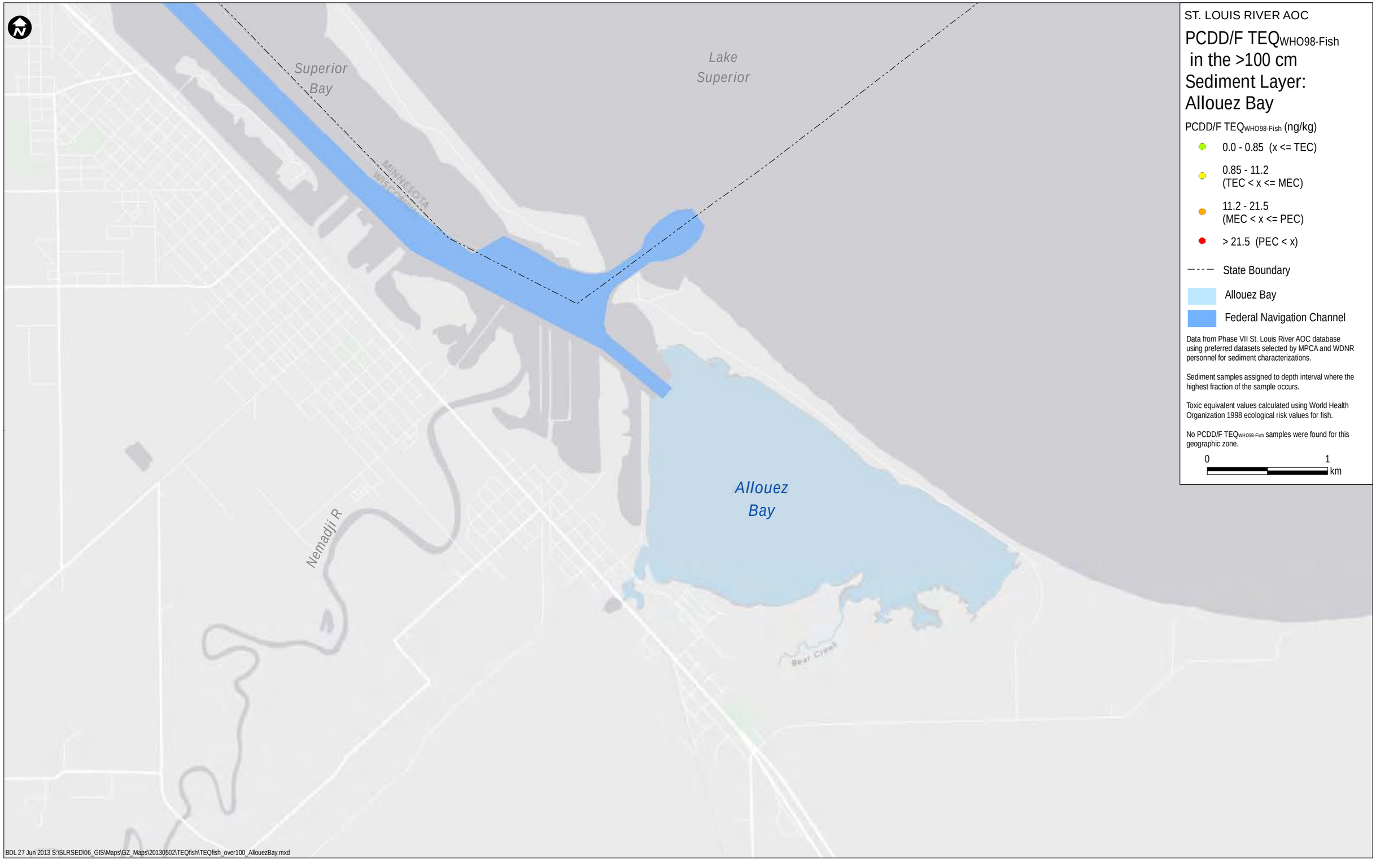
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

No PCDD/F $TEQ_{WHO98\text{-}Fish}$ samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_50to100_AllouezBay.mxd




ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the >100 cm Sediment Layer: Allouez Bay

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Allouez Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

No PCDD/F $TEQ_{WHO98\text{-}Fish}$ samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_over100_AllouezBay.mxd

ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in Surface Sediment: Superior Bay

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ in surface samples (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 km

Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_Surface_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 15 cm to 50 cm Sediment Layer: Superior Bay

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 km

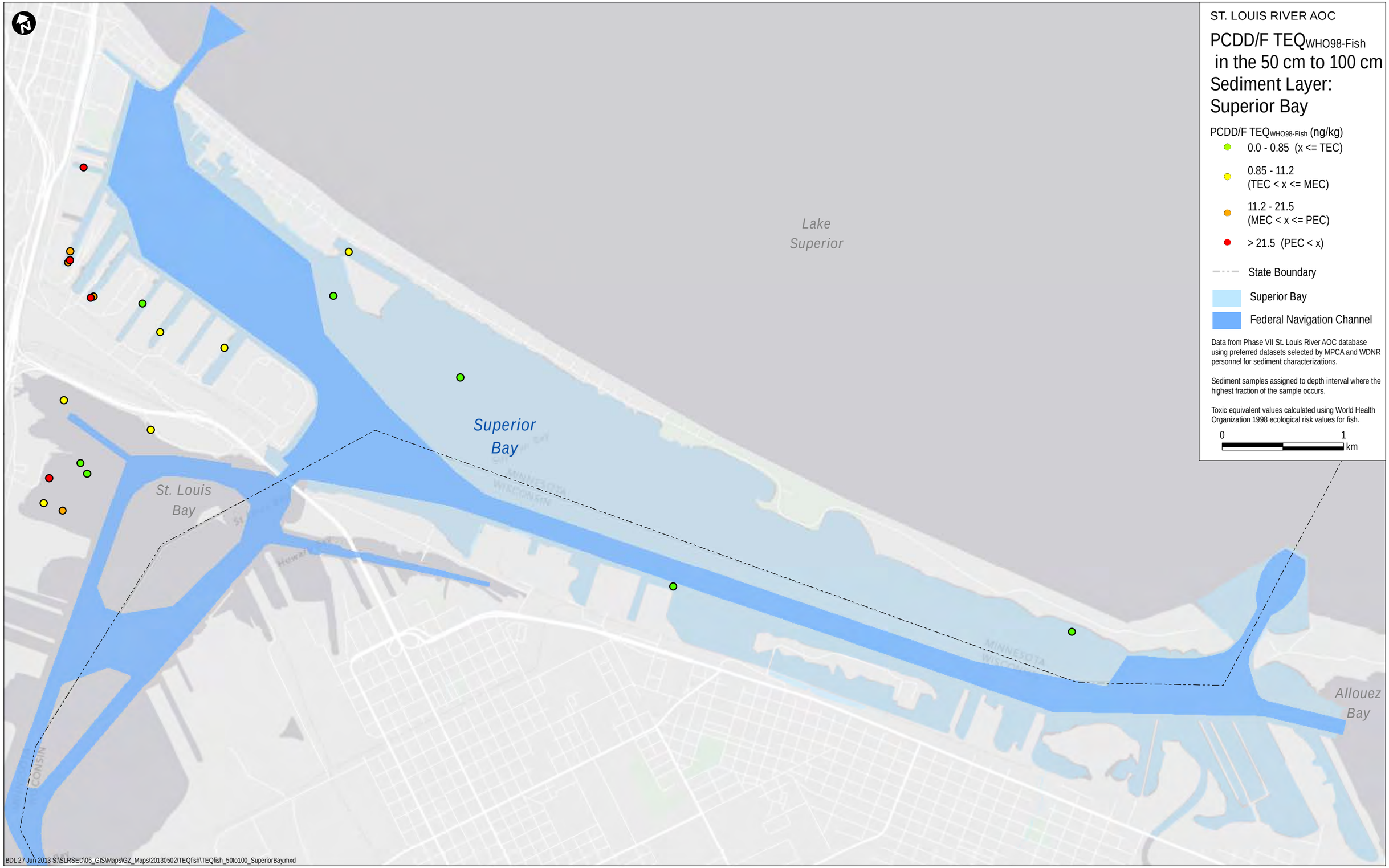
Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_15to50_SuperiorBay.mxd




ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 50 cm to 100 cm Sediment Layer: Superior Bay

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

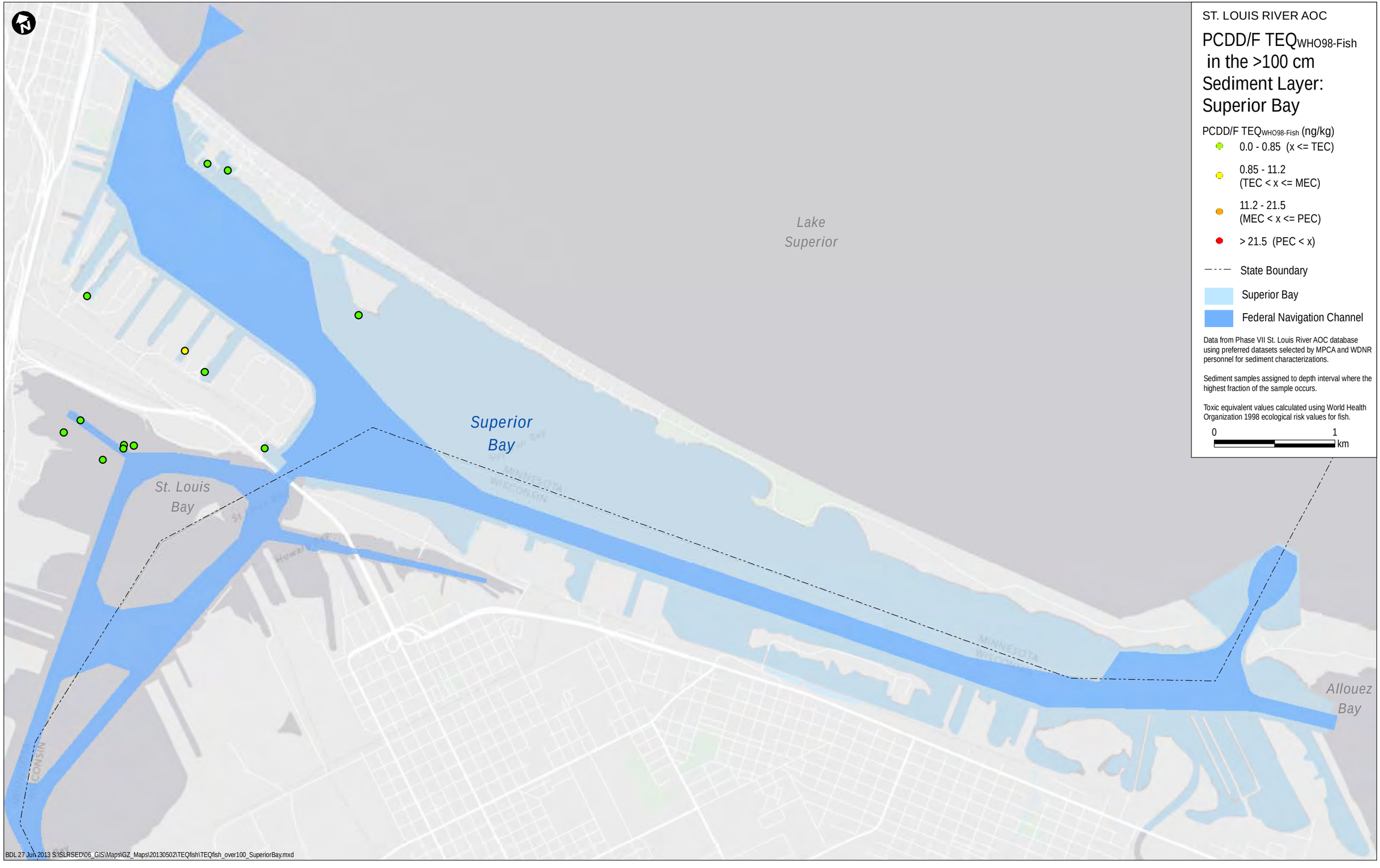
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_50to100_SuperiorBay.mxd




ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the >100 cm Sediment Layer: Superior Bay

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

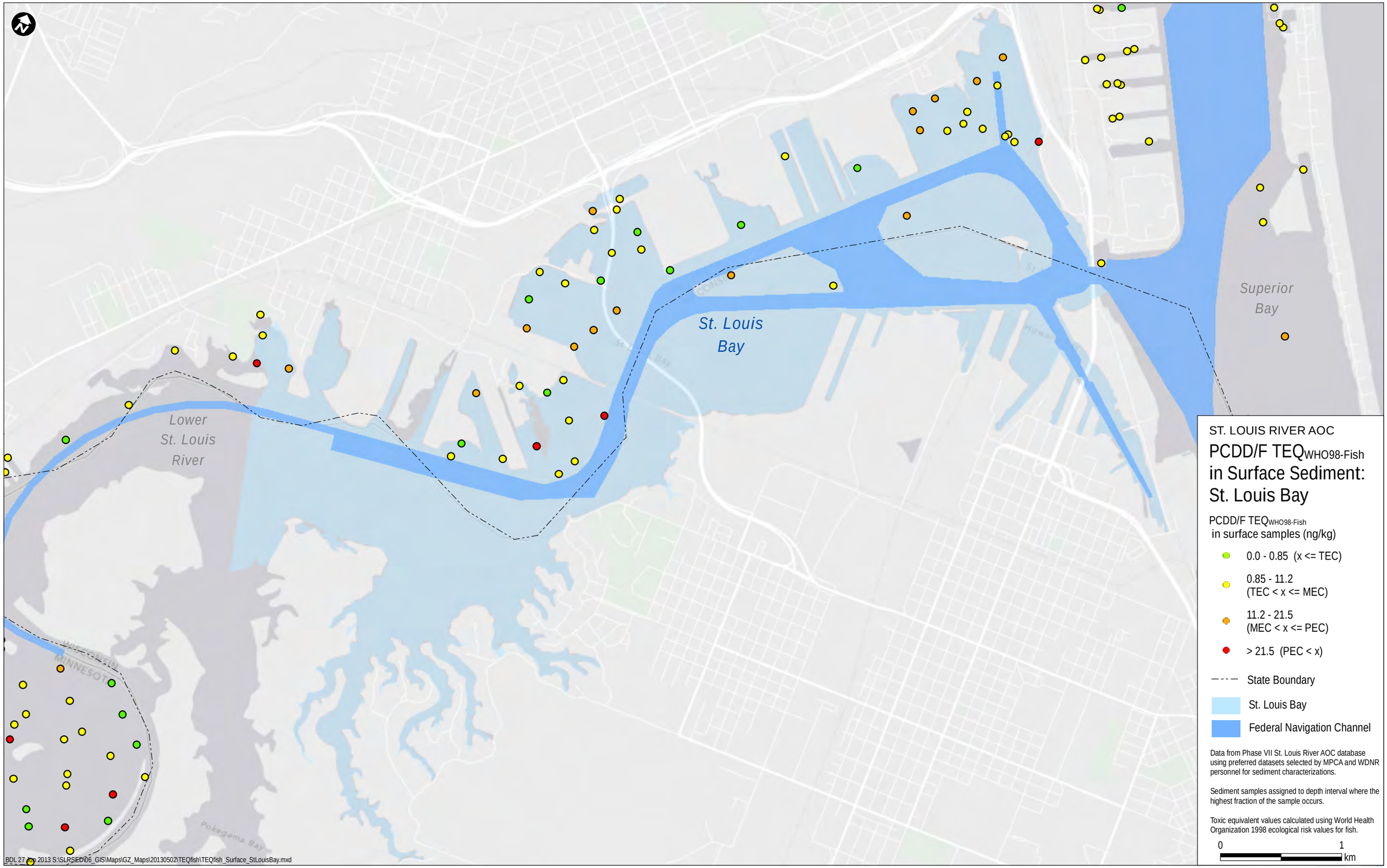
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

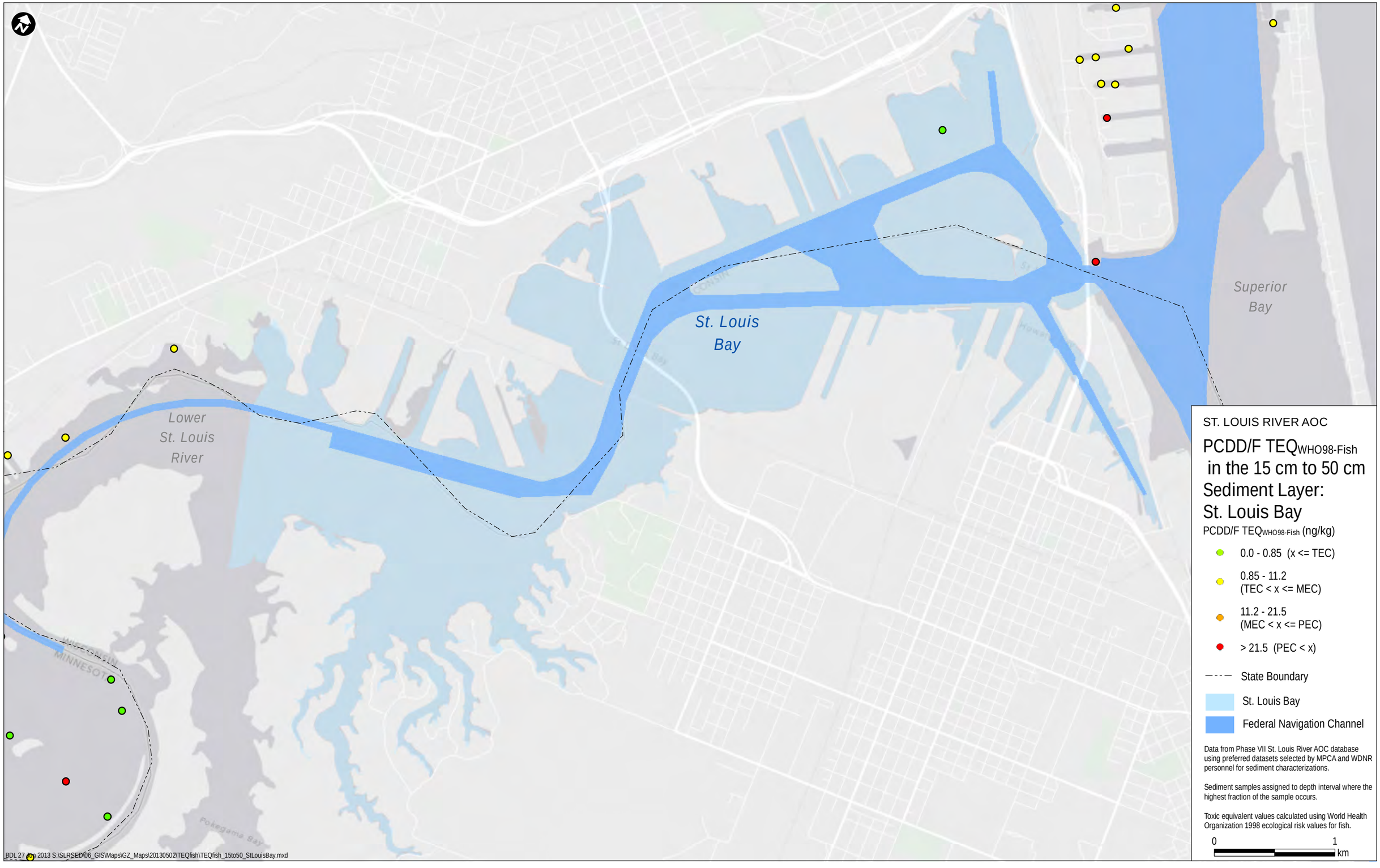
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

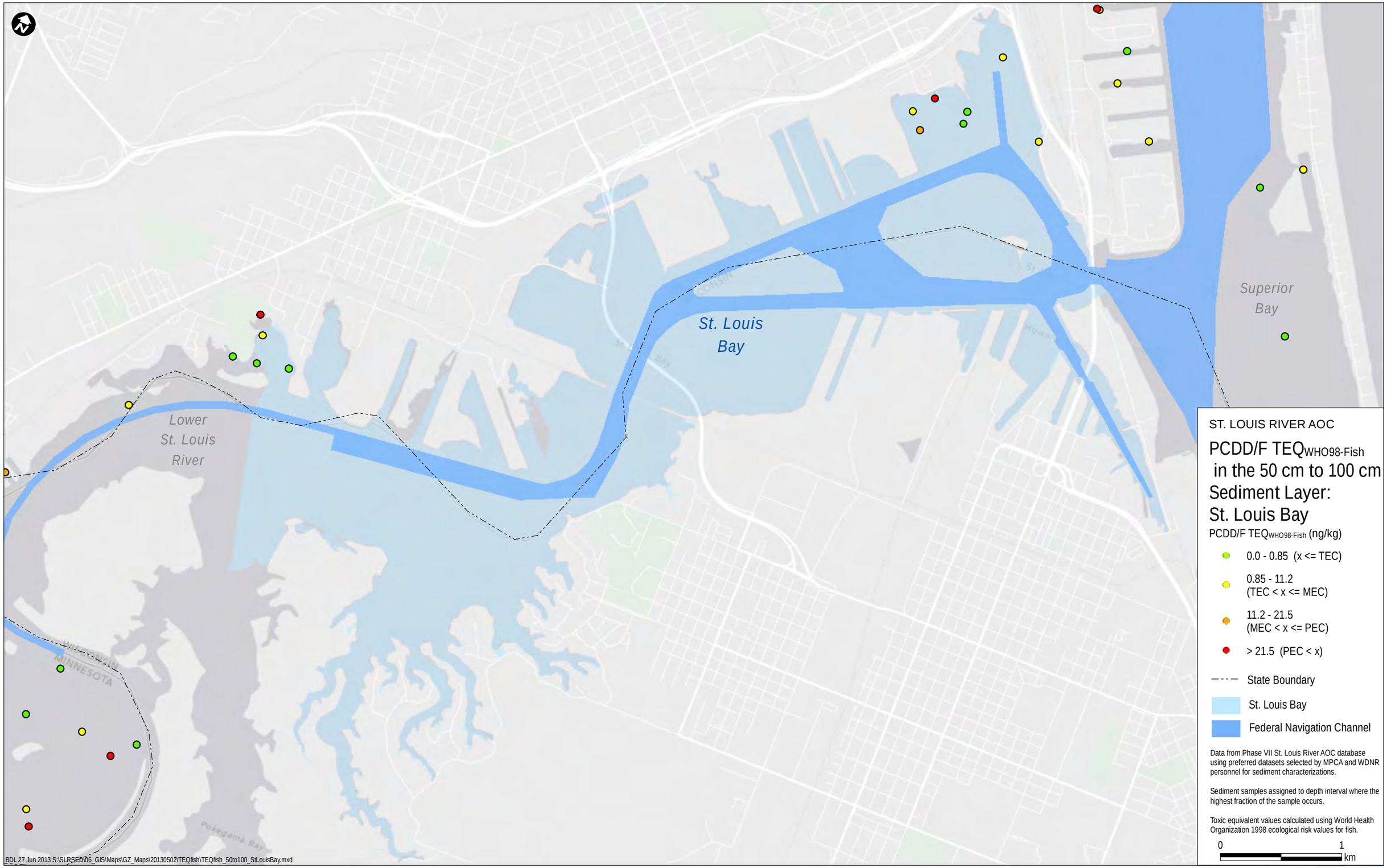
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

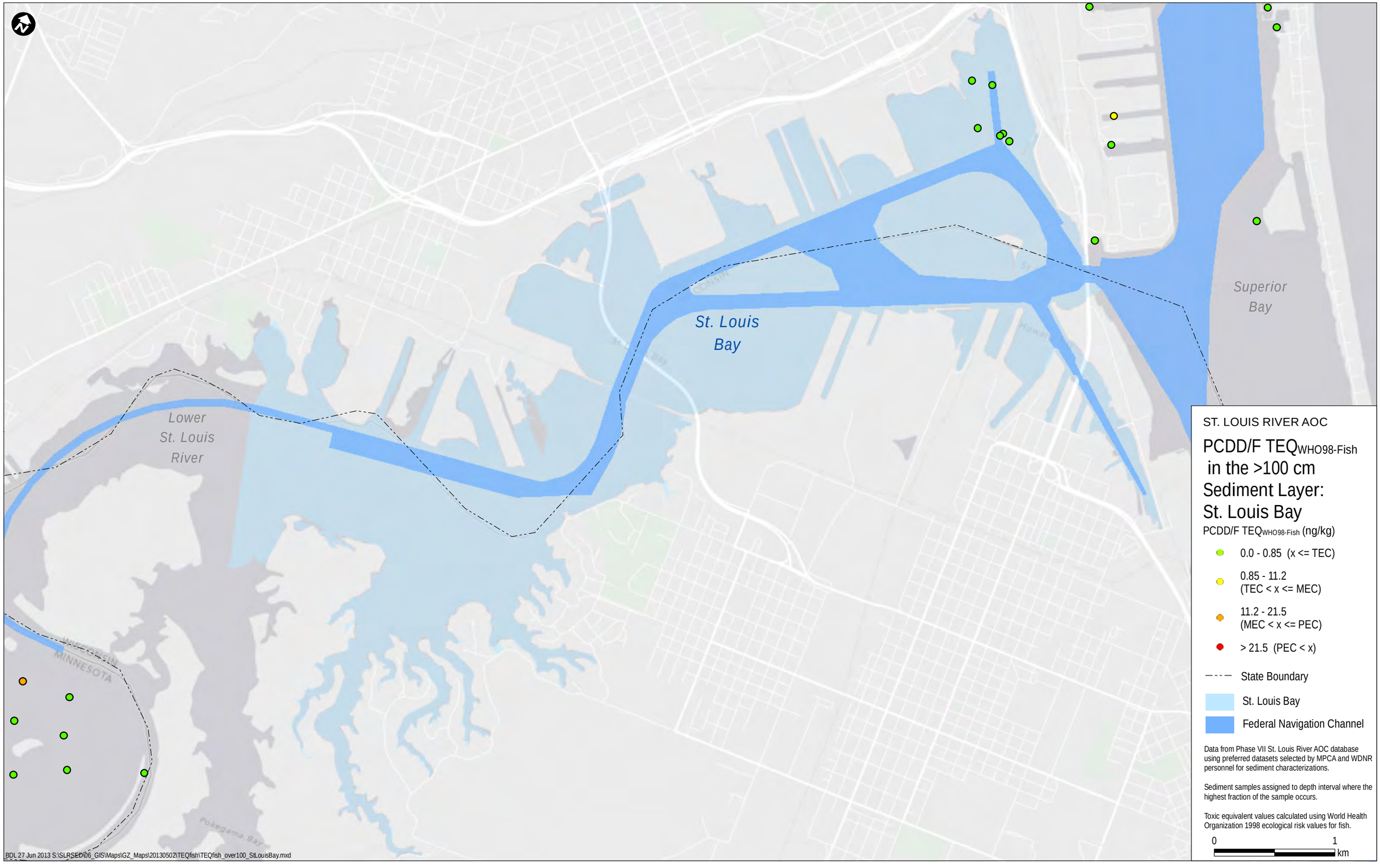
0 1 km

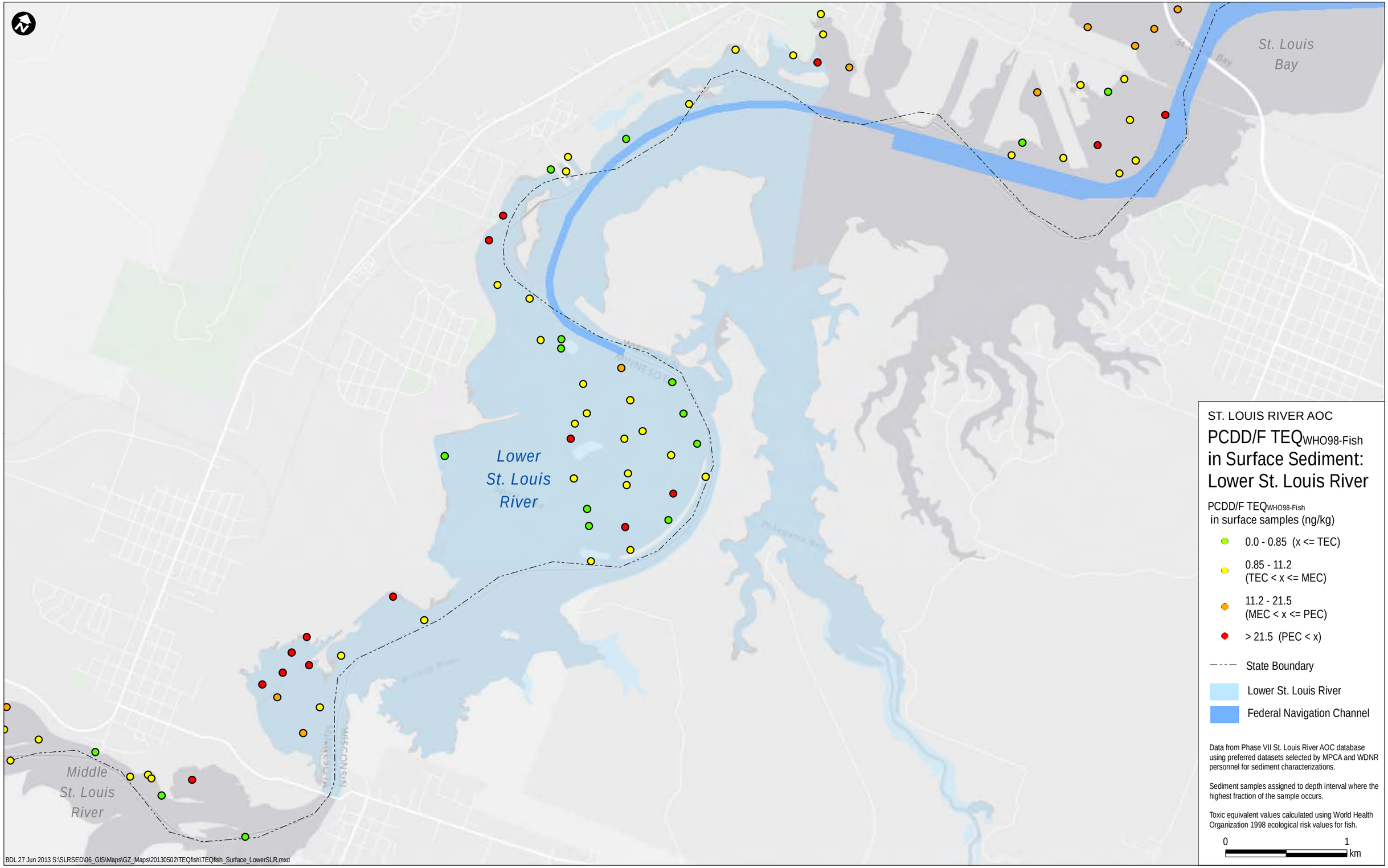
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_over100_SuperiorBay.mxd

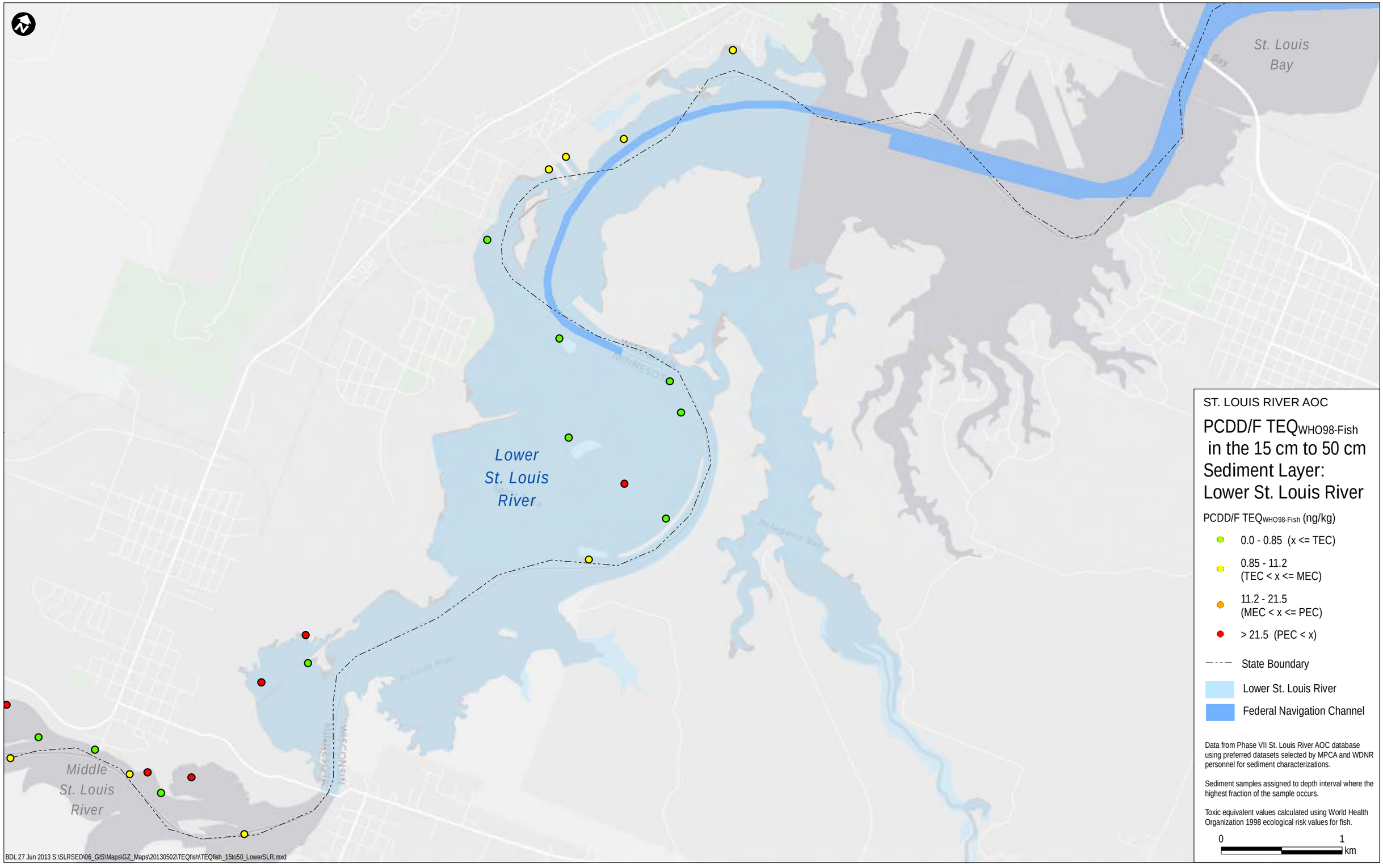

St. Louis Bay
Superior Bay
Lower St. Louis River
Pokegama Bay
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish in Surface Sediment: St. Louis Bay
PCDD/F TEQWHO98-Fish in surface samples (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2 (TEC < x <= MEC)
11.2 - 21.5 (MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jan 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_Surface_StLouisBay.mxd


St. Louis
Bay
Superior
Bay
Lower
St. Louis
River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish
in the 15 cm to 50 cm
Sediment Layer:
St. Louis Bay
PCDD/F TEQWHO98-Fish (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2
(TEC < x <= MEC)
11.2 - 21.5
(MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_15to50_StLouisBay.mxd


St. Louis
Bay
Superior
Bay
Lower
St. Louis
River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish
in the 50 cm to 100 cm
Sediment Layer:
St. Louis Bay
PCDD/F TEQWHO98-Fish (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2
(TEC < x <= MEC)
11.2 - 21.5
(MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_50to100_StLouisBay.mxd


St. Louis
Bay
Superior
Bay
Lower
St. Louis
River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish
in the >100 cm
Sediment Layer:
St. Louis Bay
PCDD/F TEQWHO98-Fish (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2
(TEC < x <= MEC)
11.2 - 21.5
(MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\LSRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_over100_StLouisBay.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish in Surface Sediment: Lower St. Louis River
PCDD/F TEQWHO98-Fish in surface samples (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2 (TEC < x <= MEC)
11.2 - 21.5 (MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_Surface_LowerSLR.mxd




ST. LOUIS RIVER AOC

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 15 cm to 50 cm Sediment Layer: Lower St. Louis River

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Lower St. Louis River

Federal Navigation Channel

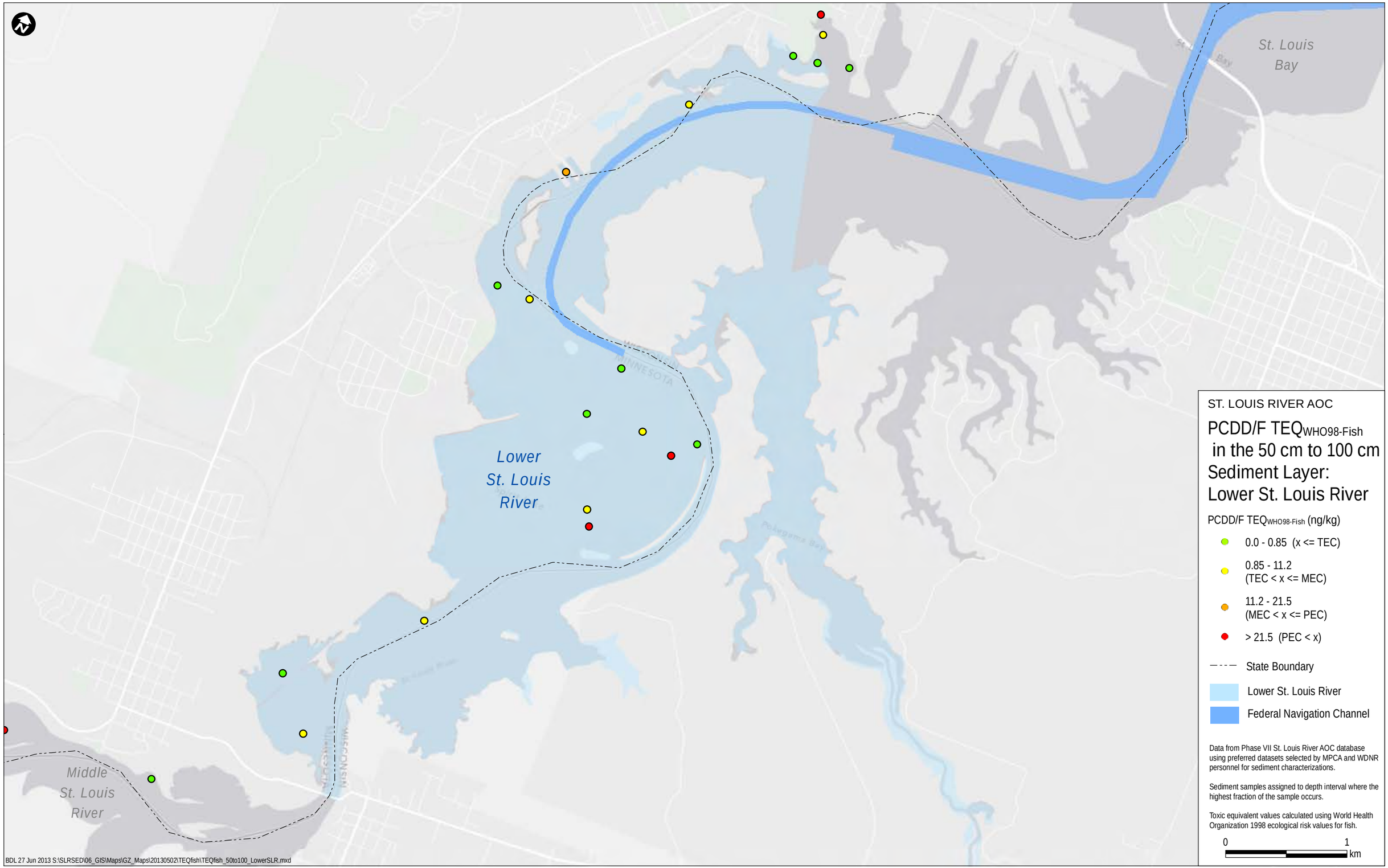
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

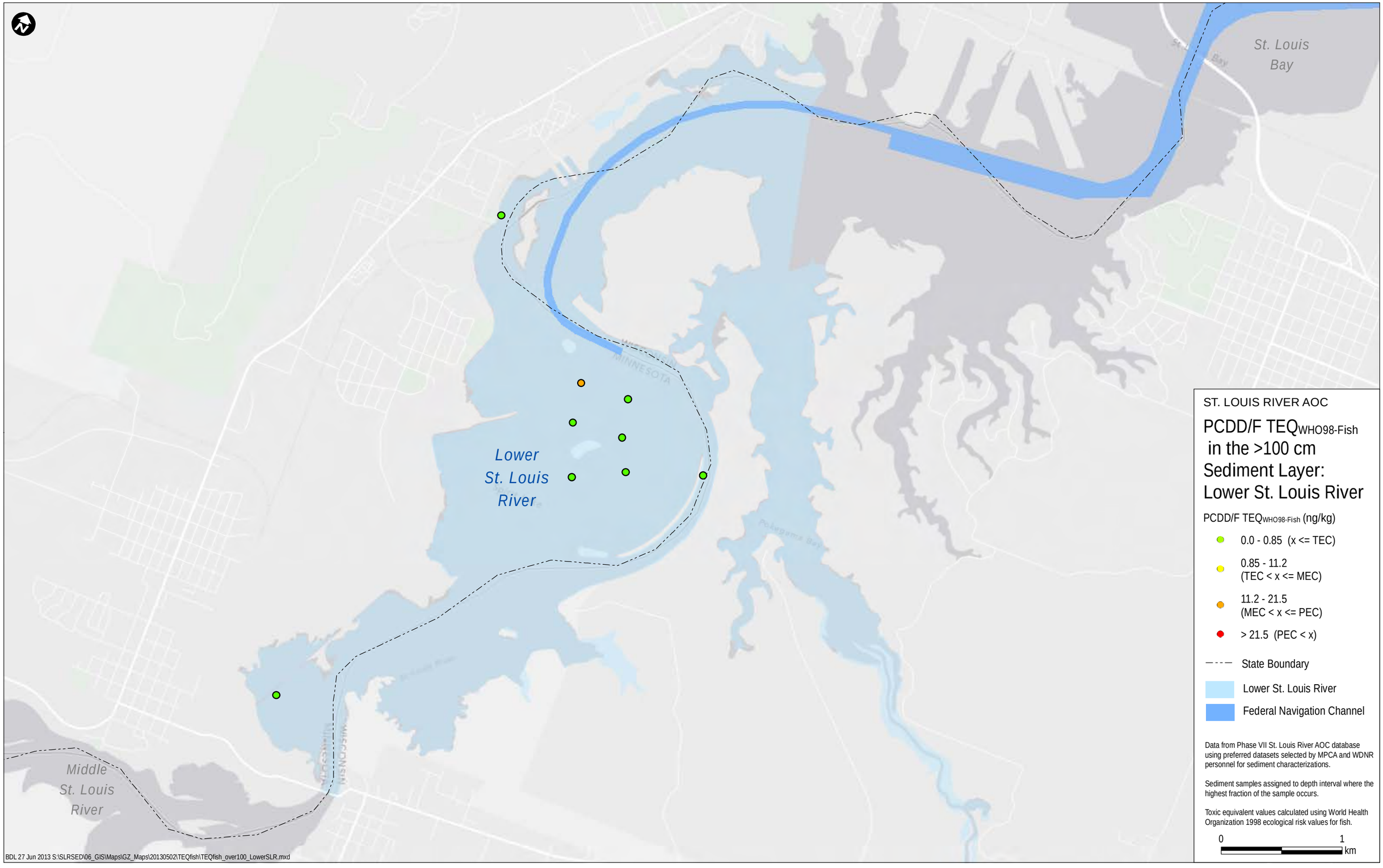
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

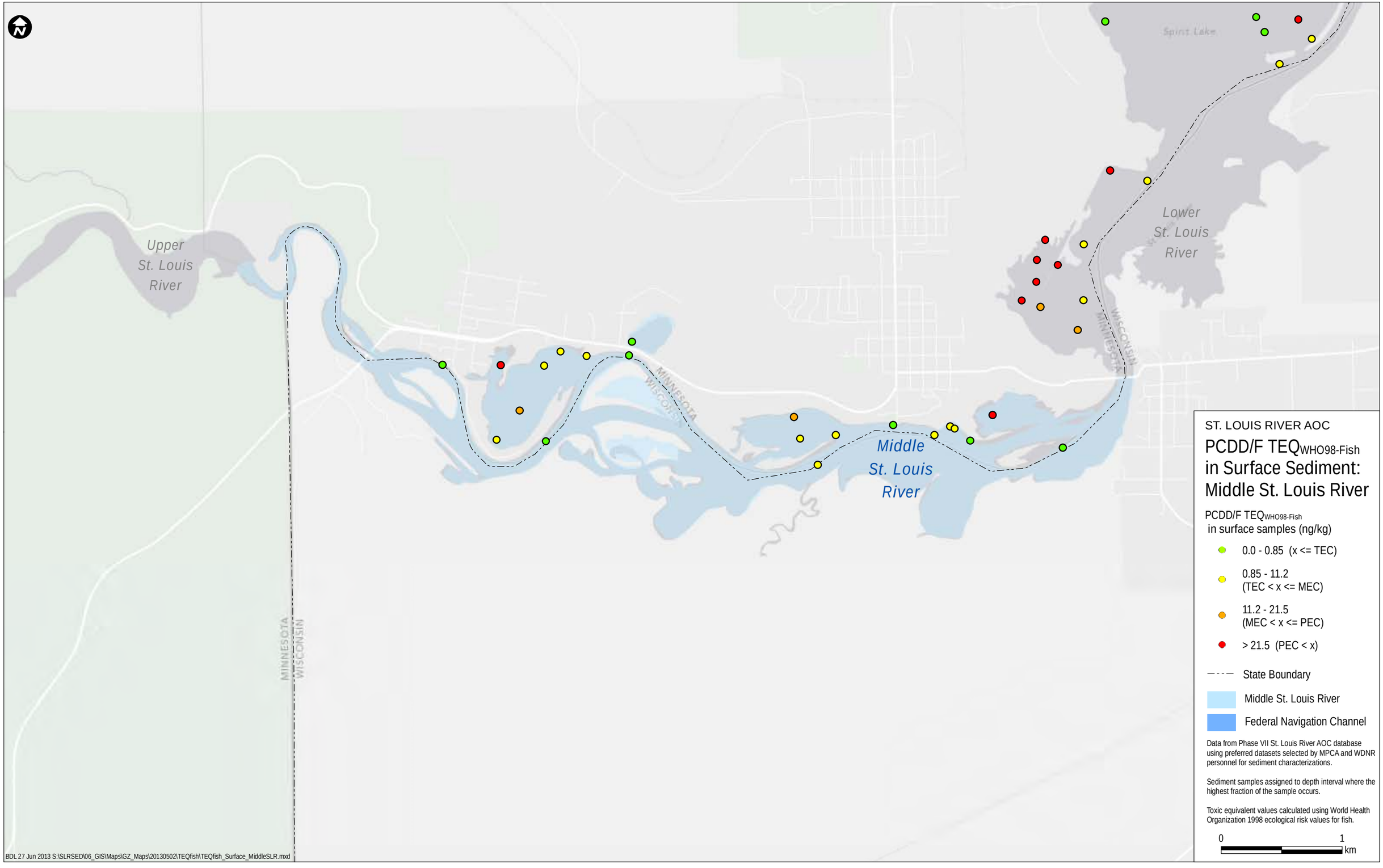
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_15to50_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish in the 50 cm to 100 cm Sediment Layer: Lower St. Louis River
PCDD/F TEQWHO98-Fish (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2 (TEC < x <= MEC)
11.2 - 21.5 (MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_50to100_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish in the >100 cm Sediment Layer: Lower St. Louis River
PCDD/F TEQWHO98-Fish (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2 (TEC < x <= MEC)
11.2 - 21.5 (MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_over100_LowerSLR.mxd




ST. LOUIS RIVER AOC

## PCDD/F $TEQ_{WHO98\text{-}Fish}$ in Surface Sediment: Middle St. Louis River

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in surface samples (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Middle St. Louis River

Federal Navigation Channel

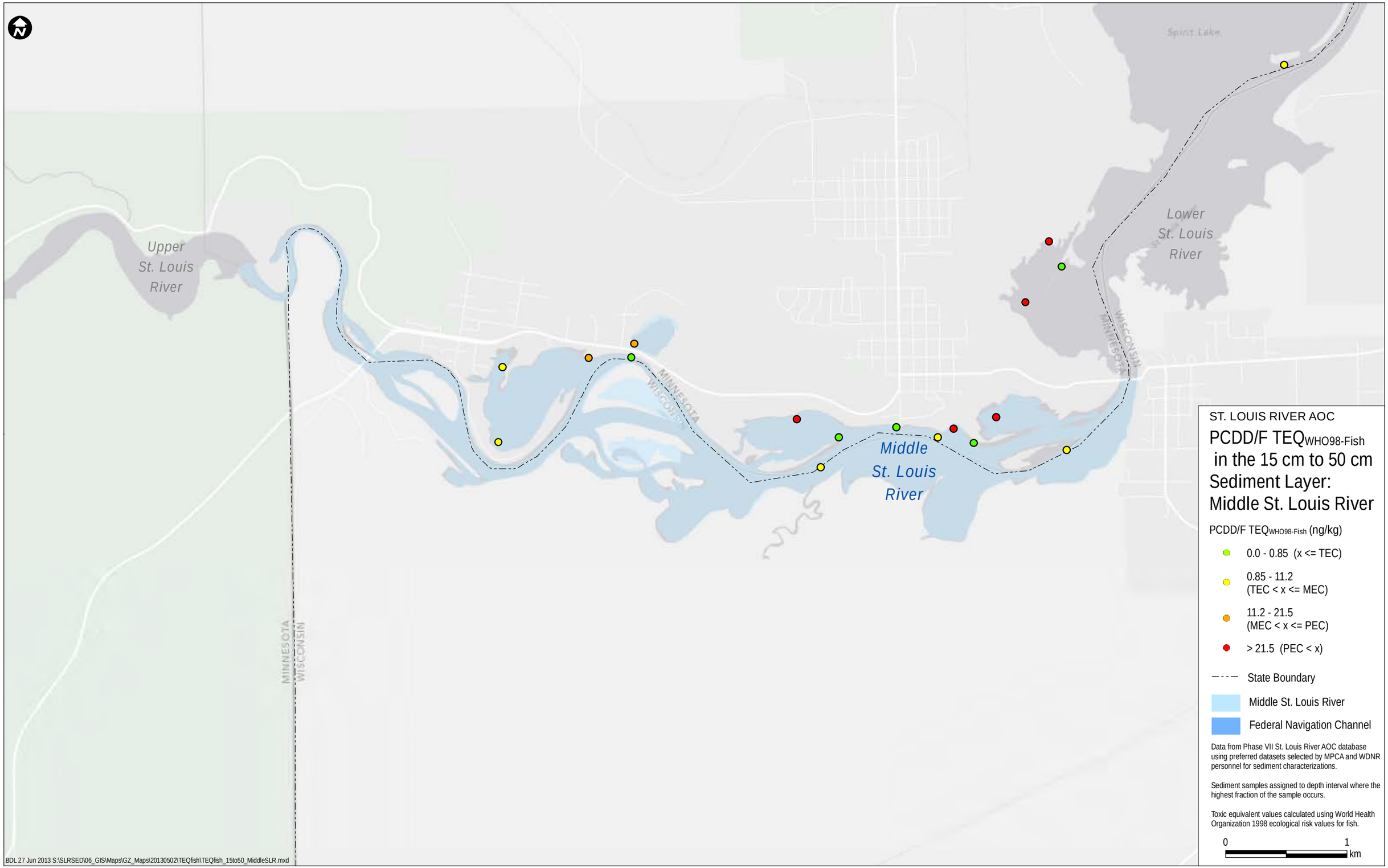
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

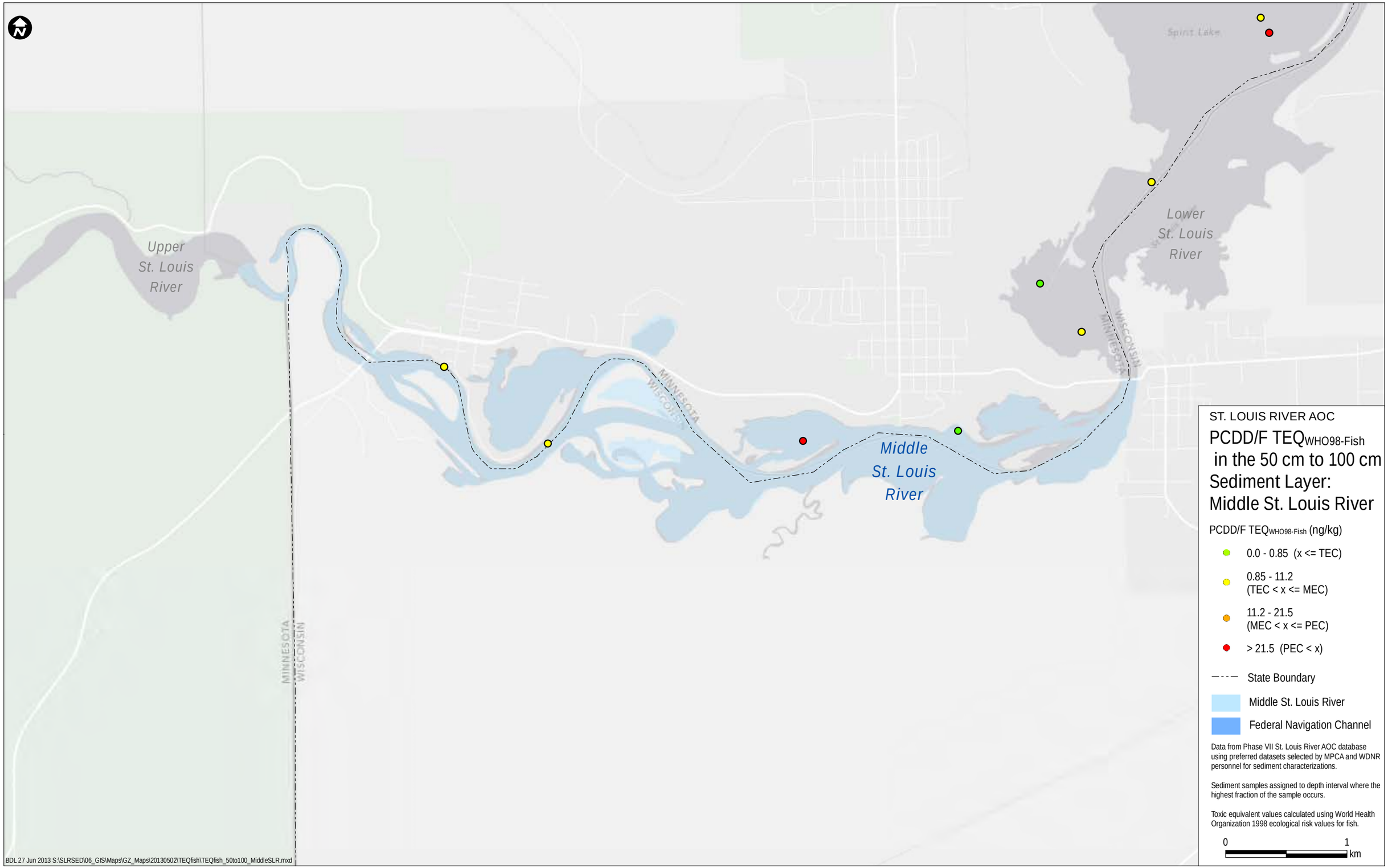
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

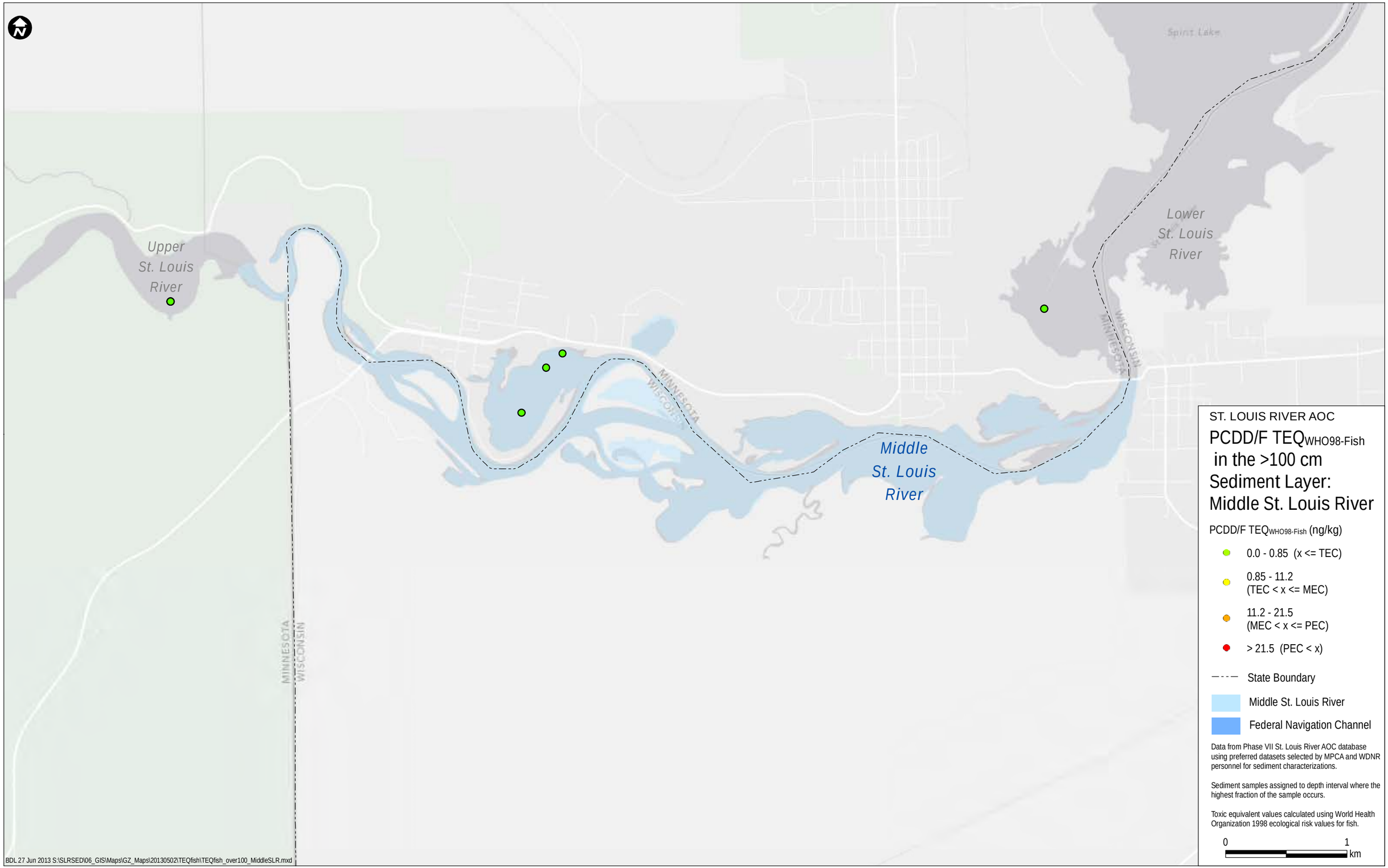
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_Surface_MiddleSLR.mxd


Spirit Lake
Upper
St. Louis
River
Lower
St. Louis
River
Middle
St. Louis
River
MINNESOTA
WISCONSIN
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish
in the 15 cm to 50 cm
Sediment Layer:
Middle St. Louis River
PCDD/F TEQWHO98-Fish (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2
(TEC < x <= MEC)
11.2 - 21.5
(MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_15to50_MiddleSLR.mxd


Spirit Lake
Lower
St. Louis
River
Upper
St. Louis
River
Middle
St. Louis
River
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish
in the 50 cm to 100 cm
Sediment Layer:
Middle St. Louis River
PCDD/F TEQWHO98-Fish (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2
(TEC < x <= MEC)
11.2 - 21.5
(MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_50to100_MiddleSLR.mxd


Spirit Lake
Upper
St. Louis
River
Lower
St. Louis
River
Middle
St. Louis
River
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
PCDD/F TEQWHO98-Fish
in the >100 cm
Sediment Layer:
Middle St. Louis River
PCDD/F TEQWHO98-Fish (ng/kg)
0.0 - 0.85 (x <= TEC)
0.85 - 11.2
(TEC < x <= MEC)
11.2 - 21.5
(MEC < x <= PEC)
> 21.5 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_over100_MiddleSLR.mxd

ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in Surface Sediment: Upper St. Louis River

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in surface samples (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

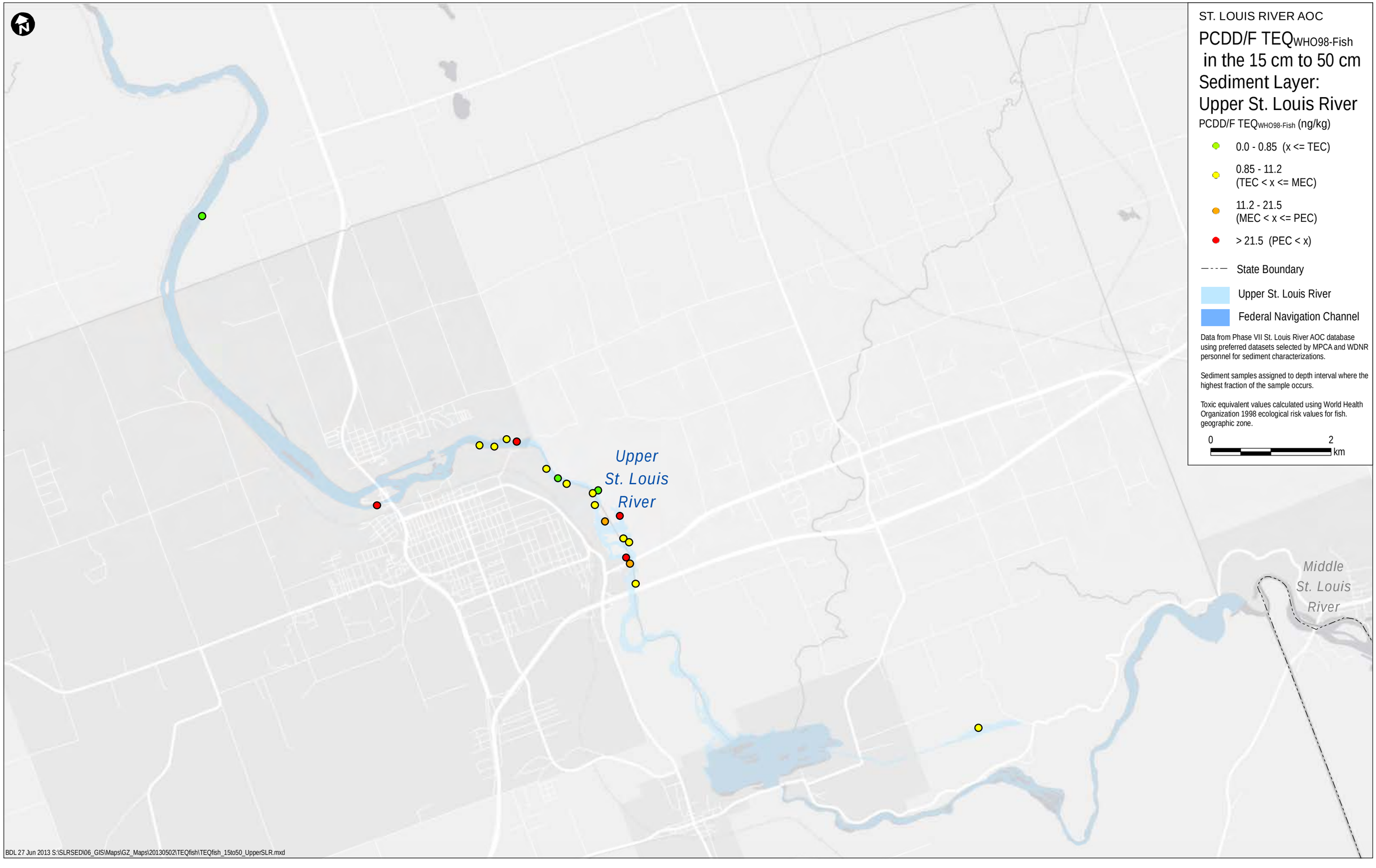
Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish. geographic zone.

0 2 km

Upper St. Louis River

Middle St. Louis River

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_Surface_UpperSLR.mxd




ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 15 cm to 50 cm Sediment Layer: Upper St. Louis River

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish. geographic zone.

0 2 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_15to50_UpperSLR.mxd

ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 50 cm to 100 cm Sediment Layer: Upper St. Louis River

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish. geographic zone.

0 2 km

Upper St. Louis River

Middle St. Louis River

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_50to100_UpperSLR.mxd


ST. LOUIS RIVER AOC

# PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the >100 cm Sediment Layer: Upper St. Louis River

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

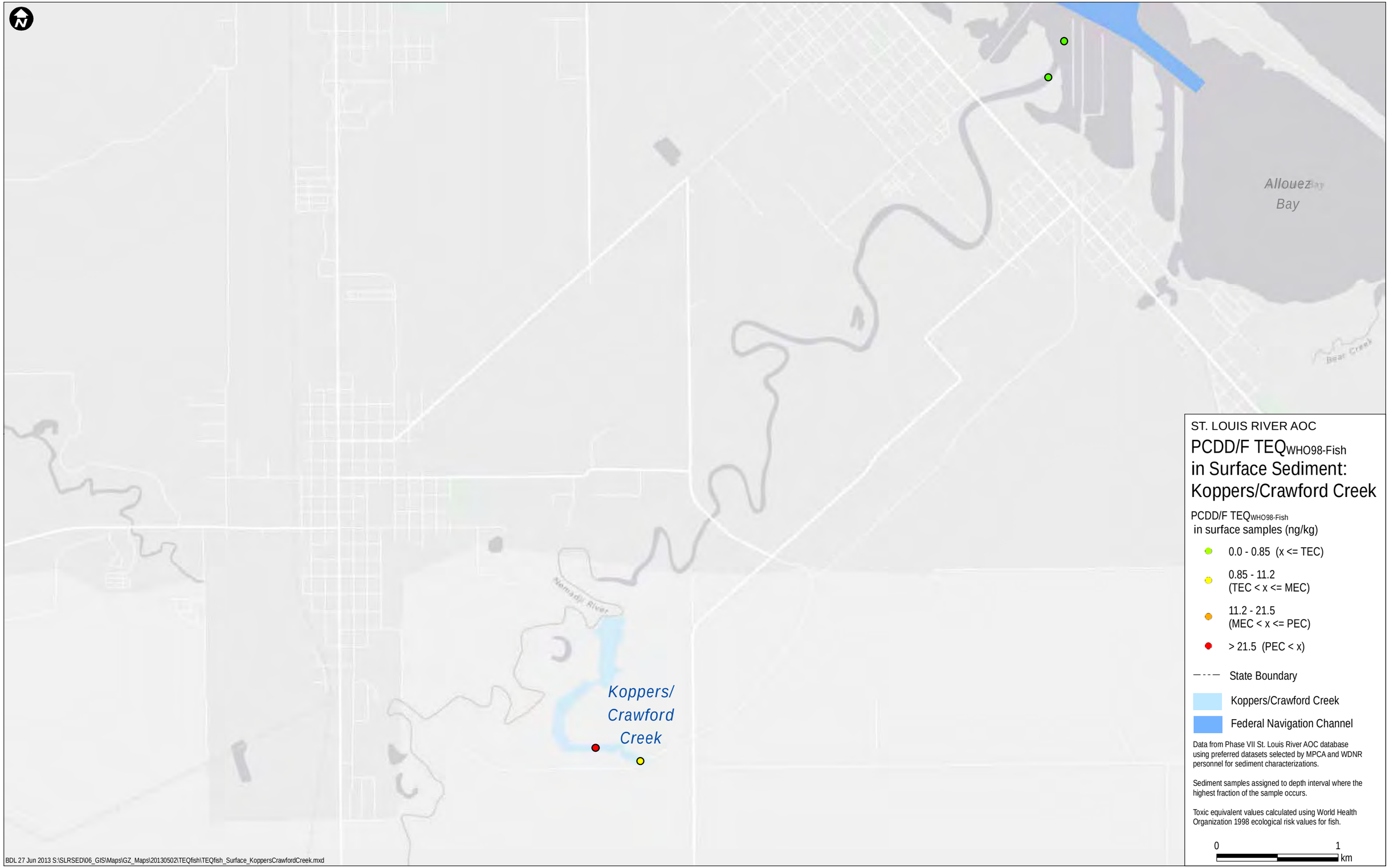
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish. geographic zone.

0 2 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_over100_UpperSLR.mxd




ST. LOUIS RIVER AOC

## PCDD/F $TEQ_{WHO98\text{-}Fish}$ in Surface Sediment: Koppers/Crawford Creek

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in surface samples (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

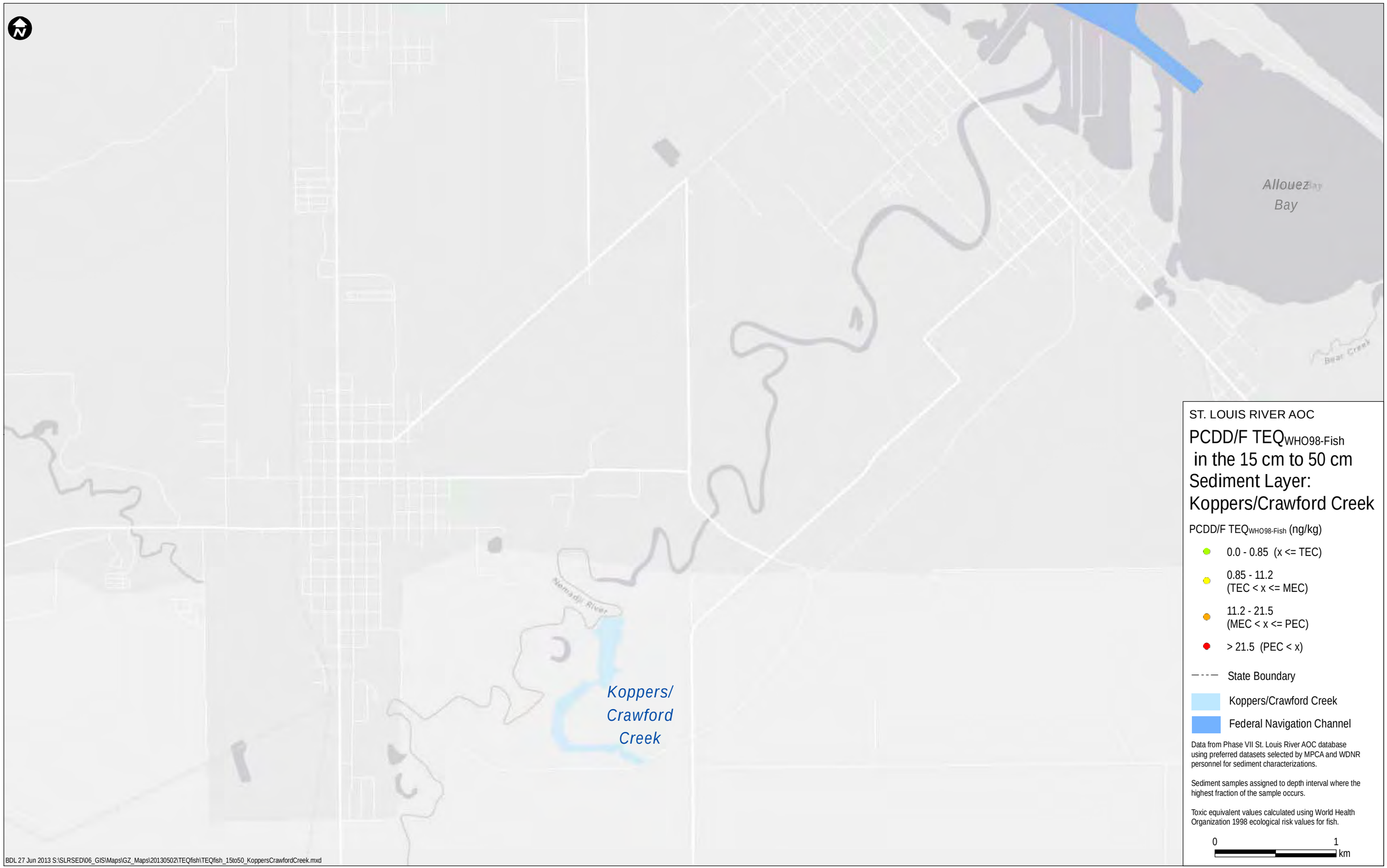
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_Surface_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

## PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 15 cm to 50 cm Sediment Layer: Koppers/Crawford Creek

$PCDD/F\ TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

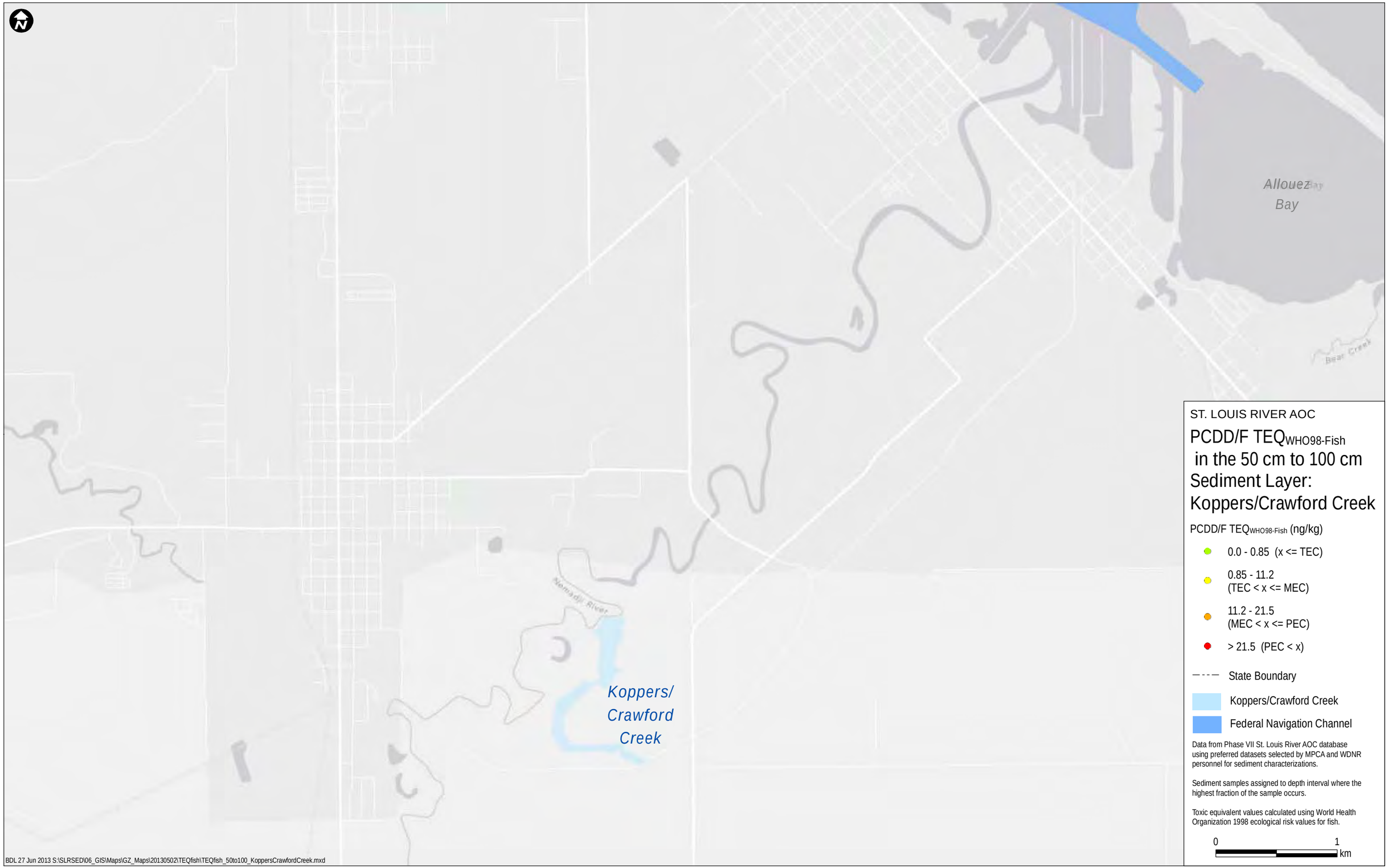
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_15to50_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the 50 cm to 100 cm Sediment Layer: Koppers/Crawford Creek

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

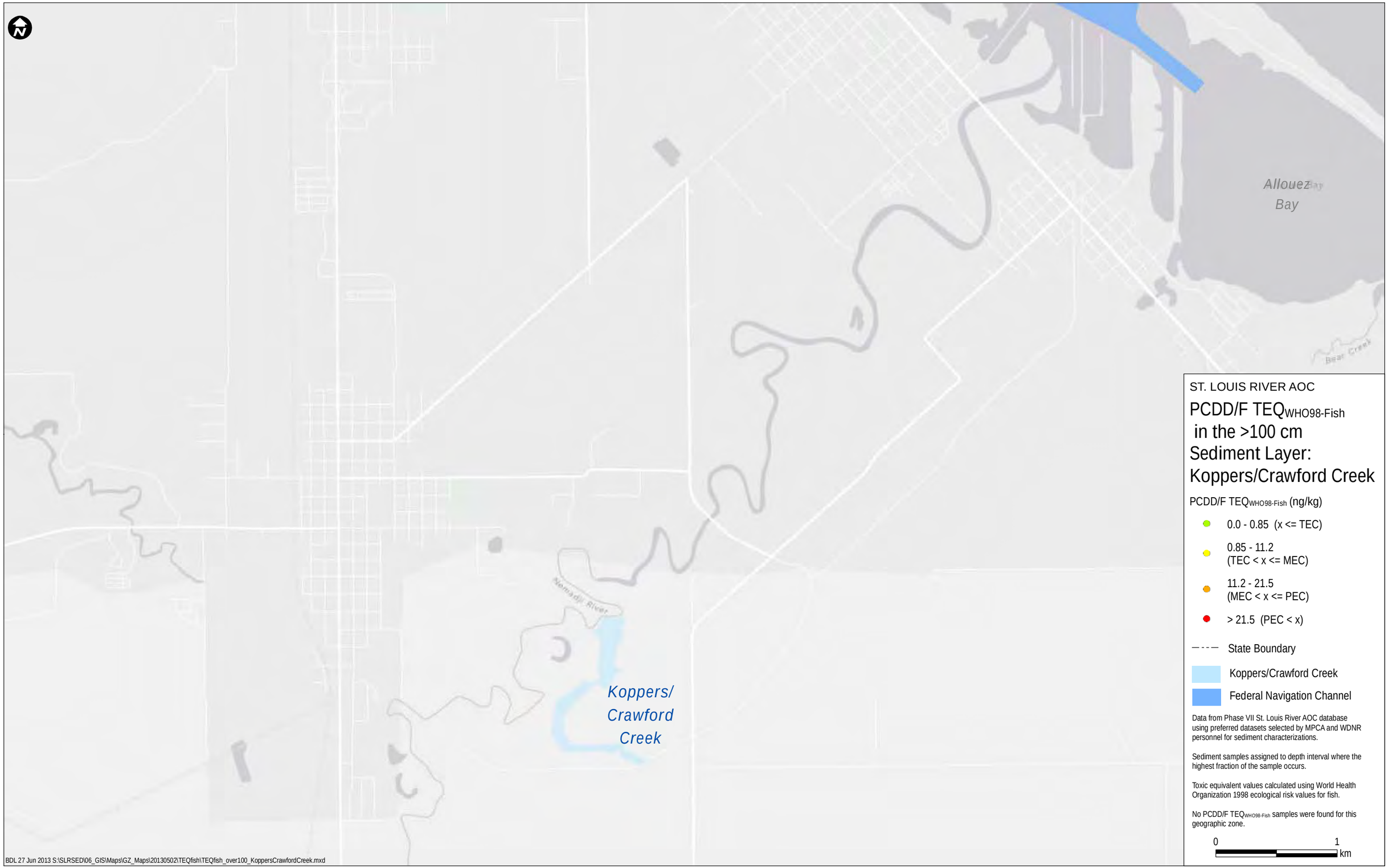
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_50to100_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

PCDD/F $TEQ_{WHO98\text{-}Fish}$ in the >100 cm Sediment Layer: Koppers/Crawford Creek

PCDD/F $TEQ_{WHO98\text{-}Fish}$ (ng/kg)

- 0.0 - 0.85 (x <= TEC)
- 0.85 - 11.2 (TEC < x <= MEC)
- 11.2 - 21.5 (MEC < x <= PEC)
- > 21.5 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

Toxic equivalent values calculated using World Health Organization 1998 ecological risk values for fish.

No PCDD/F $TEQ_{WHO98\text{-}Fish}$ samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\TEQfish\TEQfish_over100_KoppersCrawfordCreek.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Superior

Middle St. Louis River

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Lead in Surface Sediment: Geographic Zones

Lead concentrations in surface samples (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)
- State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

hbird 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\PbPh_Surface_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Lead in the 15 cm to 50 cm Sediment Layer: Geographic Zones

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

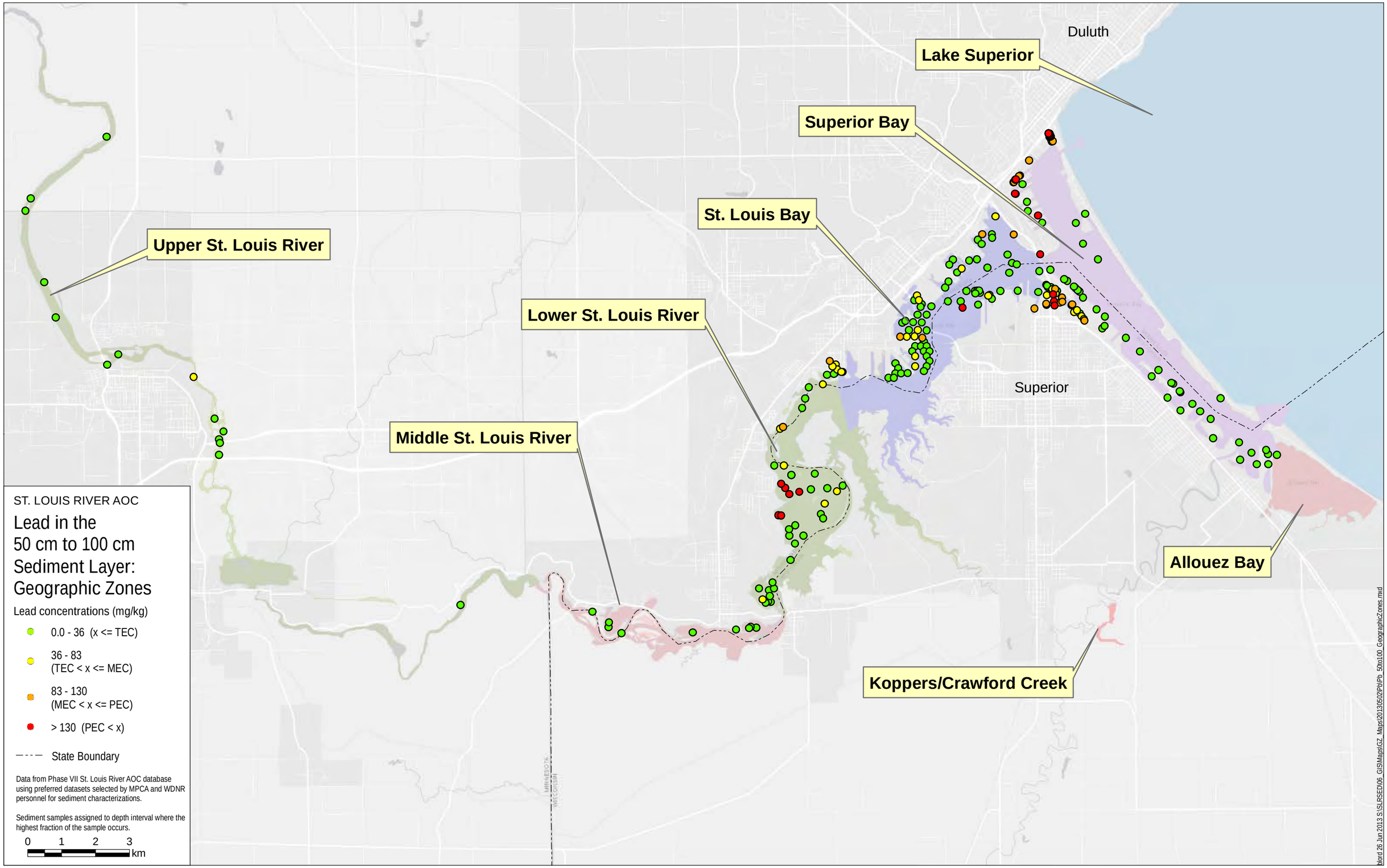
State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

blord 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130602\PbPb_15to50_GeographicZones.mxd


Duluth
Lake Superior
Superior Bay
St. Louis Bay
Upper St. Louis River
Lower St. Louis River
Middle St. Louis River
Superior
Allouez Bay
Koppers/Crawford Creek
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Lead in the
50 cm to 100 cm
Sediment Layer:
Geographic Zones
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83
(TEC < x <= MEC)
83 - 130
(MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0 1 2 3
km
bord 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\PbHPb_50to100_GeographicZones.mxd

Duluth

Lake Superior

Superior Bay

St. Louis Bay

Upper St. Louis River

Lower St. Louis River

Middle St. Louis River

Superior

Allouez Bay

Koppers/Crawford Creek

MINNESOTA
WISCONSIN

ST. LOUIS RIVER AOC

## Lead in the >100 cm Sediment Layer: Geographic Zones

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

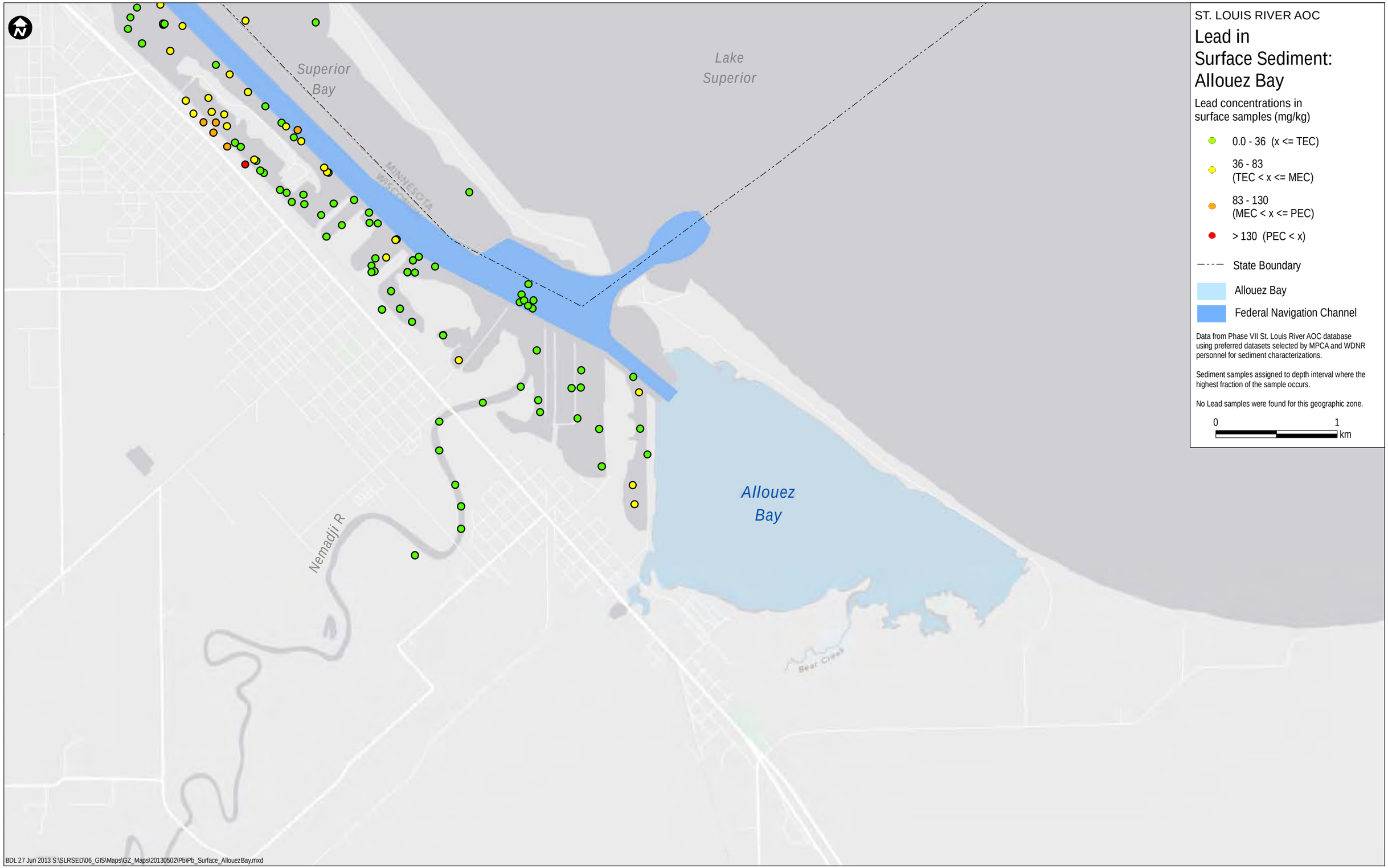
State Boundary

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 2 3 km

bord 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\PbPb_over100_GeographicZones.mxd




ST. LOUIS RIVER AOC

# Lead in Surface Sediment: Allouez Bay

Lead concentrations in surface samples (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

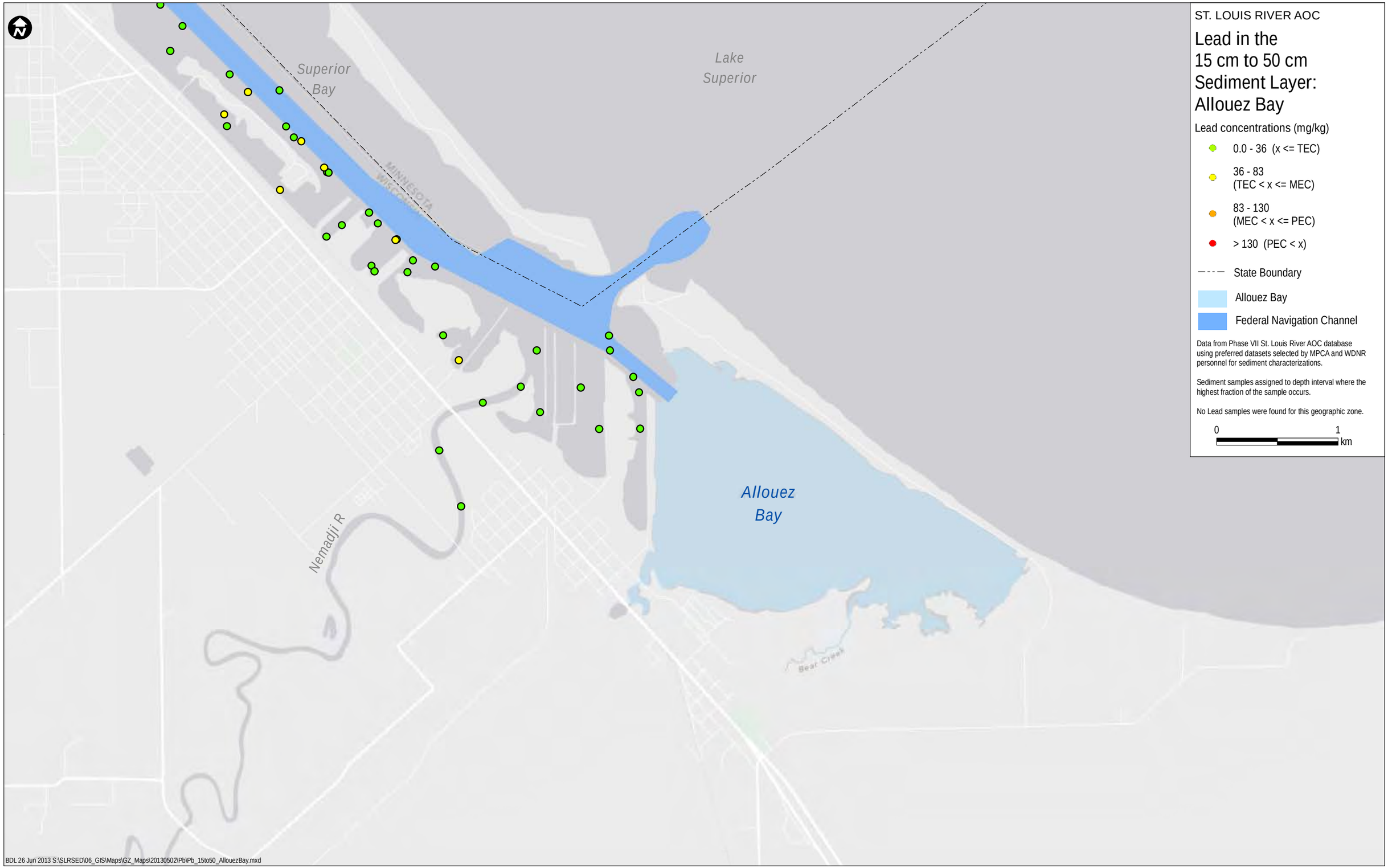
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Lead samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_Surface_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Lead in the 15 cm to 50 cm Sediment Layer: Allouez Bay

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

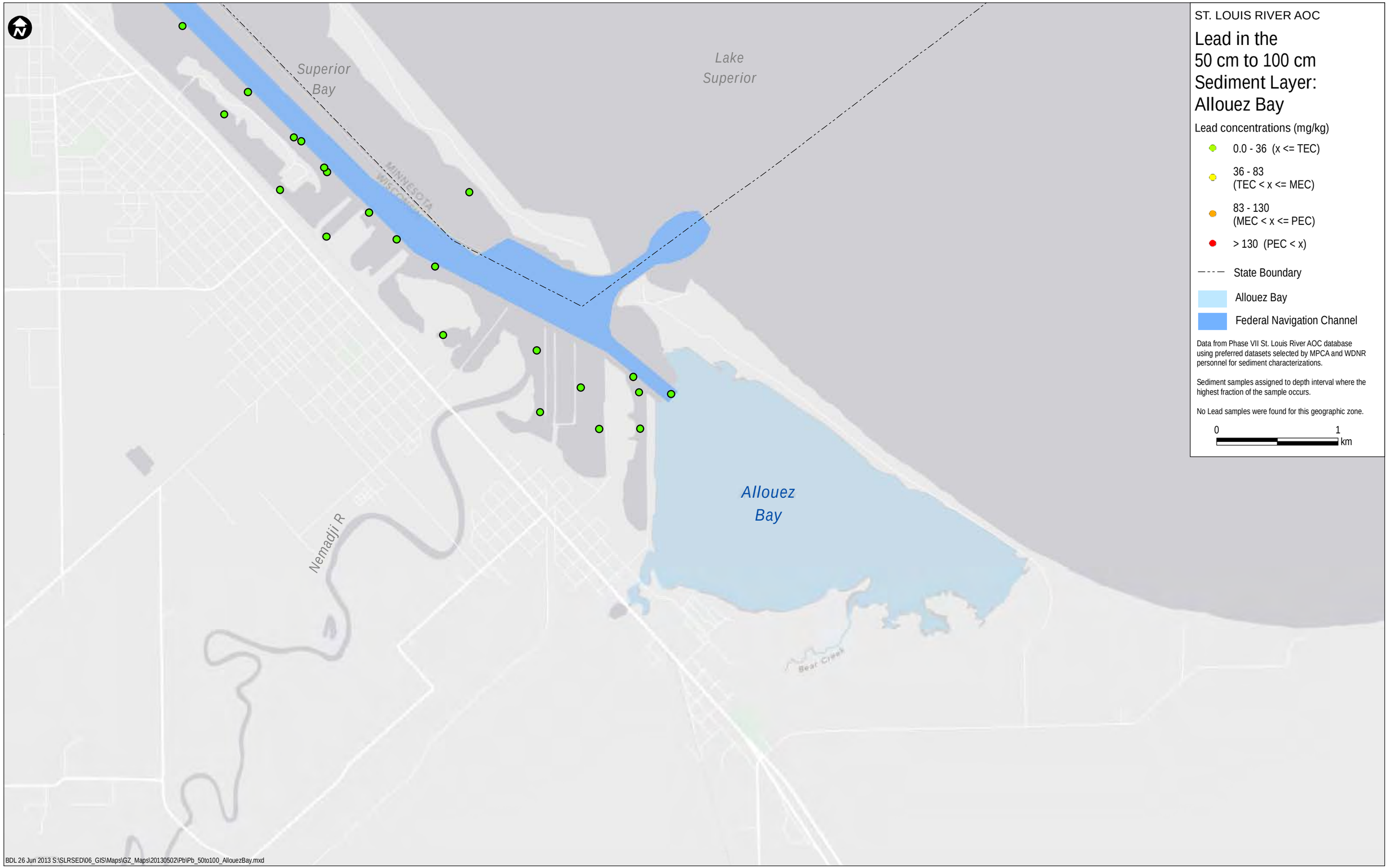
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Lead samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_15to50_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Lead in the 50 cm to 100 cm Sediment Layer: Allouez Bay

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)
- State Boundary
- Allouez Bay
- Federal Navigation Channel

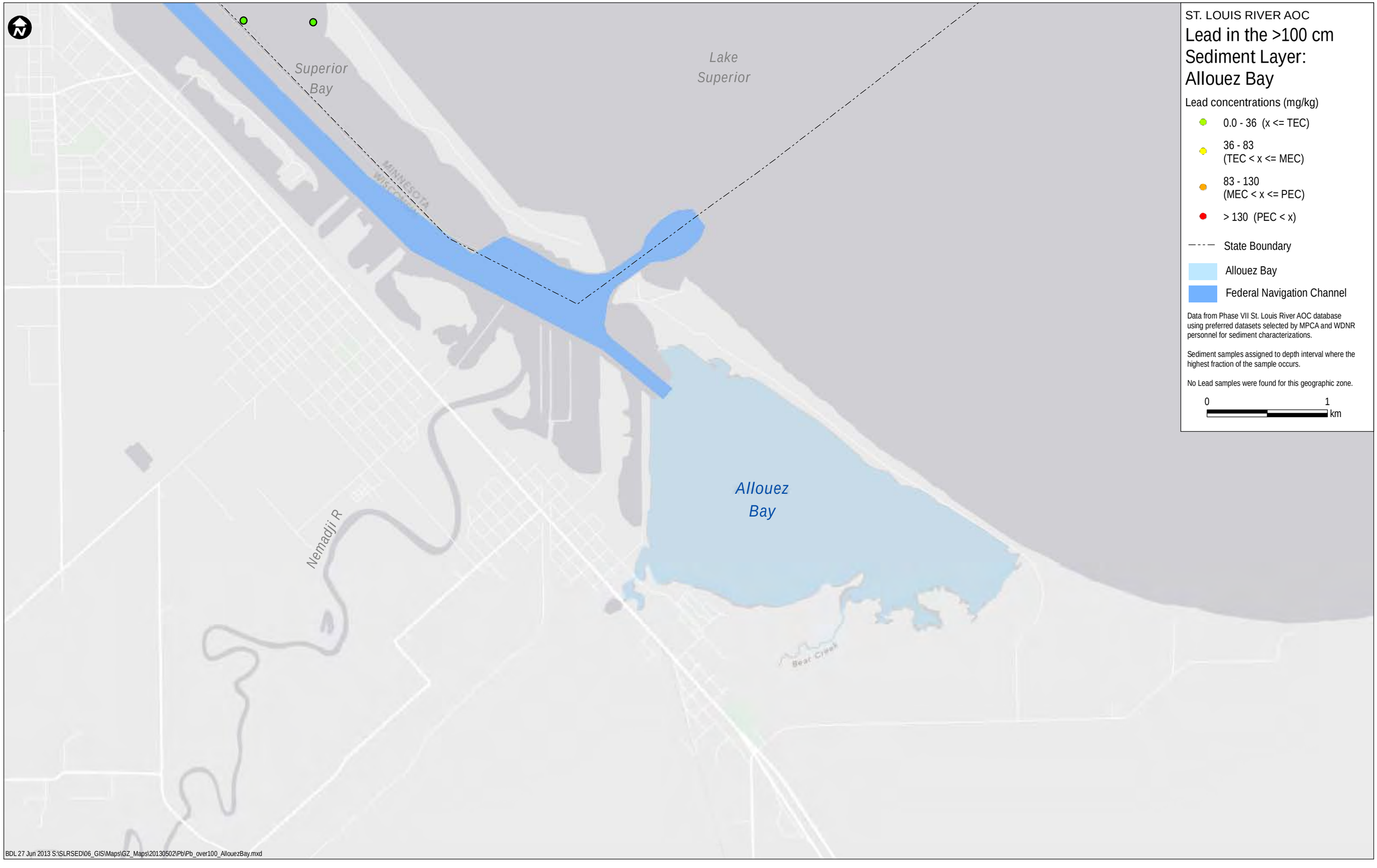
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Lead samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_50to100_AllouezBay.mxd




ST. LOUIS RIVER AOC

# Lead in the >100 cm Sediment Layer: Allouez Bay

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Allouez Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Lead samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_over100_AllouezBay.mxd

ST. LOUIS RIVER AOC

# Mercury in Surface Sediment: Superior Bay

Lead concentrations in surface samples (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

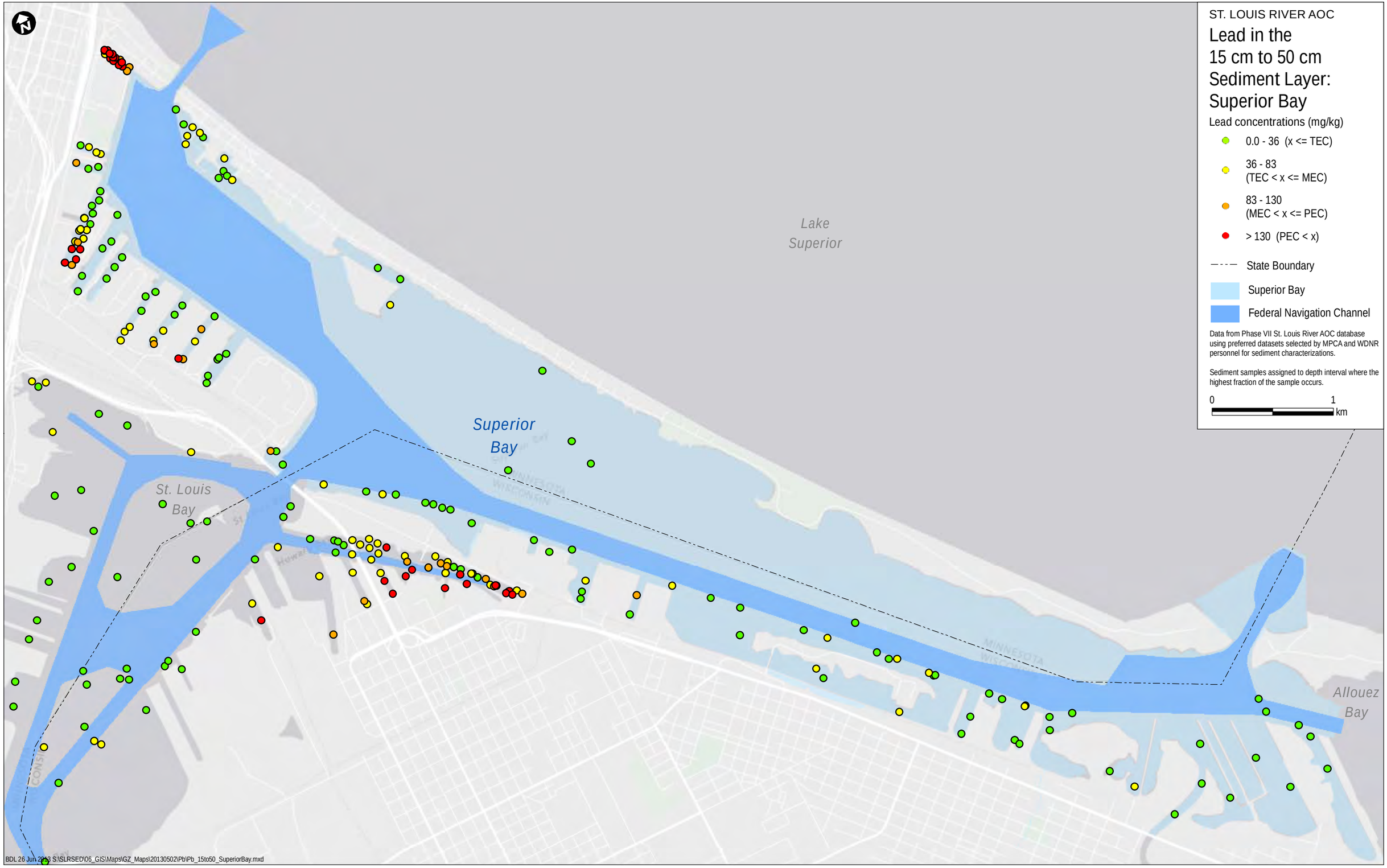
Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_Surface_SuperiorBay.mxd




ST. LOUIS RIVER AOC

# Lead in the 15 cm to 50 cm Sediment Layer: Superior Bay

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)
- State Boundary
- Superior Bay
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_15to50_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Lead in the 50 cm to 100 cm Sediment Layer: Superior Bay

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Lake Superior

Superior Bay

St. Louis Bay

Allouez Bay

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_50to100_SuperiorBay.mxd

ST. LOUIS RIVER AOC

# Lead in the >100 cm Sediment Layer: Superior Bay

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Superior Bay

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 1 km

Lake Superior

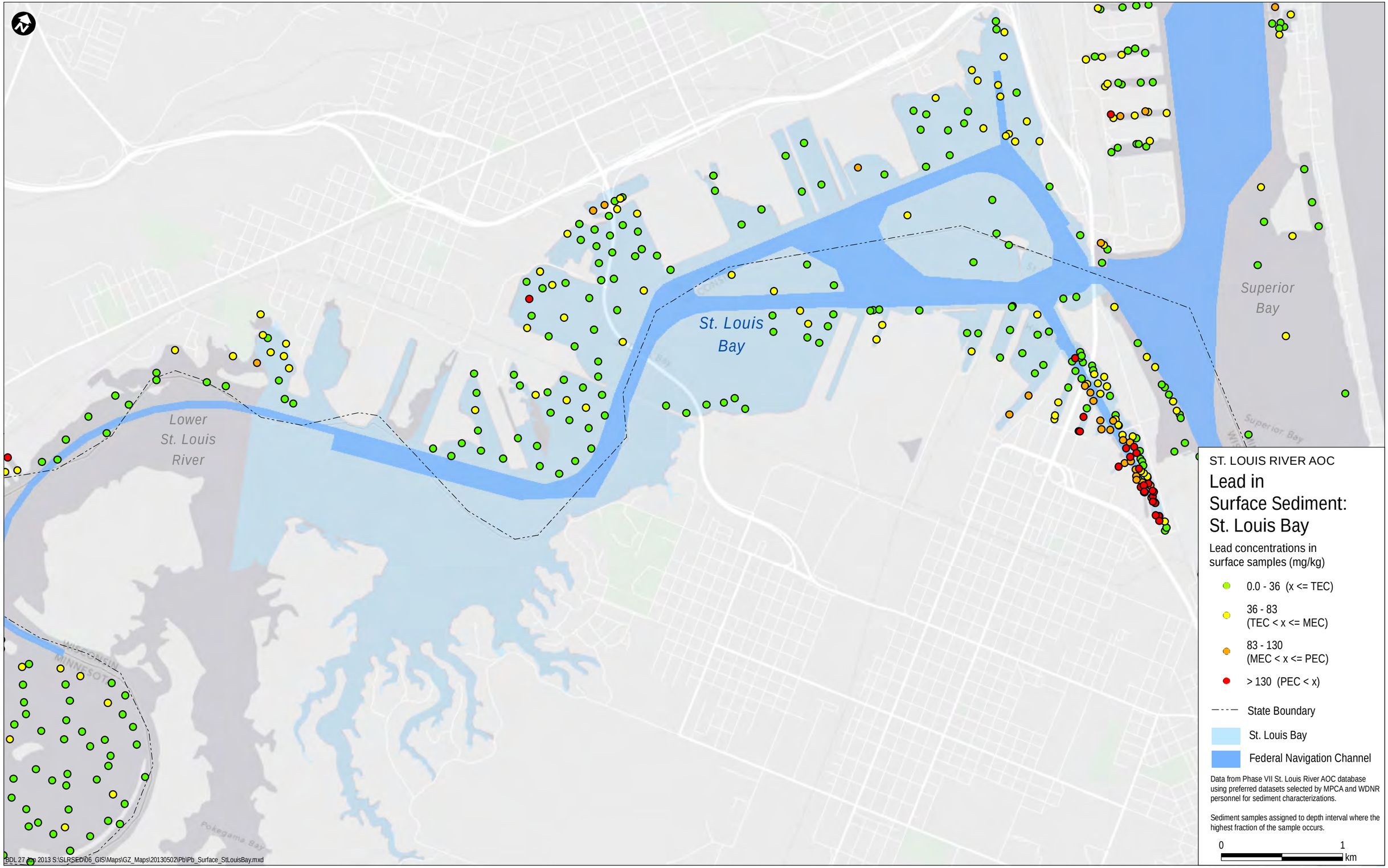
Superior Bay

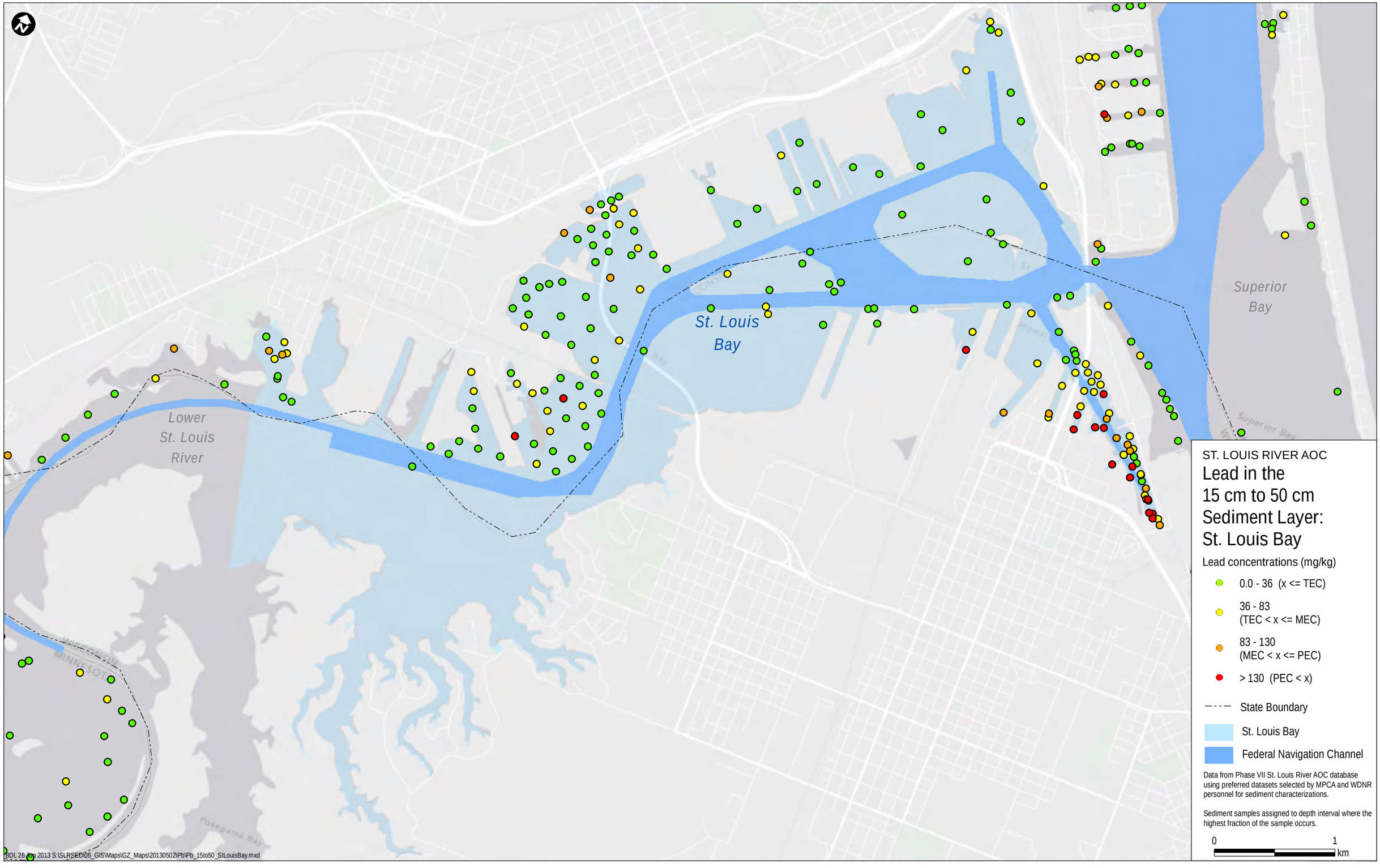
St. Louis Bay

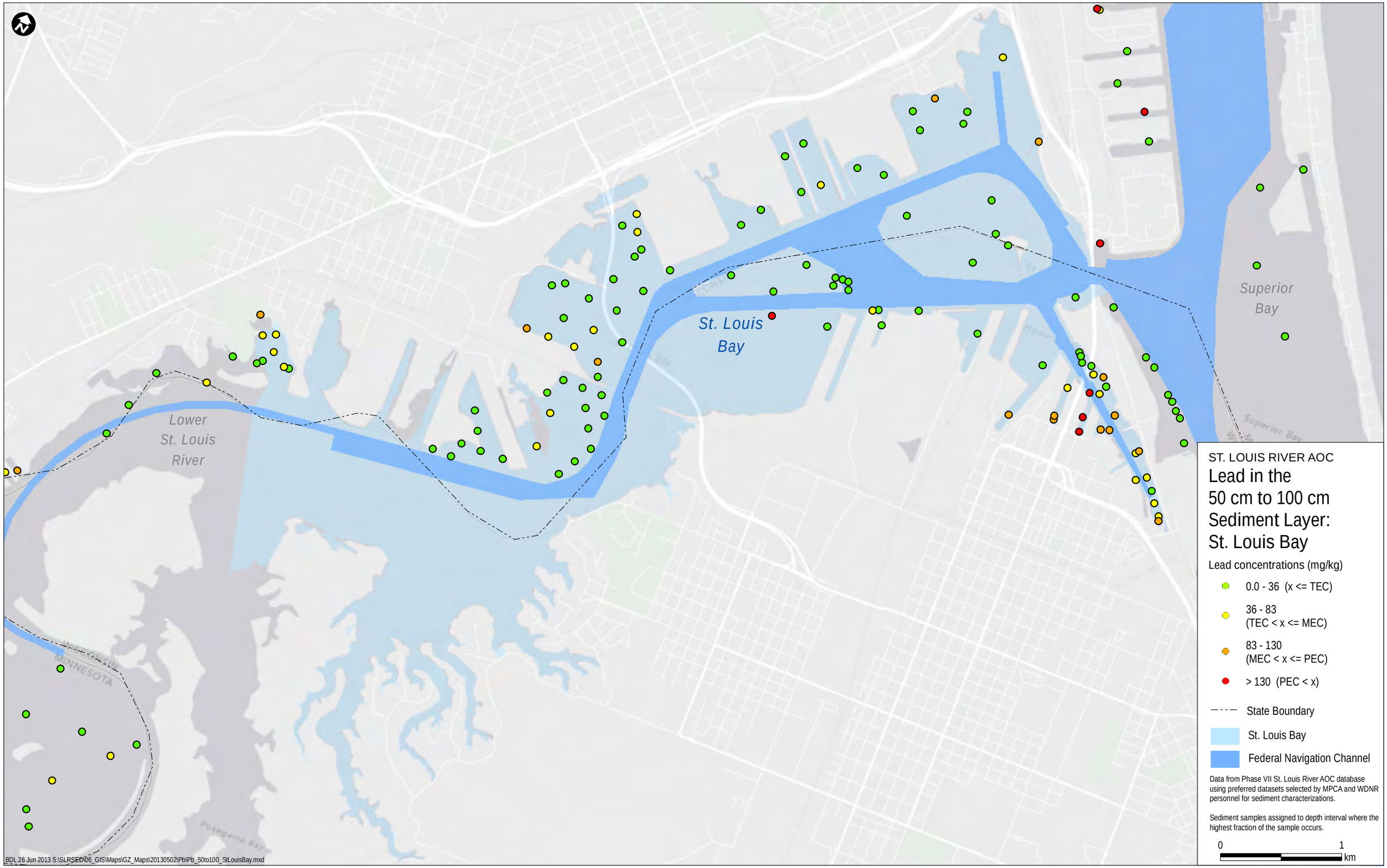
Allouez Bay

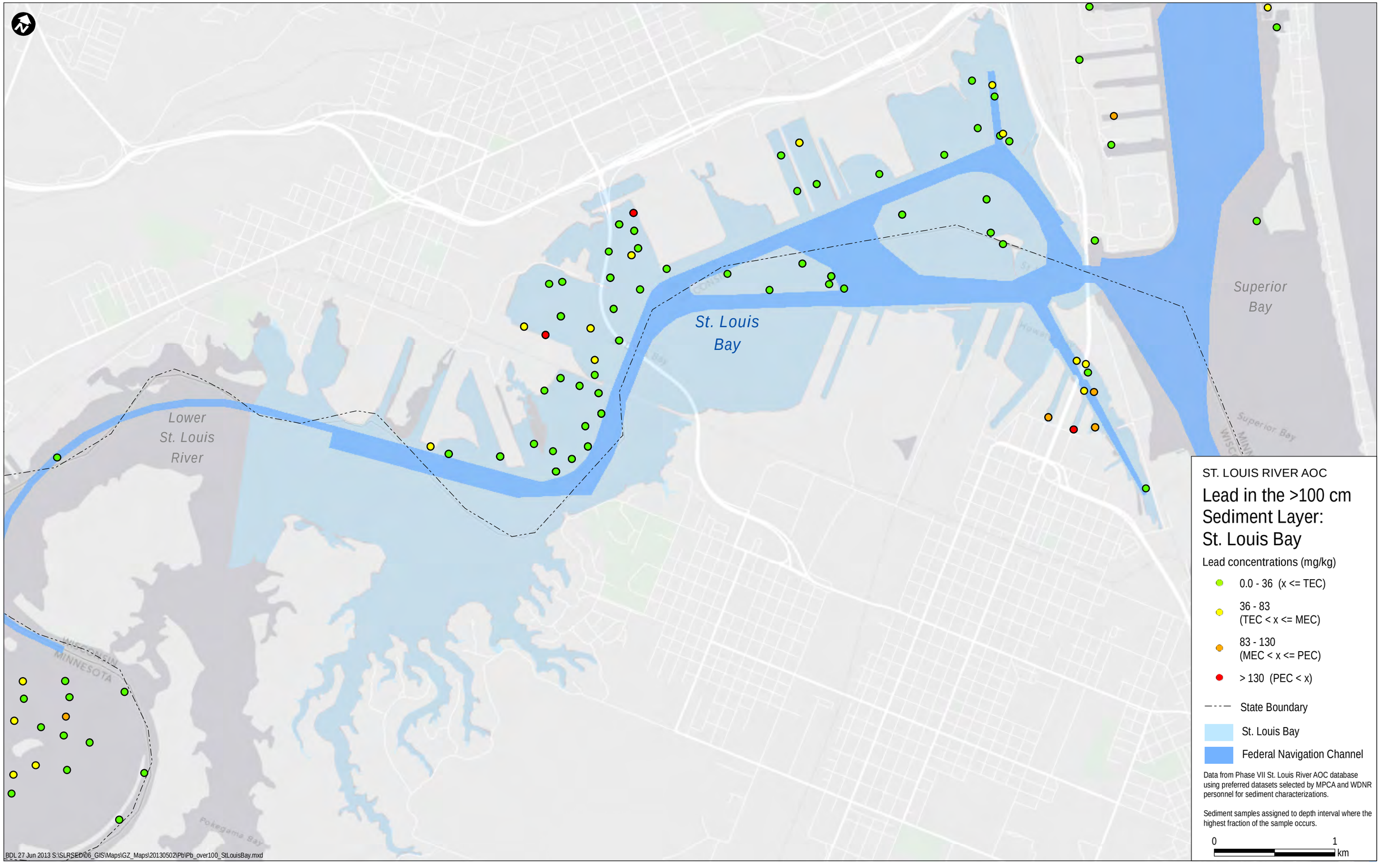
MINNESOTA WISCONSIN

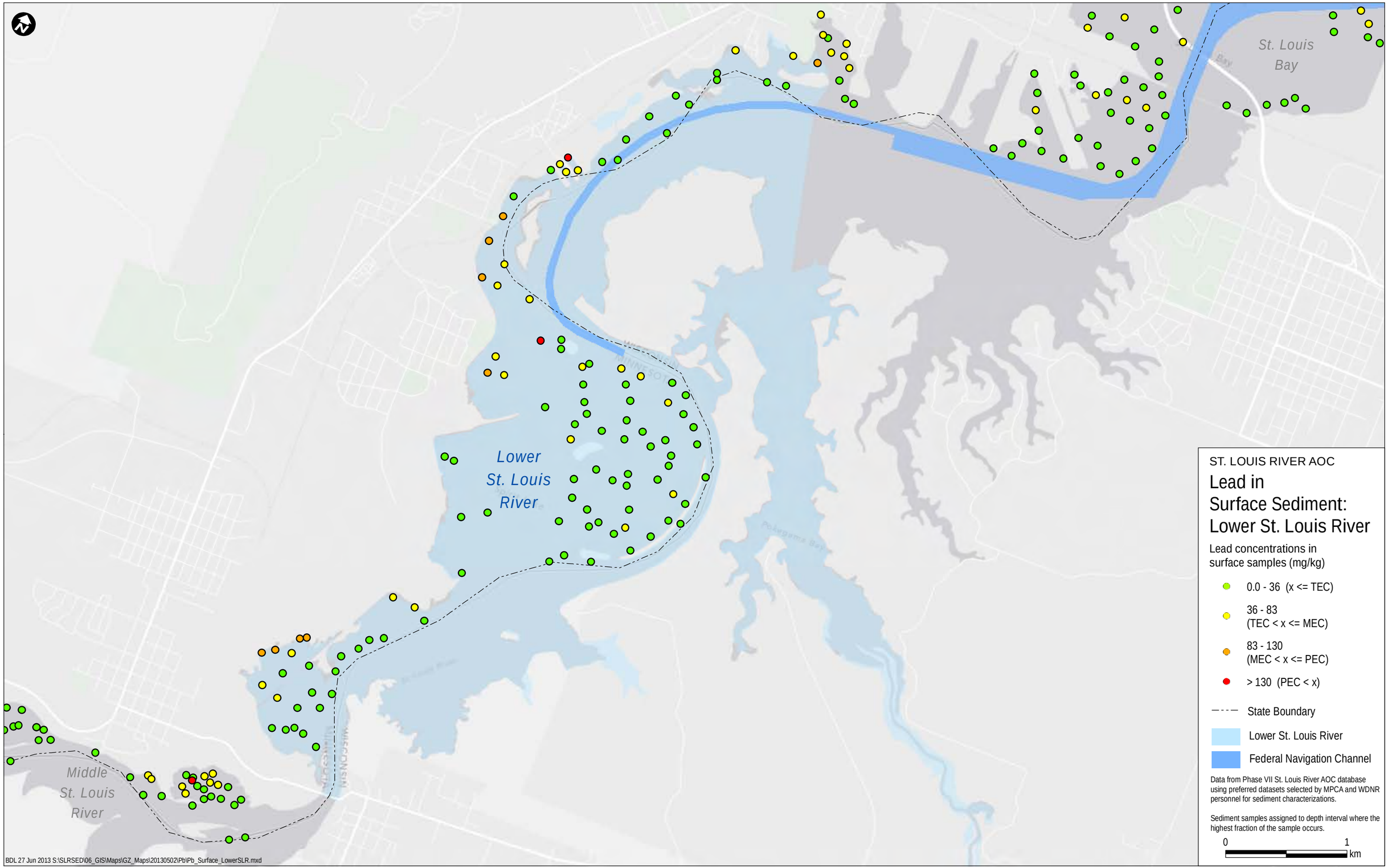
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_over100_SuperiorBay.mxd

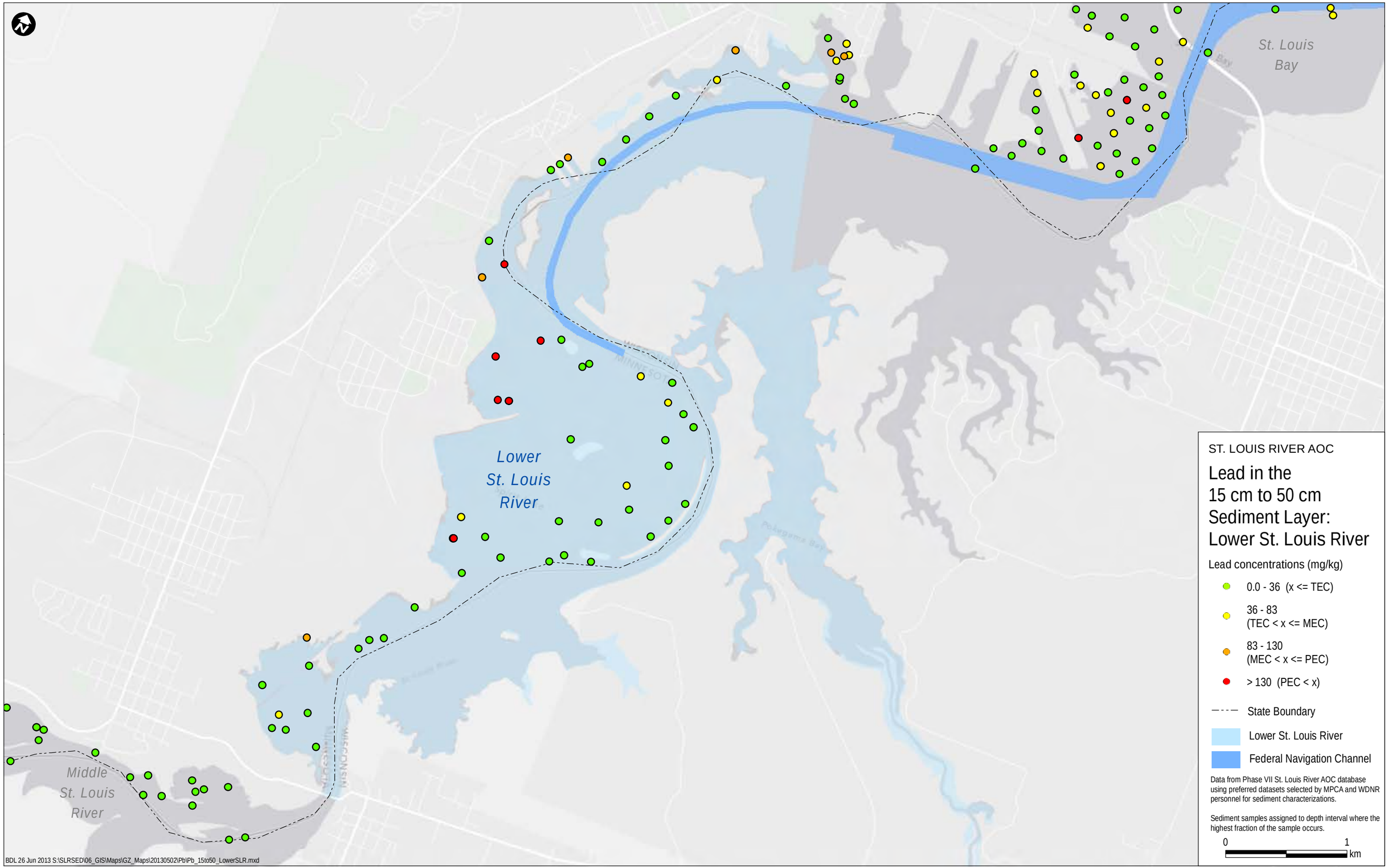

Lower
St. Louis
River
St. Louis
Bay
Superior
Bay
Superior Bay
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Lead in
Surface Sediment:
St. Louis Bay
Lead concentrations in
surface samples (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83
(TEC < x <= MEC)
83 - 130
(MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_Surface_StLouisBay.mxd

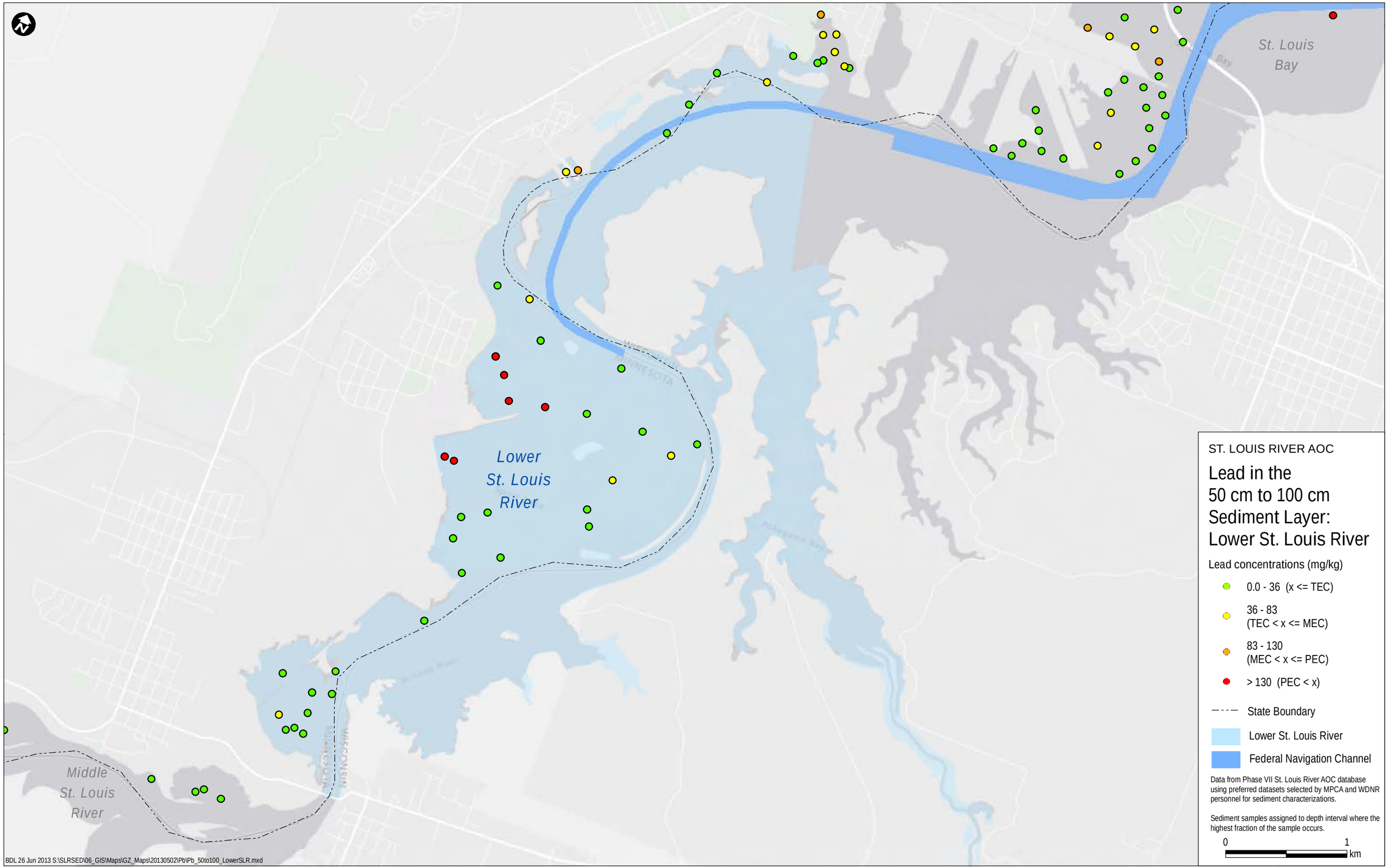

St. Louis Bay
Superior Bay
Lower St. Louis River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Lead in the 15 cm to 50 cm Sediment Layer: St. Louis Bay
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83 (TEC < x <= MEC)
83 - 130 (MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_15to50_StLouisBay.mxd

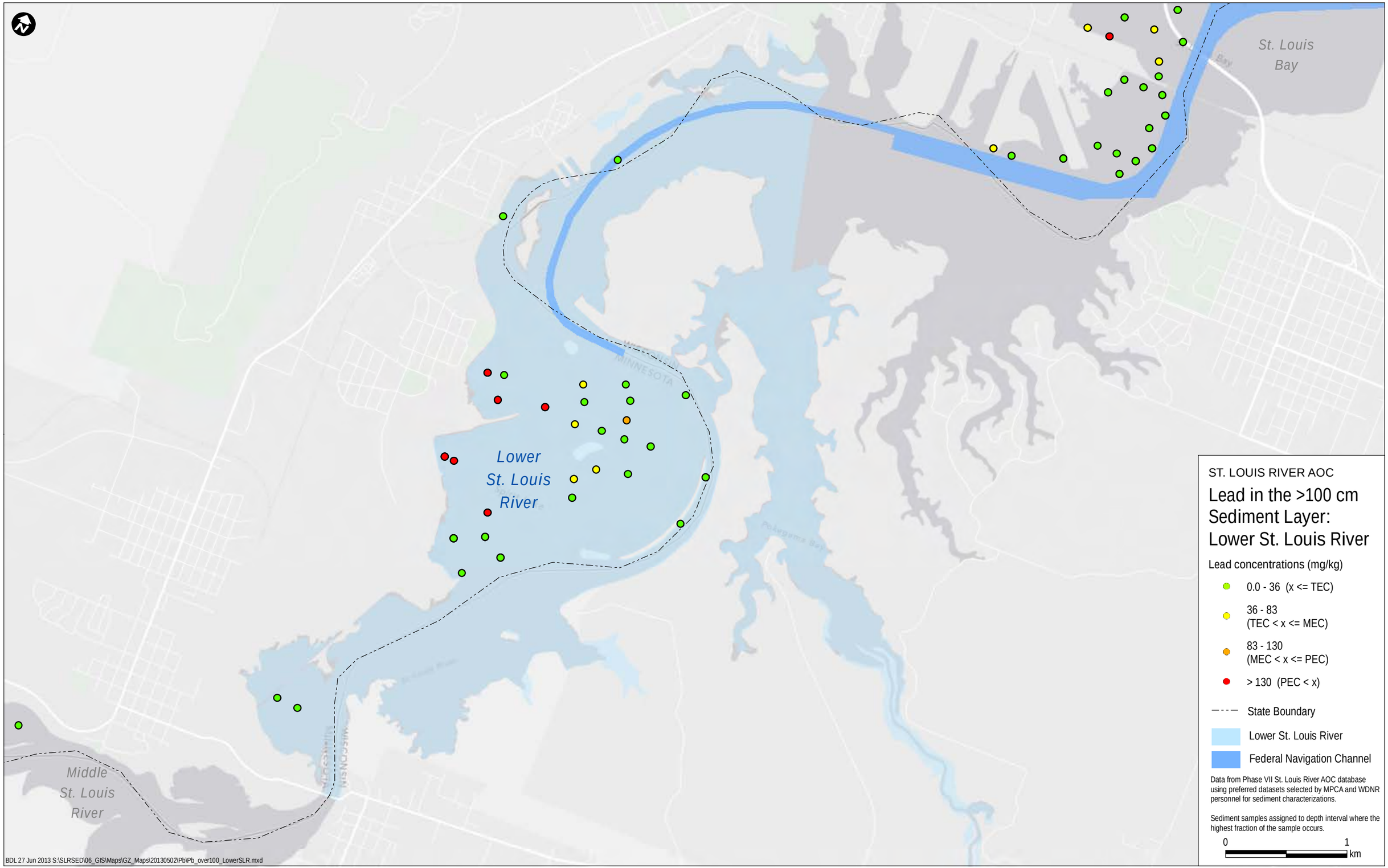

St. Louis
Bay
Superior
Bay
Lower
St. Louis
River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Lead in the
50 cm to 100 cm
Sediment Layer:
St. Louis Bay
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83
(TEC < x <= MEC)
83 - 130
(MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_50to100_StLouisBay.mxd

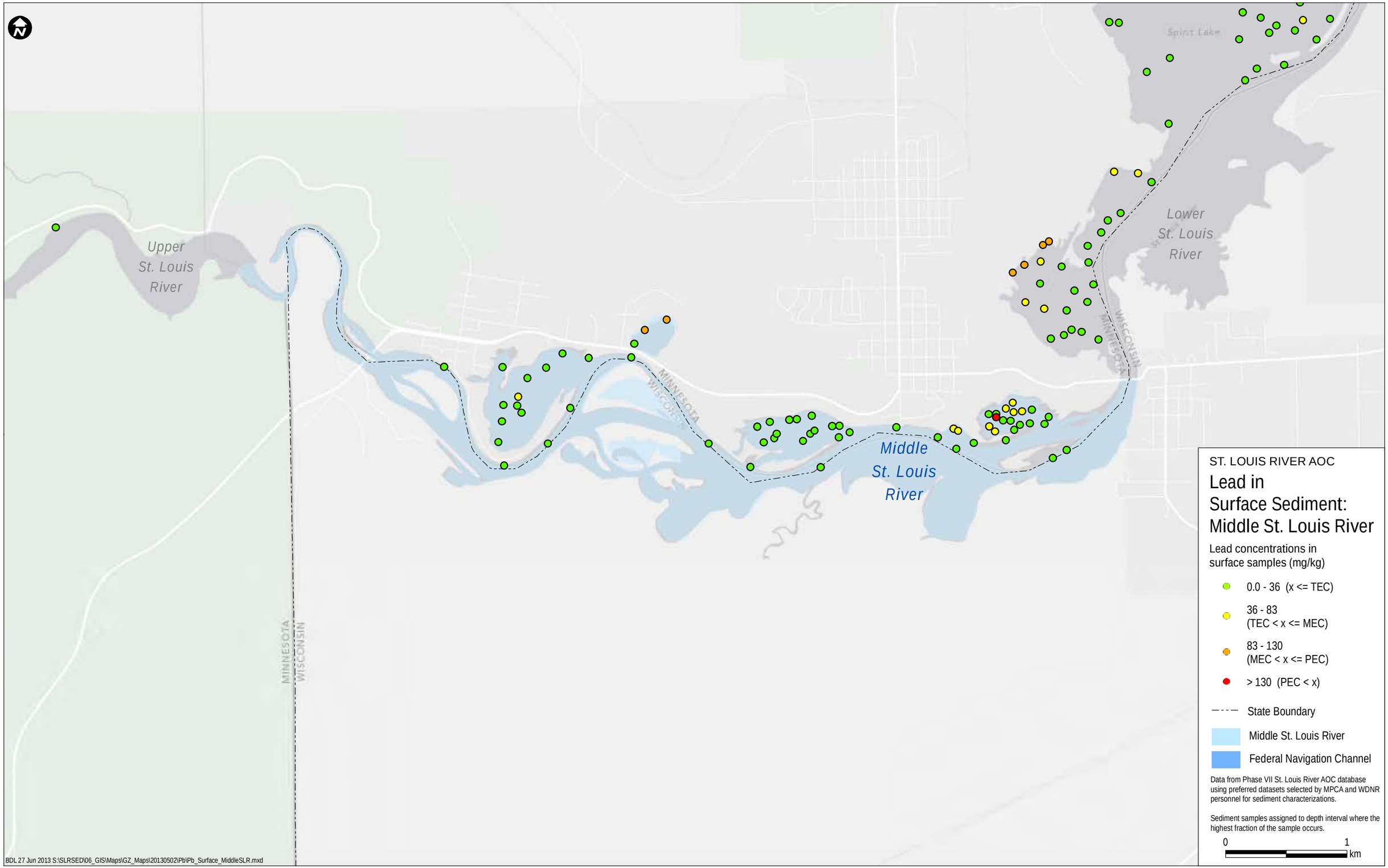

St. Louis Bay
Superior Bay
Lower St. Louis River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Lead in the >100 cm Sediment Layer: St. Louis Bay
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83 (TEC < x <= MEC)
83 - 130 (MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
St. Louis Bay
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_over100_StLouisBay.mxd

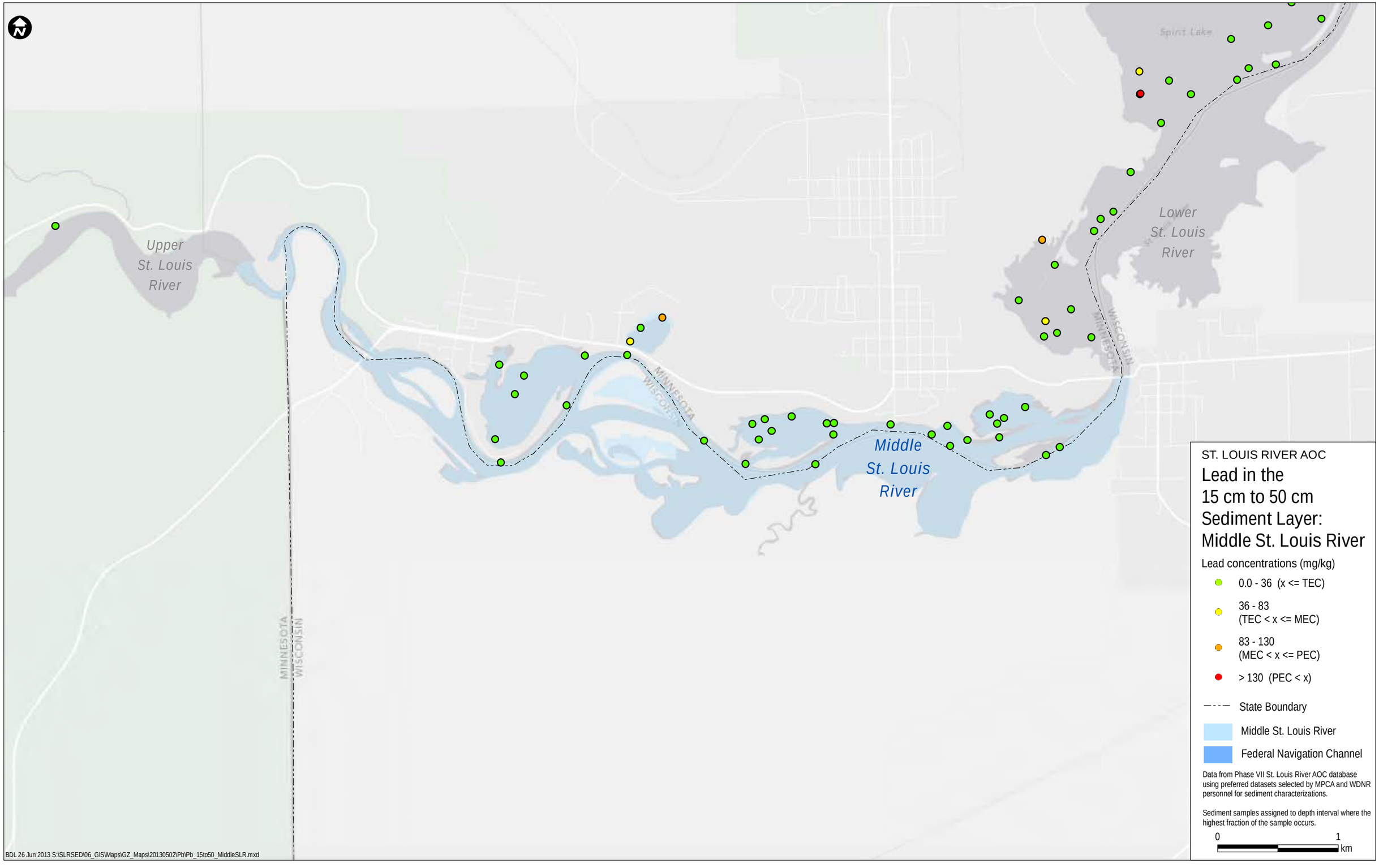

St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Lead in Surface Sediment: Lower St. Louis River
Lead concentrations in surface samples (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83 (TEC < x <= MEC)
83 - 130 (MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_Surface_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Lead in the 15 cm to 50 cm Sediment Layer: Lower St. Louis River
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83 (TEC < x <= MEC)
83 - 130 (MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_15to50_LowerSLR.mxd


St. Louis
Bay
Lower
St. Louis
River
Middle
St. Louis
River
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Lead in the
50 cm to 100 cm
Sediment Layer:
Lower St. Louis River
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83
(TEC < x <= MEC)
83 - 130
(MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_50to100_LowerSLR.mxd


St. Louis Bay
Lower St. Louis River
Middle St. Louis River
WISCONSIN
MINNESOTA
Pokegama Bay
ST. LOUIS RIVER AOC
Lead in the >100 cm Sediment Layer: Lower St. Louis River
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83 (TEC < x <= MEC)
83 - 130 (MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Lower St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_over100_LowerSLR.mxd


Upper
St. Louis
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
ST. LOUIS RIVER AOC
Lead in
Surface Sediment:
Middle St. Louis River
Lead concentrations in
surface samples (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83
(TEC < x <= MEC)
83 - 130
(MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_Surface_MiddleSLR.mxd


Upper
St. Louis
River
Middle
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River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Lead in the
15 cm to 50 cm
Sediment Layer:
Middle St. Louis River
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83
(TEC < x <= MEC)
83 - 130
(MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
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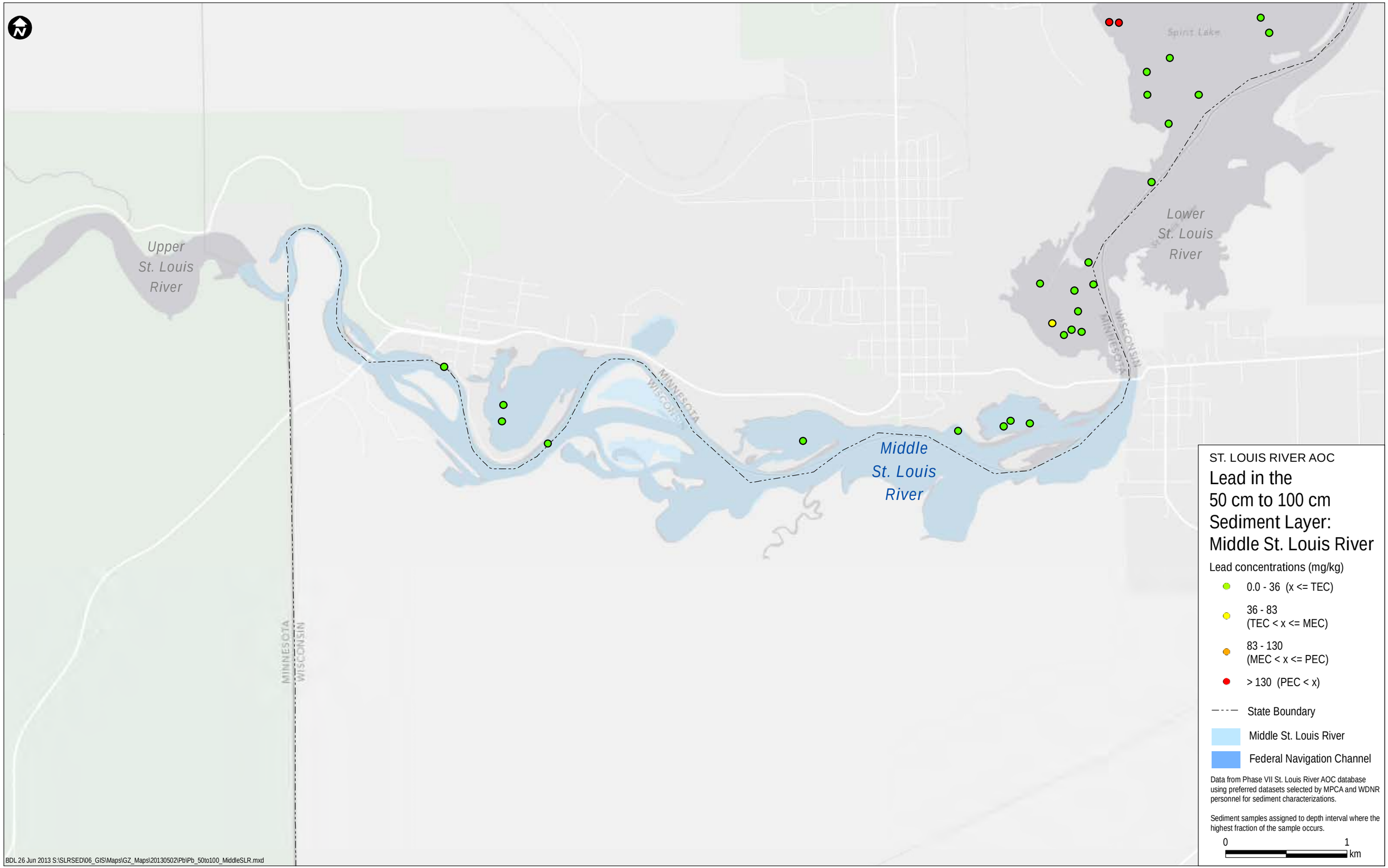
Upper
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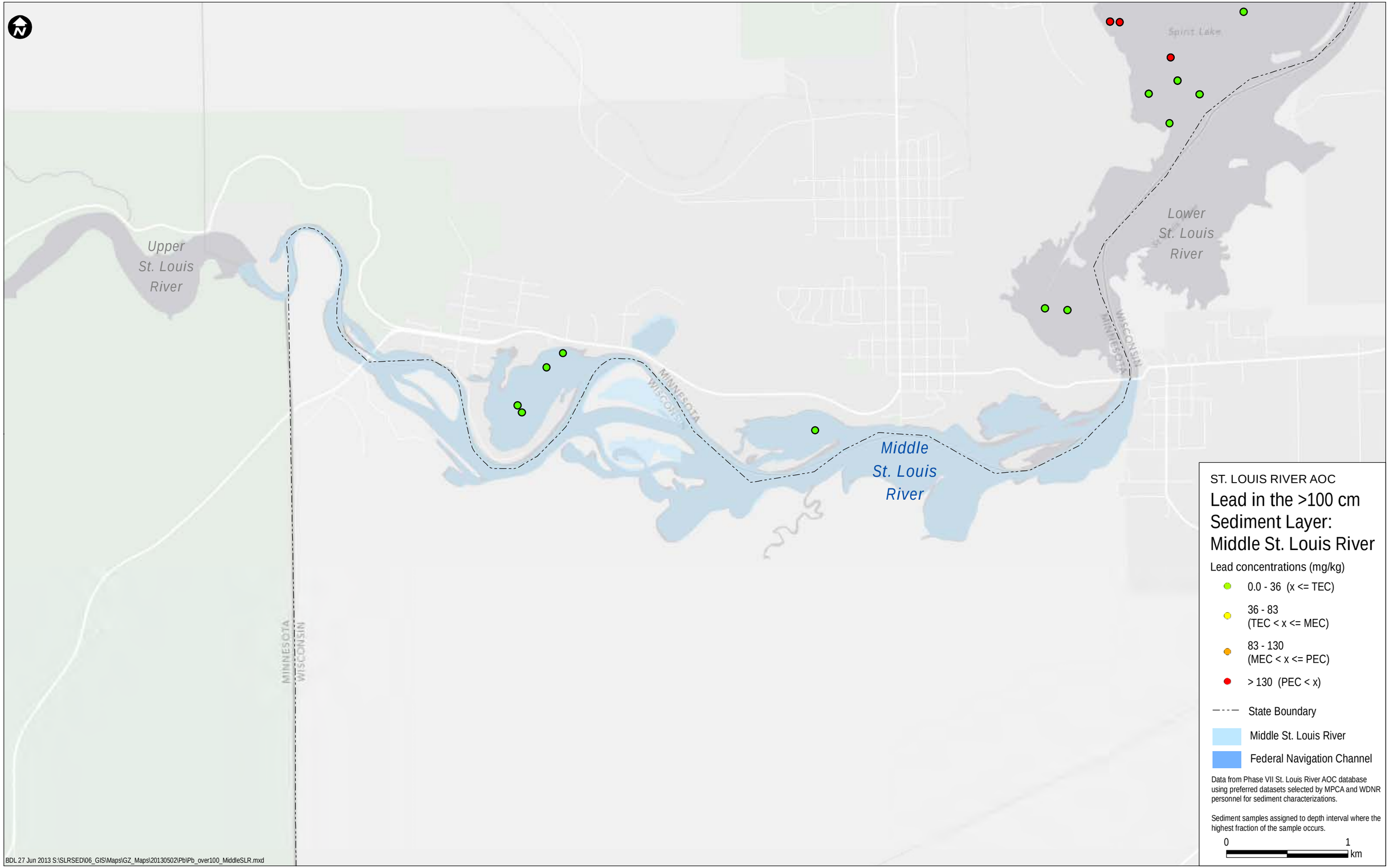
River
Middle
St. Louis
River
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Lead in the
50 cm to 100 cm
Sediment Layer:
Middle St. Louis River
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83
(TEC < x <= MEC)
83 - 130
(MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_50to100_MiddleSLR.mxd


Upper
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Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
MINNESOTA
WISCONSIN
MINNESOTA
WISCONSIN
ST. LOUIS RIVER AOC
Lead in the >100 cm
Sediment Layer:
Middle St. Louis River
Lead concentrations (mg/kg)
0.0 - 36 (x <= TEC)
36 - 83
(TEC < x <= MEC)
83 - 130
(MEC < x <= PEC)
> 130 (PEC < x)
State Boundary
Middle St. Louis River
Federal Navigation Channel
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.
Sediment samples assigned to depth interval where the highest fraction of the sample occurs.
0
1
km
BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_over100_MiddleSLR.mxd

ST. LOUIS RIVER AOC

# Lead in Surface Sediment: Upper St. Louis River

Lead concentrations in surface samples (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_Surface_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Lead in the 15 cm to 50 cm Sediment Layer: Upper St. Louis River

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_15to50_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Lead in the 50 cm to 100 cm Sediment Layer: Upper St. Louis River

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Upper St. Louis River

Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_50to100_UpperSLR.mxd

ST. LOUIS RIVER AOC

# Lead in the >100 cm Sediment Layer: Upper St. Louis River

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)
- State Boundary
- Upper St. Louis River
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

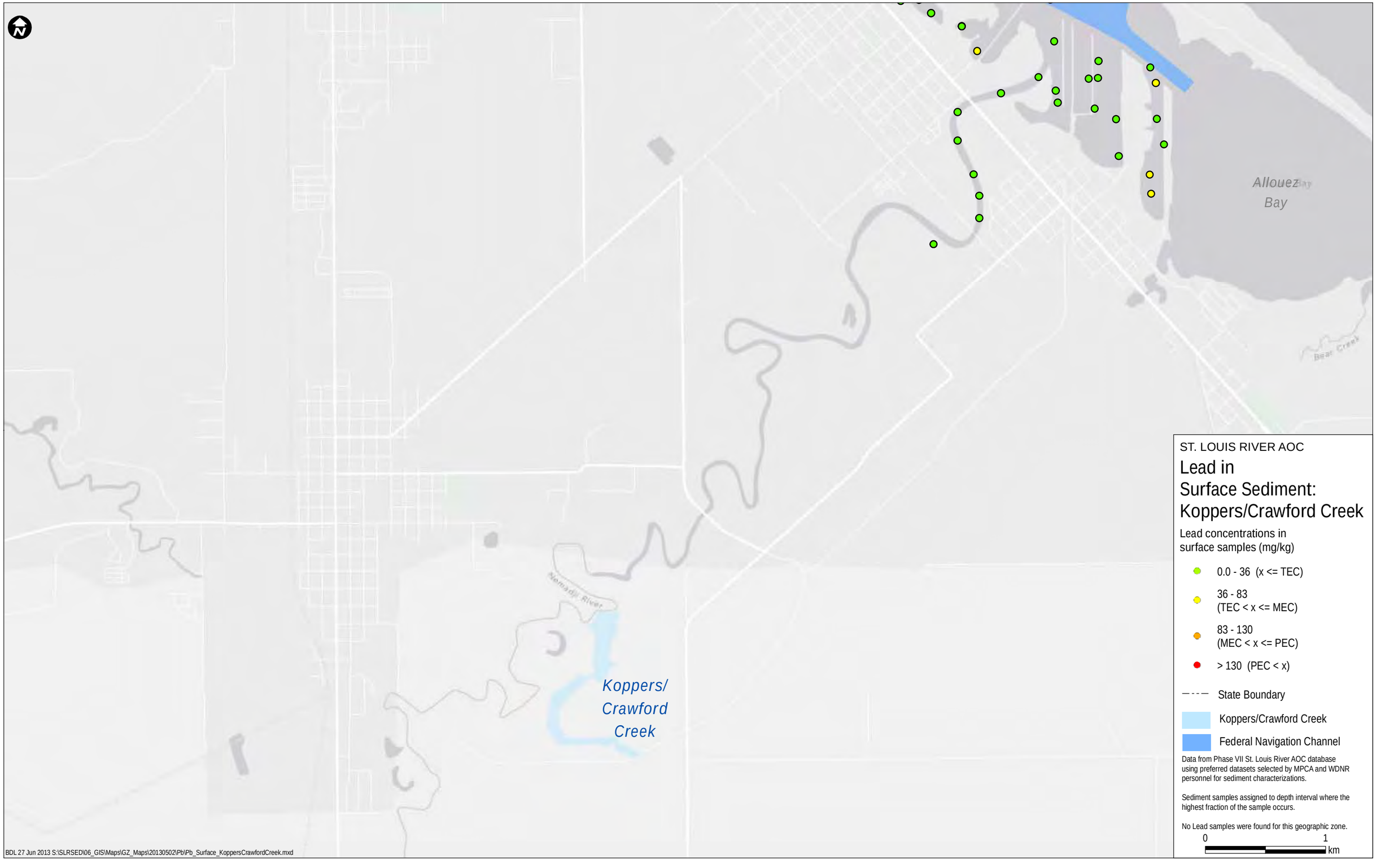
No Lead samples were found for this geographic zone.

0 2 km

*Upper St. Louis River*

*Middle St. Louis River*

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_over100_UpperSLR.mxd




ST. LOUIS RIVER AOC

# Lead in Surface Sediment: Koppers/Crawford Creek

Lead concentrations in surface samples (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

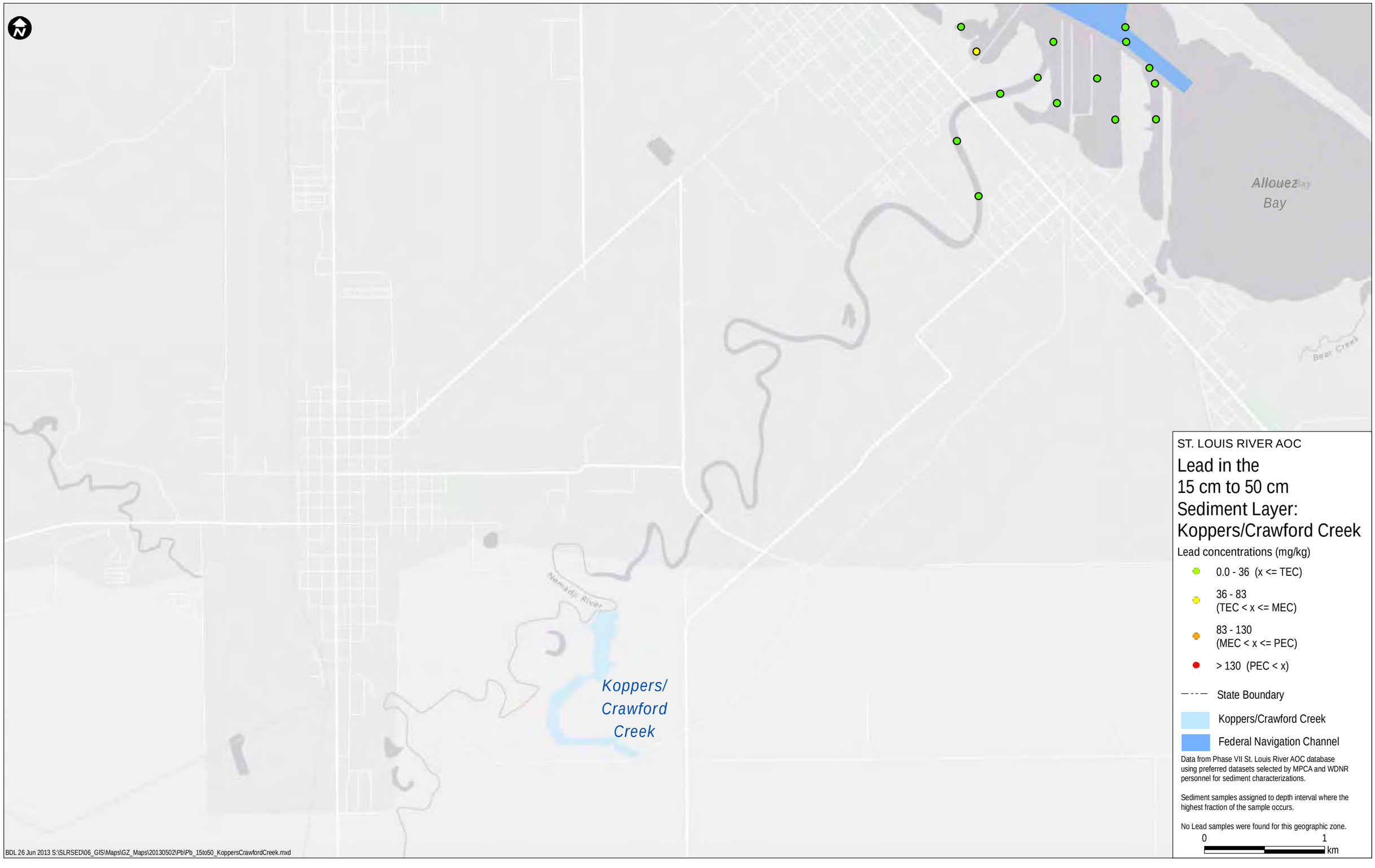
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Lead samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_Surface_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

## Lead in the 15 cm to 50 cm Sediment Layer: Koppers/Crawford Creek

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

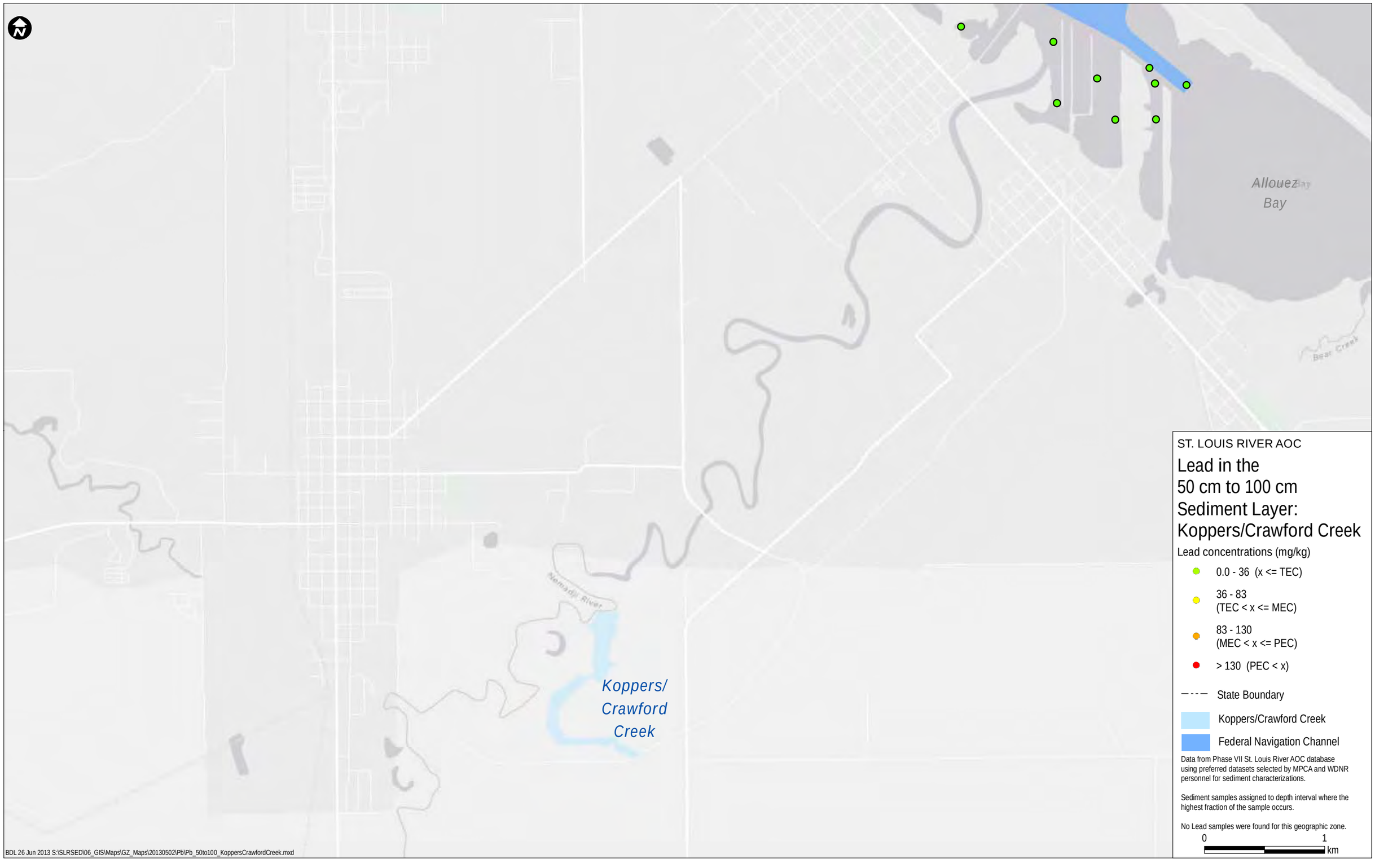
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Lead samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_15to50_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

# Lead in the 50 cm to 100 cm Sediment Layer: Koppers/Crawford Creek

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)

State Boundary

Koppers/Crawford Creek

Federal Navigation Channel

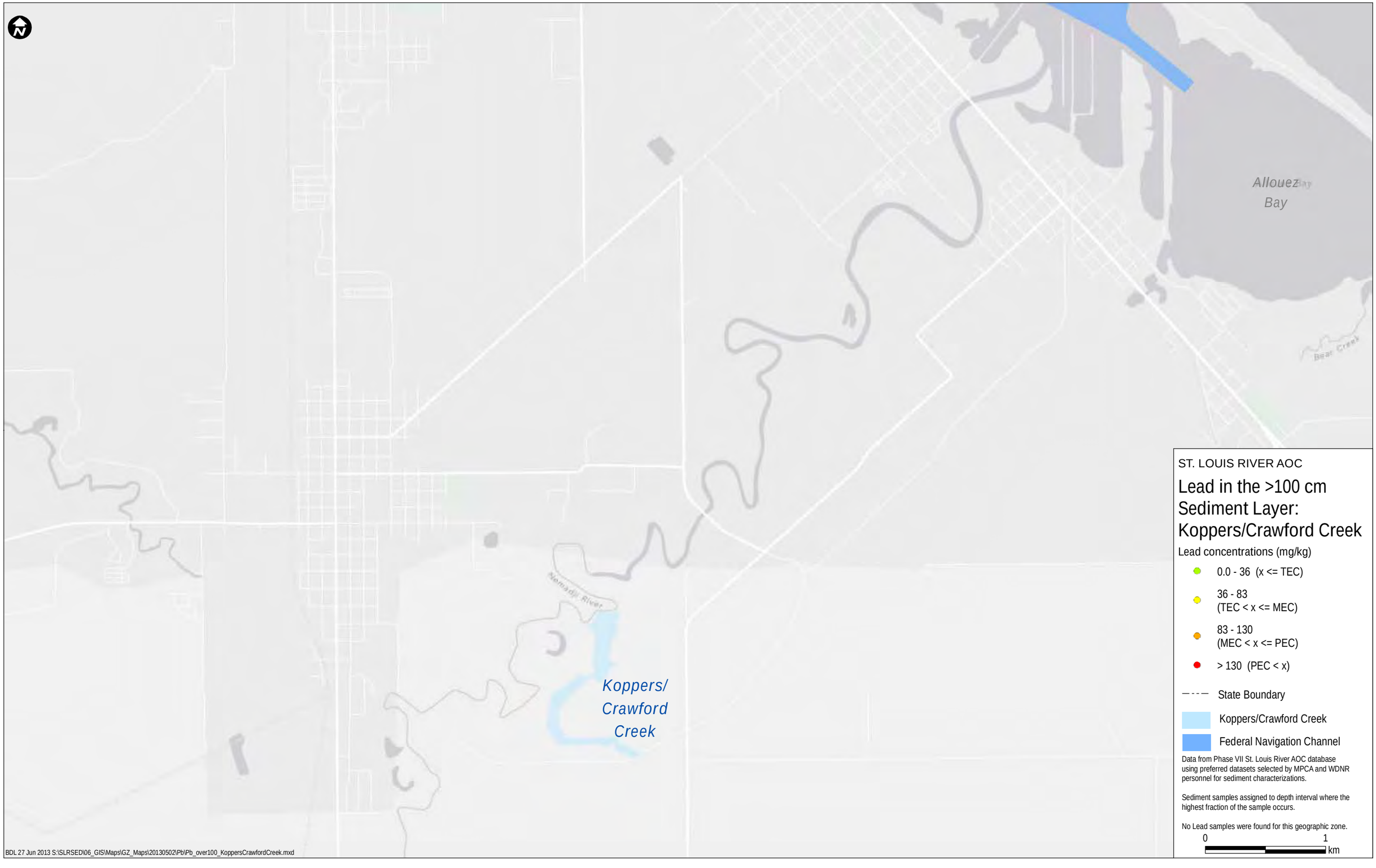
Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Lead samples were found for this geographic zone.

0 1 km

BDL 26 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_50to100_KoppersCrawfordCreek.mxd




ST. LOUIS RIVER AOC

## Lead in the >100 cm Sediment Layer: Koppers/Crawford Creek

Lead concentrations (mg/kg)

- 0.0 - 36 (x <= TEC)
- 36 - 83 (TEC < x <= MEC)
- 83 - 130 (MEC < x <= PEC)
- > 130 (PEC < x)
- State Boundary
- Koppers/Crawford Creek
- Federal Navigation Channel

Data from Phase VII St. Louis River AOC database using preferred datasets selected by MPCA and WDNR personnel for sediment characterizations.

Sediment samples assigned to depth interval where the highest fraction of the sample occurs.

No Lead samples were found for this geographic zone.

0 1 km

BDL 27 Jun 2013 S:\SLRSED\06_GIS\Maps\GZ_Maps\20130502\Pb\Pb_over100_KoppersCrawfordCreek.mxd

# Appendix C
# Remedial Categorization Memorandum

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# Memorandum

**From:** Tim Towey, Virginia Breidenbach

**Date:** June 28, 2013

**Project:** St. Louis River Sediment Characterization

**To:** Dan Breneman, Suzanne Hanson, and Nelson French, MPCA

**CC:** Tim Dekker, Scott Wade, LimnoTech

**SUBJECT: Remedial Categorization of St. Louis River Area of Concern Sediment Assessment Areas**

## Introduction

As part of the Remedial Action Plan (RAP) process for the St. Louis River Area of Concern (AOC), LimnoTech was asked by the Minnesota Pollution Control Agency (MPCA) to categorize the identified sediment assessment areas (SAAs) to assist in prioritizing future remediation and restoration activities. This memorandum describes the approach for determining the remedial categories and provides the remedial categorization for each of the Minnesota SAAs based on a screening-level analysis.

The levels of legacy contaminants St. Louis River AOC sediments are well characterized due to extensive sample collection efforts in 2010 and 2011, as well as many years of previous data collection efforts. The data from the recent sampling efforts has recently been compiled and added to the St. Louis River AOC Phase VII database. The available data is sufficient to perform a screening-level analysis to prioritize assessment areas within the AOC for remediation efforts based on beneficial use impairments linked with sediment contamination. The modified version of the Red, Yellow, Green color scale developed by the Minnesota Remedial Assessment Team (MNRAT) was adopted for this evaluation:

- Purple - Remedial action complete, monitoring of effectiveness underway or complete.
- Red - Remedial action needed.
- Red-Gray - Additional characterization and assessment needed to determine if remedial action is necessary.
- Yellow - Remediation generally not warranted but management actions must consider the presence of contaminants, especially bioaccumulative contaminants.
- Green - No known contamination. No remedial actions planned.

## Method

The following approach was used to designate remedial categories for each of the Minnesota SAAs:

- Designations from MNRAT based on site specific knowledge were used as a basis for Red and Red-Gray SAAs.

- SAAs were designated as gray if the sampling data was sparse.
- Benthic toxicity variables related to threshold ecological effects were used to identify potential additional Red SAAs and Green SAAs.
- All SAAs that were not designated as Red, Green, Red-gray, or Gray, were designated Yellow.

The remedial color designations, beyond those identified by the MNRAT, were informed both by established benthic toxicity thresholds and the identification of assessment areas that were at the high and low ends of the distribution for the screening parameters.

Additional analysis was performed to identify SAAs that contribute most significantly to fish exposure concerns, both for fish consumption and fish tumors. However, the results of that analysis indicate that a driving factor regarding fish exposure is the area of the SAA. The analysis was not used to inform remedial categorization.

## *Minnesota Remedial Assessment Team Evaluation*

Members of the MNRAT have many years of first-hand experience working in the St. Louis River AOC. The team was involved in the design of the 2010 and 2011 AOC data collection efforts and have been evaluating the data since its compilation. Additionally, they are active in the management of Superfund Sites within the AOC. Based on their knowledge of the system, including some datasets not used in this evaluation, the MNRAT developed a list of assessment areas to be pre-designated as Red (requiring remediation) and Red-gray (limited information suggests the need for remediation or further investigation). The list of Red and Red-gray SAAs identified by the MNRAT is presented in Table 1 along with comments explaining the pre-designation.

**Table 1. MNRAT designation of Red and Red-gray Sediment Assessment Areas.**

| Assessment Area ID | Assessment Area | Pre-Designation | Comment |
|---|---|---|---|
| **20** | Minnesota Slip | Red | Remedial Investigation (RI) work complete; update Feasibility Study (FS) |
| **21** | Slip 2 | Red | Polycyclic aromatic hydrocarbon (PAH) concerns |
| **23** | Slip C | Red | Lead (Pb) and PAH at surface are drivers. Back half of slip affected, front end much less risk |
| **27** | Northland Pier / AGP Slip | Red | PAH concerns. Historical data consistent. |
| **28** | Azcon Corp / Duluth Seaway Port Authority Garfield Slip C | Red | Lead and PAH concerns |
| **75.1** | Munger Landing | Red | High metals, PAHs and dioxin. Human health review needed. |
| **76** | U.S. Steel Superfund Site | Red | RI work complete; FS pending |
| **83** | Mud Lake West | Red | Additional data shows high metals near shore. Surface water impacted. |
| **22** | Slip 3 | Red-gray | Occasional PAH hits; some Pb- more sampling |
| **29** | Duluth Seaway Port Authority Garfield Slip D / Clure Public Marine Terminal Berth 1 | Red-gray | Highest PCB hit in AOC at surface, some PAH. More sampling needed. |
| **30** | Rices Point Off-Channel East | Red-gray | PAH and Pb hits at surface. Needs Human Health assessment. Old, large bridge in water, check core logs for info. |
| **37** | Slip near 21st Ave W | Red-gray | One sample location had high hits of many metals at depth. More sampling. |
| **59** | Ponds behind Erie Pier | Red-gray | Only south pond sampled (2 ponds) North pond drainage from active RCRA site. More samples needed. |
| **99** | Thomson Reservoir | Red-gray | Data limited to mercury, some elevated. Flood influenced. |
| **102** | Scanlon Reservoir | Red-gray | High Hg and dioxin. Subject to flood scour. |

*Note: The MNRAT also designated Munger Landing as Red. For this evaluation Munger Landing was included as part of the Riverside Marina SAA.*

## *Degradation of Benthos*

Degradation of Benthos is one of the beneficial use impairments identified in the St. Louis River AOC. Two metrics have been calculated as part of the sediment characterization project that serve

to integrate a range of contaminant measurements compared to their benthic toxicity thresholds and form the basis of the proposed ranking method:

> **Mean Probable Effects Concentration Quotient (Mean PEC-Q; Crane and Hennes, 2007 and WDNR 2003)** - The Mean PEC-Q is an average of ratios of sediment contaminant levels to their Level II Sediment Quality Targets (SQTs).
>
> **Sediment Quality Index (SeQI; CCME, 2007) -** The SeQI is a metric that incorporates both the frequency and magnitude of exceedances of the toxicity thresholds. A SeQI score was calculated for comparison to both the Level I SQTs and the Level II SQTs.

Sample depth is an important consideration when evaluating benthic toxicity. The MPCA has defined three relevant sample depth intervals: surface samples (highly bioactive), the bioactive zone (BAZ), and below the BAZ. The ranking method uses the same sample data sets selected for each SAA by the Minnesota and Wisconsin teams for display in the dashboards and AOC-wide point maps. Within these datasets, samples were assigned to the surface and BAZ as follows:

- Surface samples: 0-15 cm
- BAZ:
    - 15-100 cm for samples collected in areas with less than 8ft of water depth
    - 15-50 cm for samples collected in areas with greater than 8 ft of water depth

All remaining samples were categorized as below BAZ. The samples were categorized based on the interval where the highest fraction of the sample was found (e.g, a sample that extends from 0-20 cm was categorized as a surface sample).

For this evaluation, surface samples were assigned a weight of four, BAZ samples were assigned a weight of two, and below BAZ samples were assigned a weight of one. While these weights are necessarily somewhat arbitrary, the selected weights are intended to reflect the idea that highly bioactive surface samples are about twice as important as BAZ samples which are in turn about twice as important as below BAZ samples when considering benthic toxicity. The selected weights could be refined with site-specific knowledge of factors such as scour potential and bioturbation, but are appropriate for a screening level analysis such as this one.

The following method was used to create depth-weighted metrics to evaluate the assessment areas:

- Mean PEC-Q values were calculated for surface samples, samples in the BAZ, and samples below the BAZ for each assessment area
- The Level 1-SeQI , Level 2-SeQI, and average of the Level 1 and Level 2-SeQIs were calculated for the same depth intervals
- Depth-interval-weighted Mean PEC-Q, Level 1-SeQI, Level 2 SeQI, and average SeQI were calculated for each area

## *Designation of Gray SAAs*

Some of the SAAs had very few samples. Generally these areas were not thought to be priorities during the planning of the sample collection efforts in 2010 and 2011. SAAs that had a low number of total samples and were very sparsely sampled were classified as Gray.

Based on a visual examination of the mercury and PAH contribution to SWAC, a search radius of approximately 200 meters was determined to adequately characterize a site. This radius corresponds with 1 sample per 30 acres. Twelve assessment areas with fewer than 1 sample per 30 acres were identified. Eleven of the Gray SAAs had zero, one, or two samples, so the gray assignment was undoubtedly appropriate. However, Superior Bay had 16 station locations sampled at multiple depth intervals, which is not consistent with the intended meaning of the Gray categorization. It was not included in the Gray category.

## *Fish Consumption and Fish Tumors*

Both Minnesota and Wisconsin have issued fish consumption advisories for the St. Louis River based on PCBs and mercury. Fish tumors have also been identified as a beneficial use impairment in the St. Louis River AOC. Although no definitive cause of fish tumors in the AOC has been identified, several studies have linked polycyclic aromatic hydrocarbons (PAHs) to tumor formation in fish and wildlife (Eisler, 1987). Total PAHs (based on the 13 priority PAHs) were used as an indicator for addressing fish tumors.

For both fish consumption and fish tumor formation, the average surface sediment contaminant concentration is an important factor for evaluating fish exposure levels. To assess which SAAs contribute the most to surface-weighted average concentrations (SWACs), LimnoTech generated a series of interpolations using inverse distance weighting and then calculated the incremental contribution to mercury and PAH SWAC for each assessment area. (The sediment PCB data contained to0 many values below the detection limit to create reasonable interpolations.)

The inverse distance weighting (IDW) tool from ArcGIS was used to interpolate cell values with a linearly weighted combination of a set of sample points. The IDW interpolation was performed using mercury and PAH concentrations in surface samples (o-15 cm). Input parameters used for the IDW interpolation in ArcGIS include:

- Cell size - the cell size at which the output raster will be created
- Power – controls the significance of surrounding points in the interpolated value
- Search Radius - distance within which all sample points will be used for the interpolation
- Number of Points – the number of nearest input samples points to be used in the interpolation
- Barrier Line – the assessment area boundary used to break or limit the interpolation

An IDW routine with variable search radiuses, power functions, and search neighborhoods was developed. The IDW interpolation was run 60 times for a series of different input parameters. The ranges of input parameters are defined in the Table 2.

**Table 2. Inverse distance weighting input parameters.**

| Parameter | Value Range |
|---|---|
| **Cell Size** | 25 meters (constant) |
| **Power (exponent)** | 0.5-2.5 |
| **Search Radius** | 100-1,000 meters |
| **Number of Points** | 6-24 |

The surface-area weighted average concentrations (SWACs) for each assessment area were calculated for each of the 60 iterations of the interpolation. The incremental contribution to the Minnesota AOC-wide SWAC was calculated as follows:

$$Contribution\ to\ SWAC\ of\ AAi = \frac{SWAC_{AAi} x\ Area_{AAi}}{\sum_{n=1}^{107} SWAC_{AAn} x\ Area_{AAn}}$$

The contributions to SWAC were compared across iterations. With the exception of a few sites with relatively few samples, the contributions to SWAC were stable across iterations. The median contribution to SWAC from the 60 iterations was used in further evaluations.

## Data Evaluation and Results

Scatterplots were used to determine whether there were strong relationships between the various screening parameters and to identify whether there were clear breaks in the data that could be used to categorize the assessment areas. Figure 1 shows a series of scatterplots comparing the Mean PEC-Q, Average SeQI, contribution to Hg SWAC, and contribution to PAH SWAC for each of the SAAs. The plots show that the two benthic toxicity parameters (top left plot) and the two exposure parameters (bottom right plot) are correlated. However, the benthic toxicity parameters are not well-correlated with the fish exposure parameters. Also, the scatterplots do not show clear breaks in the data at either the high end or the low end that would be useful for assigning remedial categories.

To better identify logical break points for remedial categories, the distributions of individual benthic toxicity parameters for each assessment area were plotted in rank order of increasing impairment. Figure 2 shows the distribution of each of the benthic toxicity parameters. Clear inflection points are present at the upper end of the distribution for each of the parameters. The Mean PEC-Q has an established Level 2 SQT of 0.6. Assessment areas with a depth-weighted Mean PEC-Q greater than 0.6 were designated as Red; only the Minnesota Slip had a depth weighted Mean PEC-Q greater than 0.6. The SeQI values do not have established SQTs, so the assessment areas with values above the inflection points were given Red designations. The sites requiring remediation based on the evaluation of benthic toxicity were all previously identified as Red or Red-gray by the MNRAT.

A similar approach was used to evaluate the fish exposure parameters. The distributions of SAAs were plotted in rank order of increasing incremental contribution to SWAC of PAHs and mercury. For both PAHs and mercury, an inflection point is present at around 5% contribution. Only the U.S. Steel Superfund Site and Superior Bay are above the 5% threshold for PAHs. However. The U.S. Steel site alone accounts for 60% of the Total PAH SWAC among the Minnesota SAAs. For mercury, several SAAs exceed the 5% threshold including three that were not identified as Red sites through the MNRAT or benthic toxicity evaluations: Superior Bay, 21st Avenue, and Spirit Lake/Devil's Elbow.

A related approach to setting thresholds for contributions to SWAC is presented in Figure 4. These plots show the cumulative contribution to PAH and mercury SWAC, with the SAAs ranked from highest contribution to lowest. Using an approach that designates all SAAs up to the knee-of-the-curve as red, would result in a Red designation for most of the largest sites in the AOC.

The contribution to the mercury and PAH SWAC for many sites is driven, at least in part, by their large areas. Because surface mercury is relatively even throughout the AOC (with a few higher

concentrations on the Wisconsin side), it may not be appropriate to use SAA boundaries for addressing this impairment. Bioaccumulation potential and prevalence of fish habitat would also be considered before making a remedy plan to address mercury and PAH in fish. For this reason, the evaluation of fish exposure variables was not used to generate remedial categories at this time.

Only select parameters were used to designate Green SAAs. Green sites are intended to represent those that are ready for restoration with no further remedial consideration necessary. The benthic toxicity parameters integrate a number of chemical constituents. The SAAs with the lowest benthic toxicity scores are unlikely to have legacy sediment contamination issues that would require remediation prior to restoration activities. A relatively conservative threshold was established for the designation of Green SAAs: the SAA must have a depth-weighted Mean PEC-Q value below the established Level 1 SQT of 0.1 and the Level 1 SeQI score must be below the inflection point at the lower end of the distribution. The Level 1 SQTs were used because they represent threshold effects, which are appropriate for designating the cleanest of the SAAs. Figure 5 shows the distribution plots for delineating Green areas.

Sediment Assessment Areas that were neither categorized as Gray, Red, or Green were designated as Yellow. Available data for yellow sites must be evaluated prior to initiating restoration activities. Strategic remediation of legacy contaminant issues may be needed. However, many of these SAAs have levels of sediment contamination consistent with levels in other urban rivers.

Table 3 shows the color designation for each of the Minnesota Sediment Assessment Areas in the AOC, along with the rationale for the designation of Red sites. Maps of the color coded SAAs are shown as Figures 6-10.

**Table 3. Color designation for each of the Minnesota Sediment Assessment Areas in the St. Louis River AOC.**

| Assessment Area ID | Assessment Area | Color Designation | Red Site Rationale |
|---|---|---|---|
| **1** | Lake Superior - Minnesota | GRAY | |
| **3** | Minnesota Pocket | GRAY | |
| **10** | Superior Bay - Minnesota | YELLOW | Contribution to mercury SWAC |
| **18** | Hearding Island | YELLOW | |
| **19** | North Park Point Bayside | YELLOW | |
| **20** | Minnesota Slip | RED | MNRAT designation, benthic toxicity |
| **21** | Slip 2 | RED | MNRAT designation, benthic toxicity |
| **22** | Slip 3 | RED-GRAY | MNRAT designation |
| **23** | Slip C | RED | MNRATdesignation, benthic toxicity |
| **24** | General Mills Elevator A Slip | YELLOW | |
| **25** | Cargill Elevator B1 Slip | YELLOW | |
| **26** | Cargill Elevator B2 / Northland Pier Slip | YELLOW | |
| **27** | Northland Pier / AGP Slip | RED | MNRAT designation, |

| Assessment Area ID | Assessment Area | Color Designation | Red Site Rationale |
|---|---|---|---|
| | | | benthic toxicity |
| **28** | Azcon Corp / Duluth Seaway Port Authority Garfield Slip C | RED | MNRAT designation, benthic toxicity |
| **29** | Duluth Seaway Port Authority Garfield Slip D / Clure Public Marine Terminal Berth 1 | RED-GRAY | MNRAT designation, benthic toxicity, elevated PCB surface sample |
| **30** | Rices Point Off-Channel East | RED-GRAY | MNRAT designation |
| **31** | Duluth Harbor Basin Off-Channel | GRAY | |
| **36** | Rices Point Off-Channel West | YELLOW | |
| **37** | Slip near 21st Ave W | RED-GRAY | MNRAT designation |
| **38** | 21st Avenue | YELLOW | Contribution to mercury SWAC |
| **39** | Interstate Island Off-Channel | GRAY | |
| **40** | Bay NE of Canadian National / DM&IR | GREEN | |
| **41** | Interstate Island Flats | GREEN | |
| **43** | DM&IR | YELLOW | |
| **44** | Hibbard | YELLOW | |
| **45** | Bay NE Side of Erie Pier | GREEN | |
| **58** | Erie Pier Slip | GREEN | |
| **59** | Ponds behind Erie Pier | RED-GRAY | MNRAT designation, elevated PCB surface sample |
| **60** | Coffee Ground | YELLOW | |
| **63** | Grassy Point | YELLOW | |
| **65** | Belknap Flats | GRAY | |
| **66** | C. Reiss Coal Dock Slip | YELLOW | |
| **67** | Bay between C. Reiss and SLRIDT 7 / W. Grassy Point Estuary Flats | YELLOW | |
| **68** | SLRIDT Superfund Site | PURPLE | |
| **70** | Kingsbury Bay | YELLOW | |
| **71.1** | Tallas Island | YELLOW | |
| **71.2** | Kingsbury Bay | YELLOW | |
| **75.1** | Riverside Marina | YELLOW | |
| **75.2** | Munger Landing | RED | MNRAT designation |
| **76** | U.S. Steel Superfund Site | RED | MNRAT designation, benthic toxicity, contribution to PAH SWAC, contribution to Hg SWAC |

| Assessment Area ID | Assessment Area | Color Designation | Red Site Rationale |
|---|---|---|---|
| **77** | Spirit Lake / Devils Elbow NC | GRAY | |
| **78** | Spirit Lake / Devils Elbow | YELLOW | Contribution to mercury SWAC |
| **80** | Steelton Bay | GREEN | |
| **81** | New Duluth Stretch | GREEN | |
| **82** | Mud Lake East | YELLOW | |
| **83** | Mud Lake West | RED | MNRAT designation |
| **84** | Middle St. Louis River - Minnesota | GREEN | |
| **85** | Cedar Yard Bay (Radio Tower Bay) | YELLOW | |
| **88** | New Duluth Bay | YELLOW | |
| **89** | North Bay | YELLOW | |
| **90** | Fond du Lac Stretch | GREEN | |
| **91** | Perch Lake | YELLOW | |
| **92** | Rask Bay | GREEN | |
| **93** | Chambers Grove Reach | GREEN | |
| **94** | Fond du Lac Reservoir | GRAY | |
| **95** | Lower Jay Cooke State Park Reach | GREEN | |
| **96** | Middle Jay Cooke State Park Reach | GRAY | |
| **97** | Oldenburg Point Rapids Reach | GRAY | |
| **98** | Lower Thomson Reach | GRAY | |
| **99** | Thomson Reservoir | RED-GRAY | MNRAT designation, contribution to Hg SWAC |
| **100** | Forbay Reservoir | GRAY | |
| **101** | Scanlon to Thomson Whitewater Reach | YELLOW | |
| **102** | Scanlon Reservoir | RED-GRAY | MNRAT designation |
| **103** | NW Paper Company Reach | YELLOW | |
| **104** | Cloquet Reservoir | YELLOW | |
| **105** | Knife Falls Reservoir | YELLOW | |
| **106** | Spafford Park Reach | YELLOW | |
| **107** | Fond du Lac Indian Reservation Reach | GREEN | |

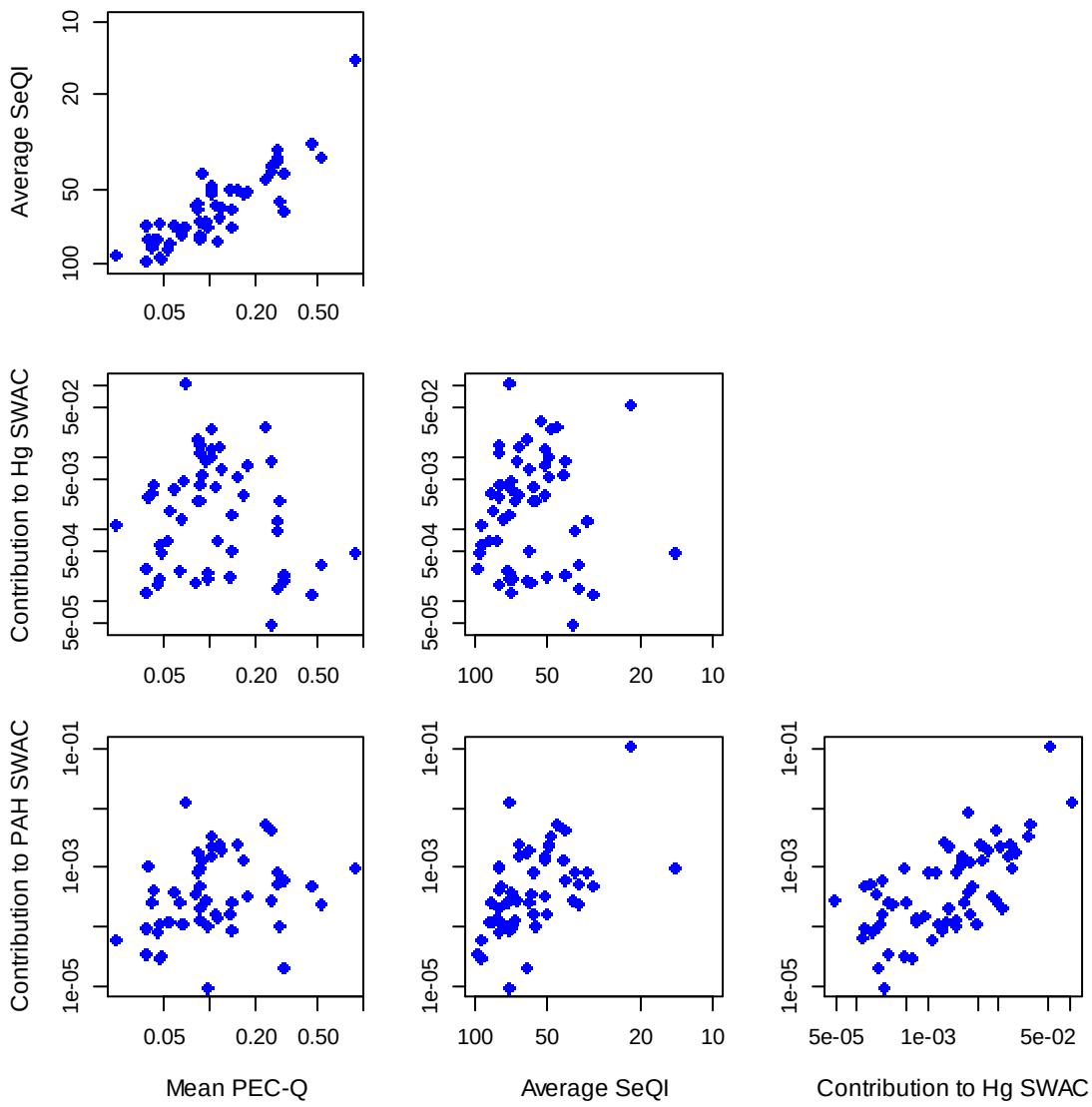



**Figure 1. Scatterplots to evaluate relationships of benthic toxicity and fish exposure parameters.**

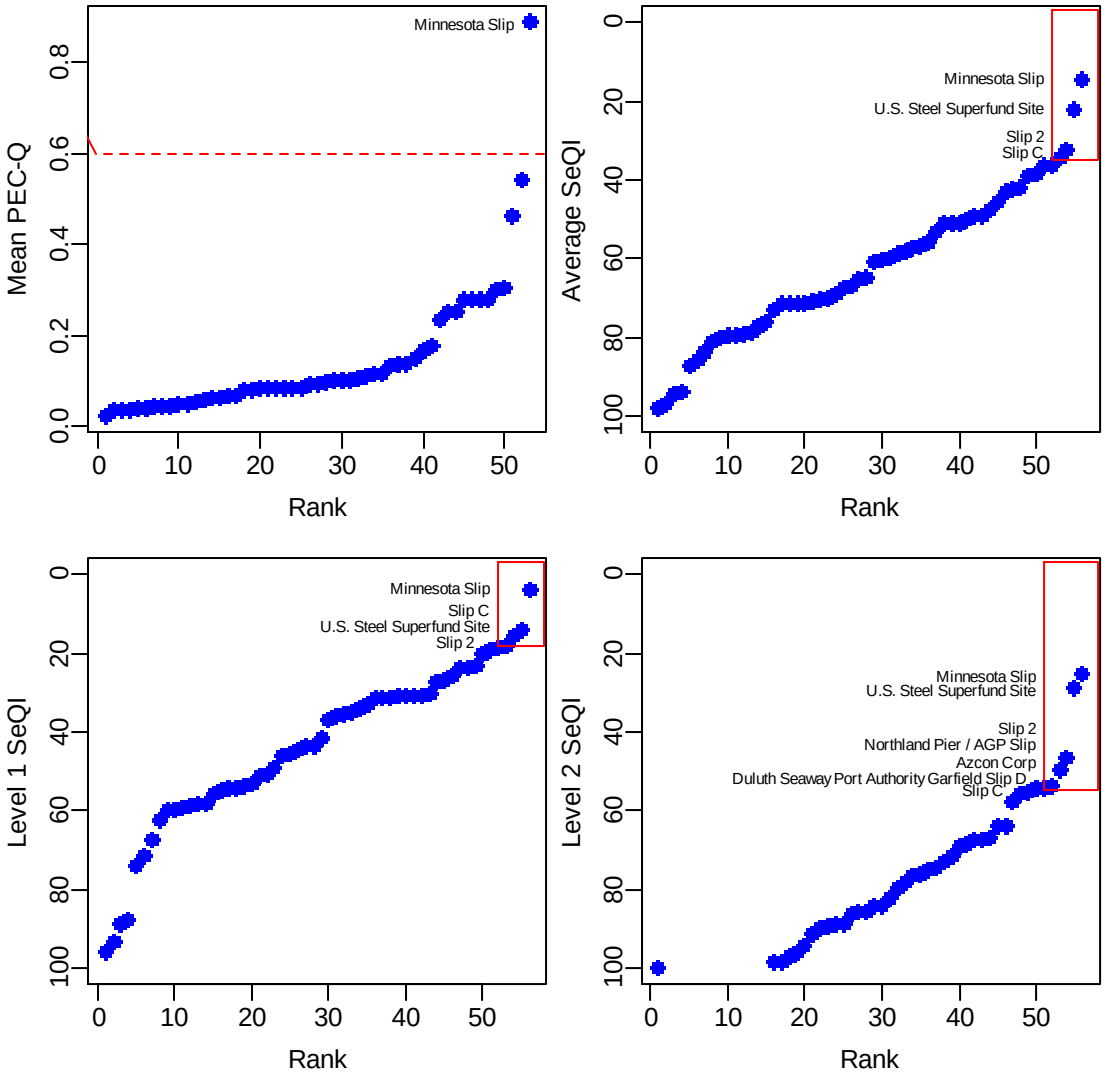



**Figure 2. Rank order of Mean PEC-Q, Average SeQI, Level 1 SeQI, and Level 2 SeQI scores used to designate additional Red assessment areas. The dashed red line indicates the Mean PEC-Q Level 2 Sediment Quality Target. The red rectangles indicate scores above inflection points for each of the SeQI variables.**

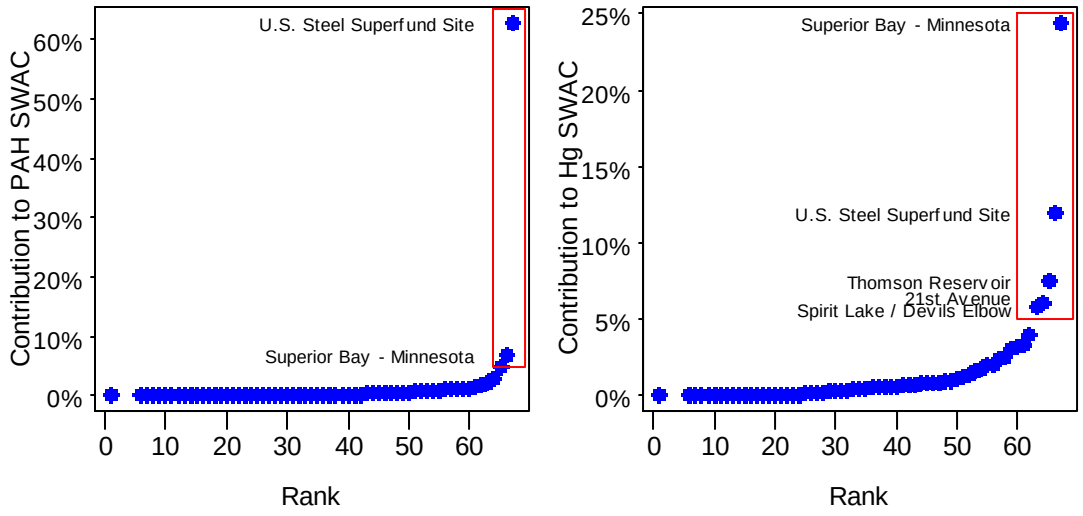



**Figure 3. Rank order of contribution to PAH and mercury. The red rectangles indicate assessment areas above the 5% inflection point.**

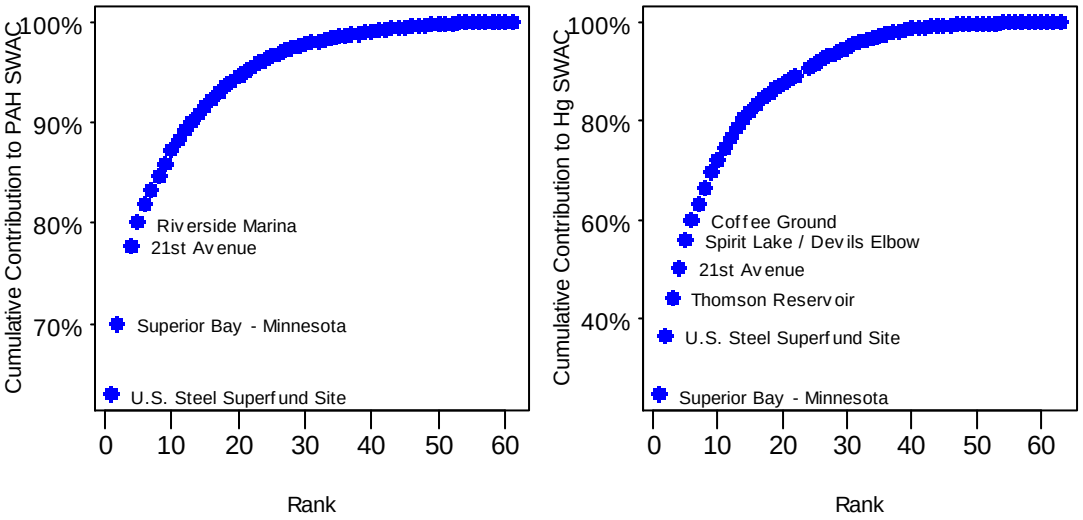



**Figure 4. Cumulative contribution to PAH and mercury SWAC. Assessment areas labeled as examples only. *No thresholds were set based on this method.***

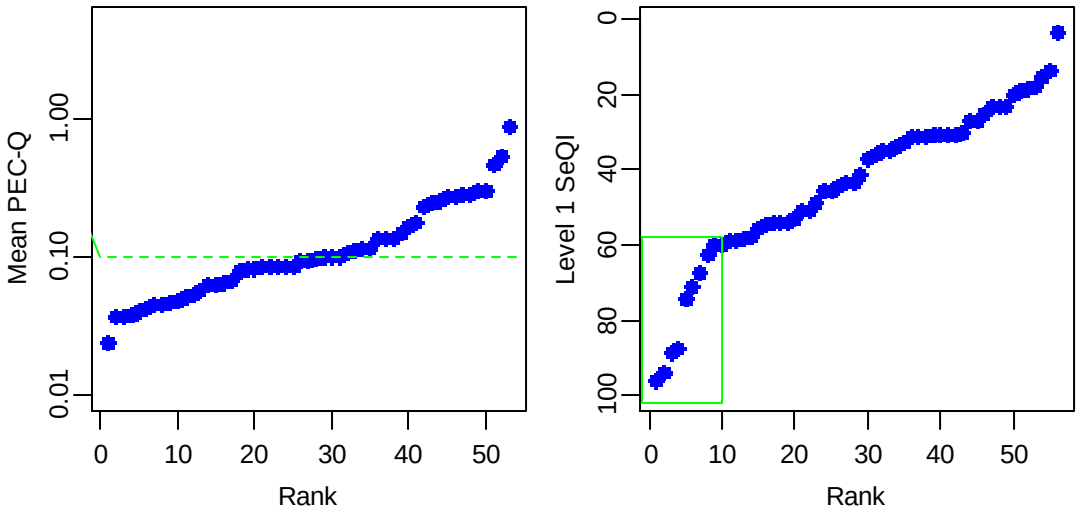



**Figure 5. Mean PEC-Q and Level 1 SeQI scores used to designate green assessment areas. The dashed green line indicates the Level 1 SQT for Mean PEC-Q. The green rectangle indicates the Level 1 SeQI scores that are below the inflection point at the low end of the distribution. Note: the Mean PEC-Q values are shown on a log scale to more clearly represent the SAAs below 0.1.**

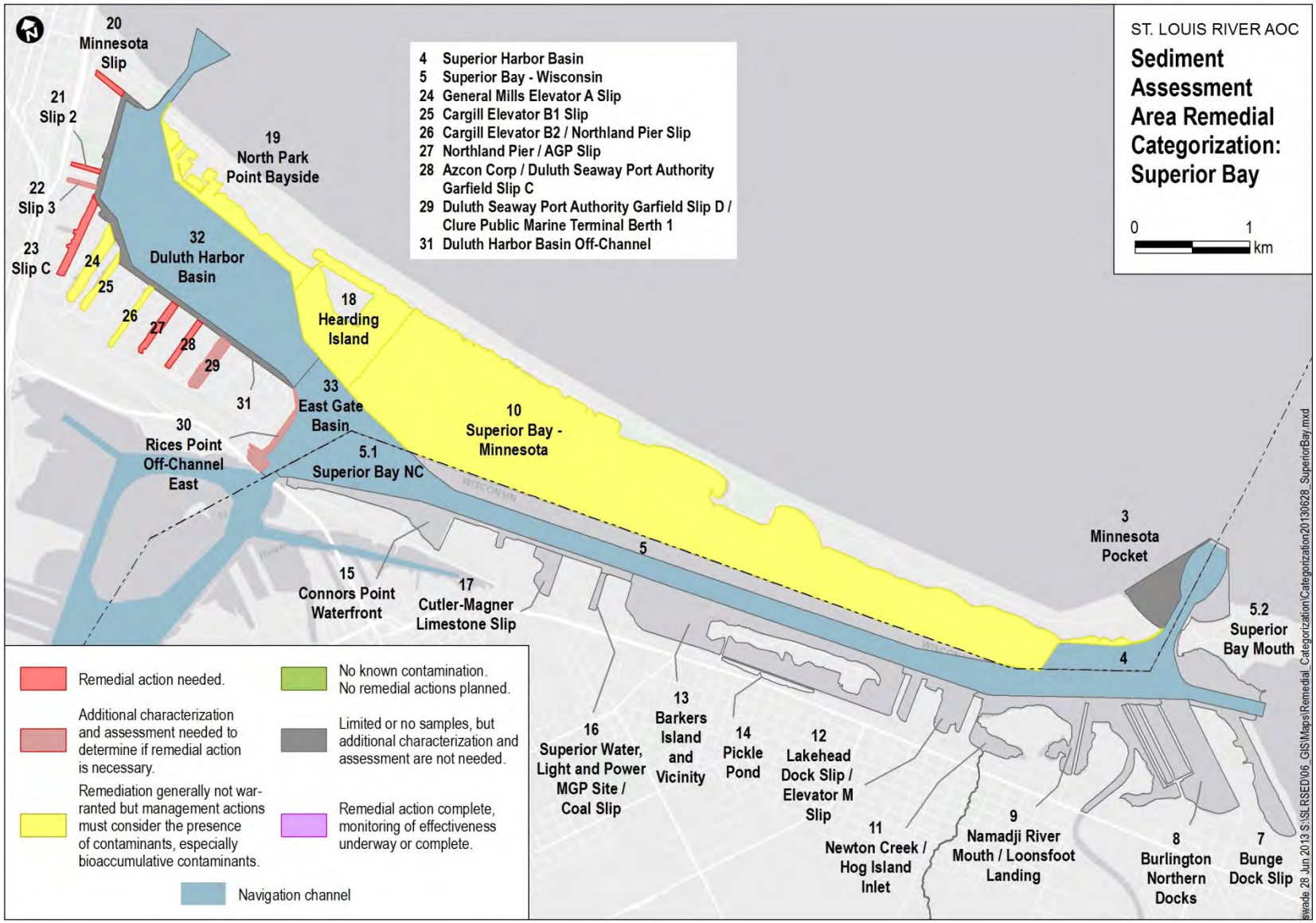



**Figure 6. Remedial categories in Superior Bay.**

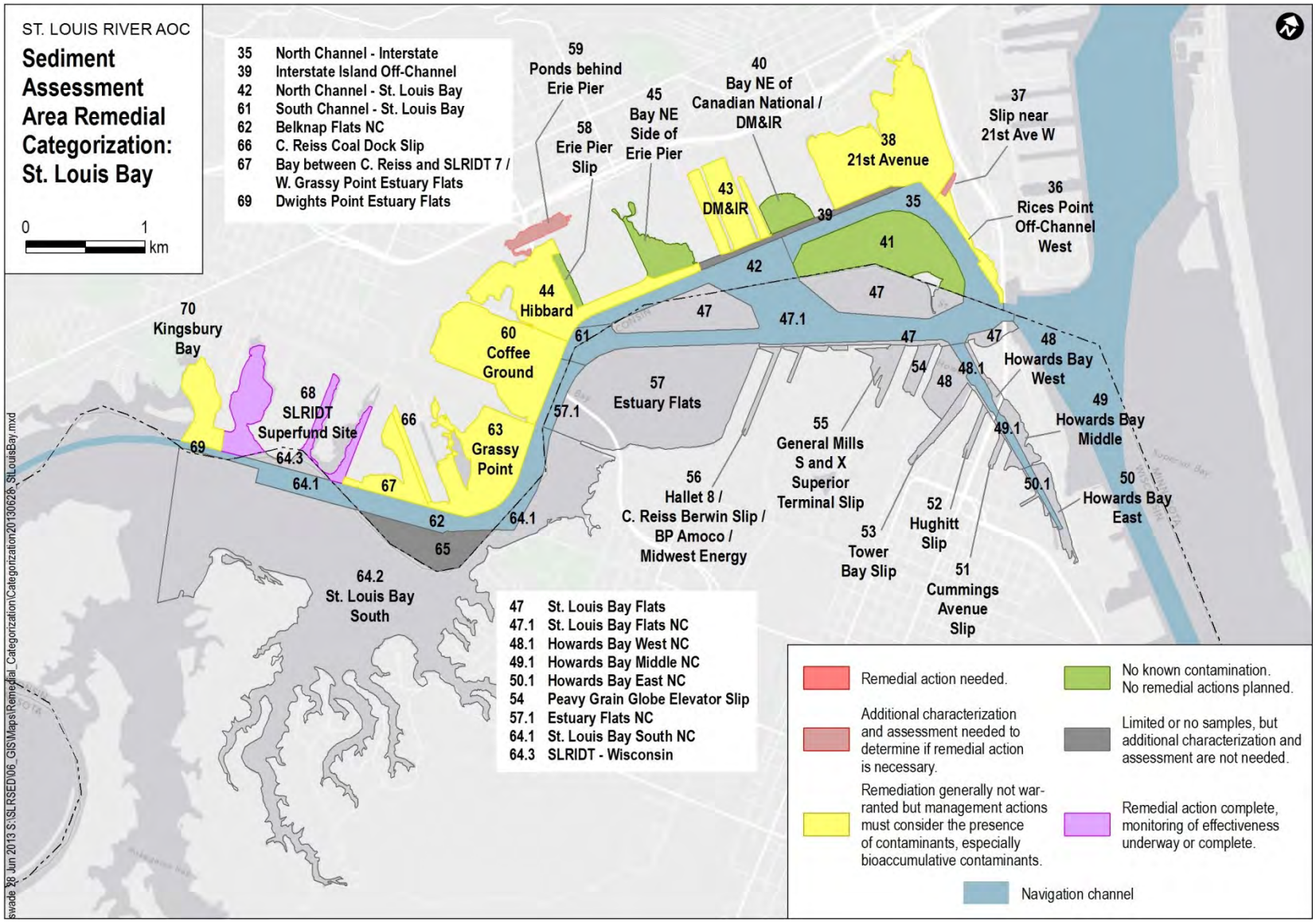



**Figure 7. Remedial categories in St. Louis Bay.**

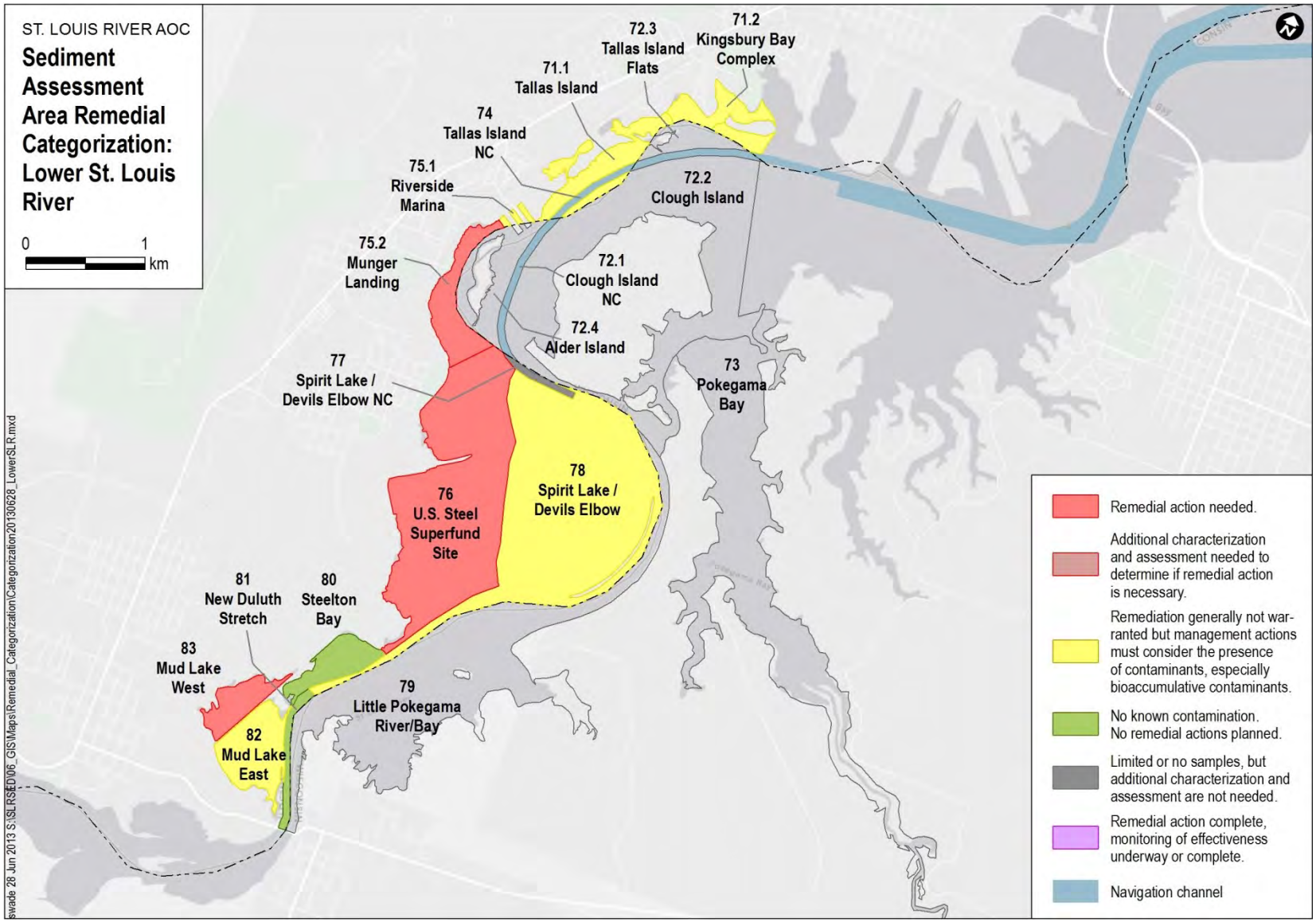



**Figure 8. Remedial categories in the Lower St. Louis River.**

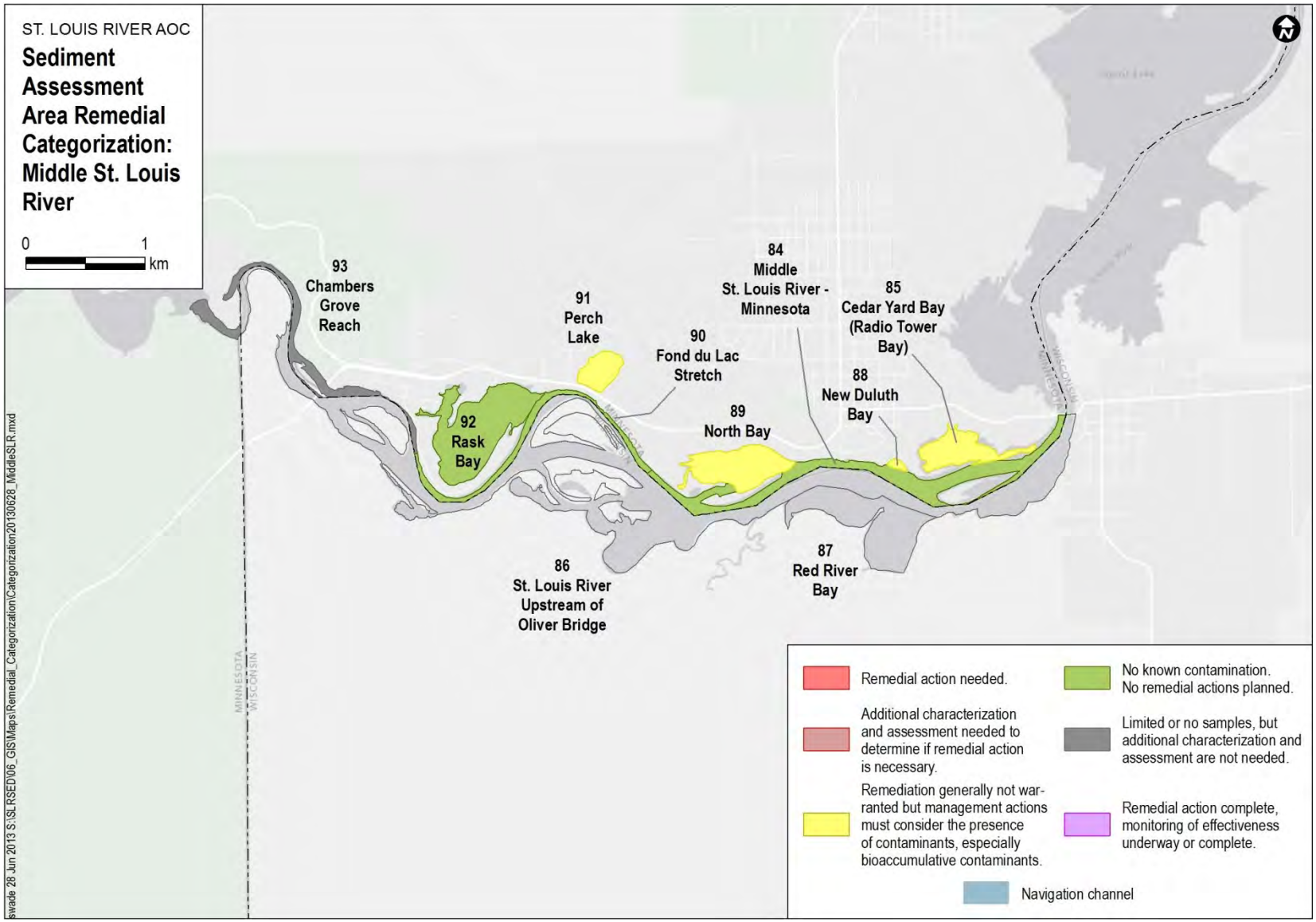



**Figure 9. Remedial categories in the Middle St. Louis River.**

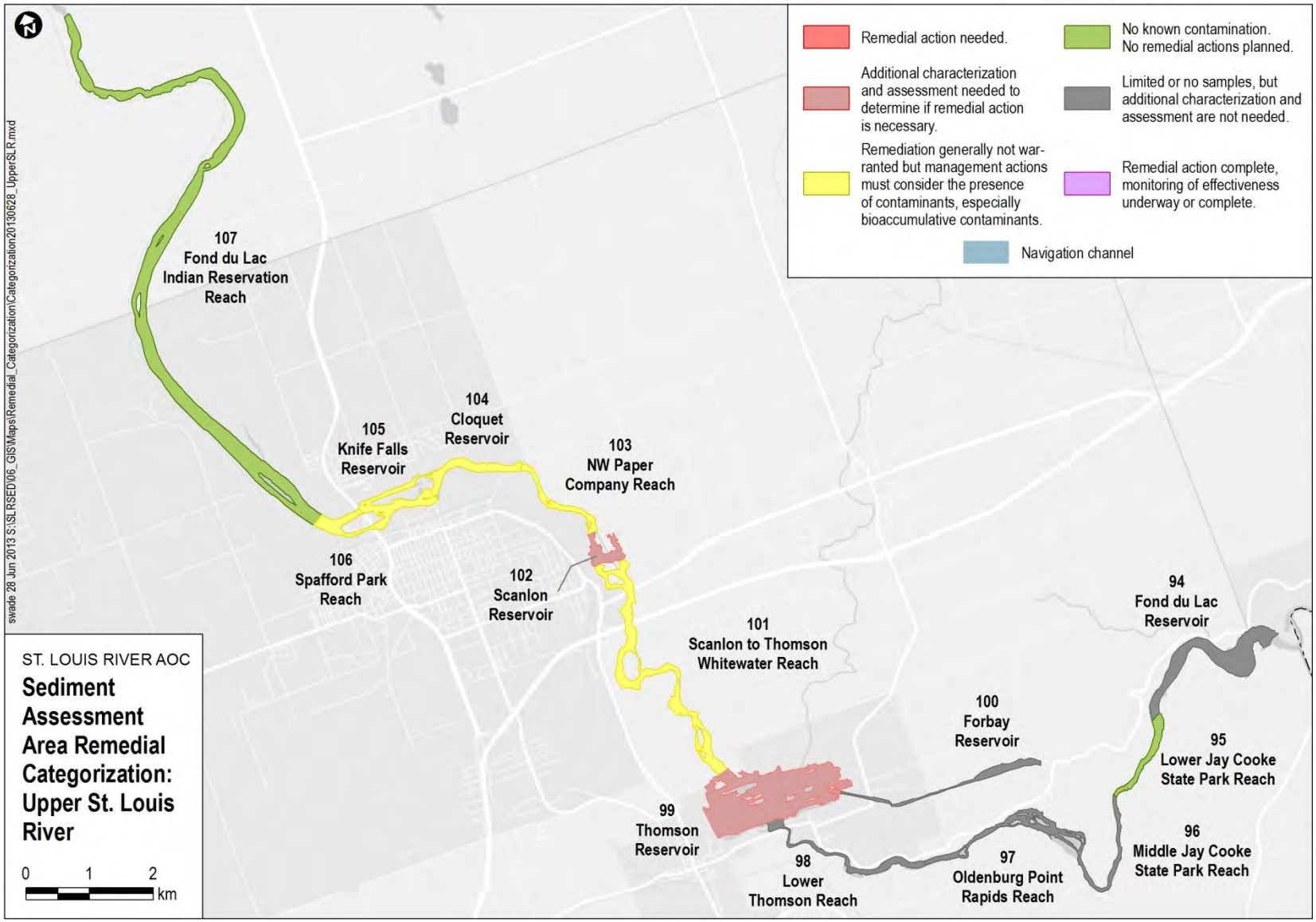



**Figure 10. Remedial categories in the Upper St. Louis River.**

## References

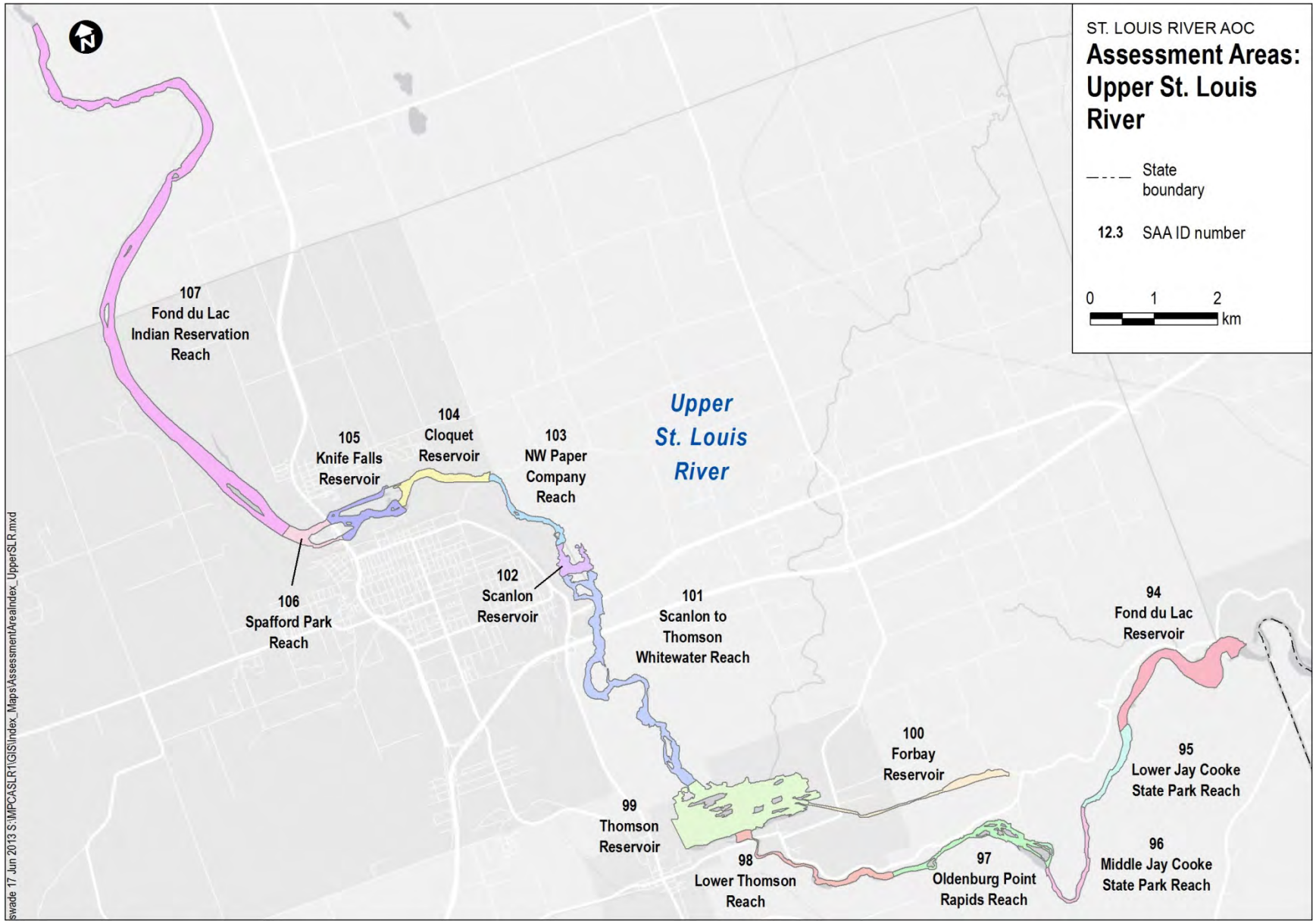
Canadian Council of Ministers of the Enviroenment (CCME). 2007. *SeQI 1.0.* PN 1378 ISBN 978-1-896997-65-0

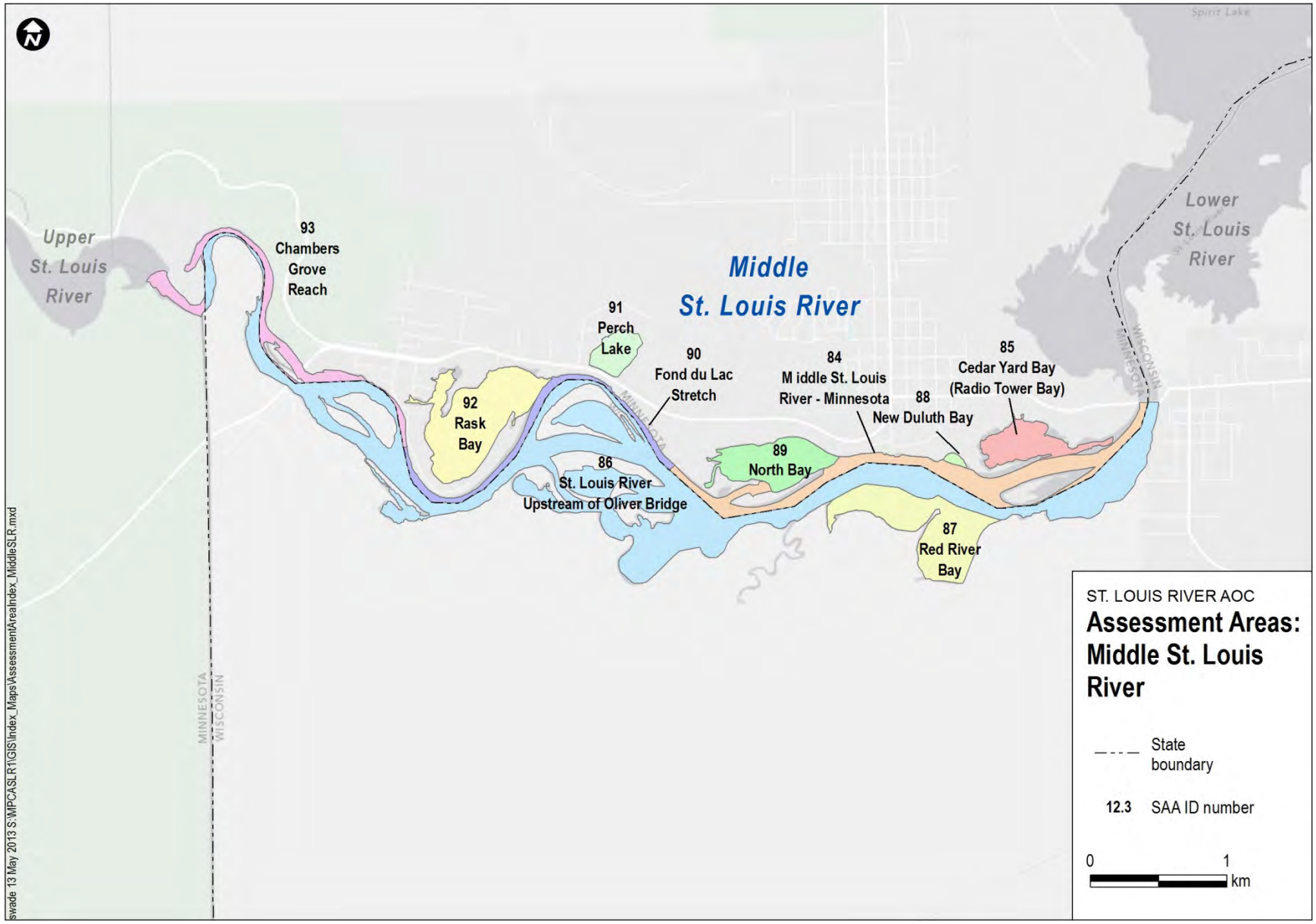
Crane, Judy and Steve Hennes. February 2007. *Guidance for theUse and Application of Sediment Quality Targets for the Protection of Sediment-Swelling Organisms in Minnesota.* Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency

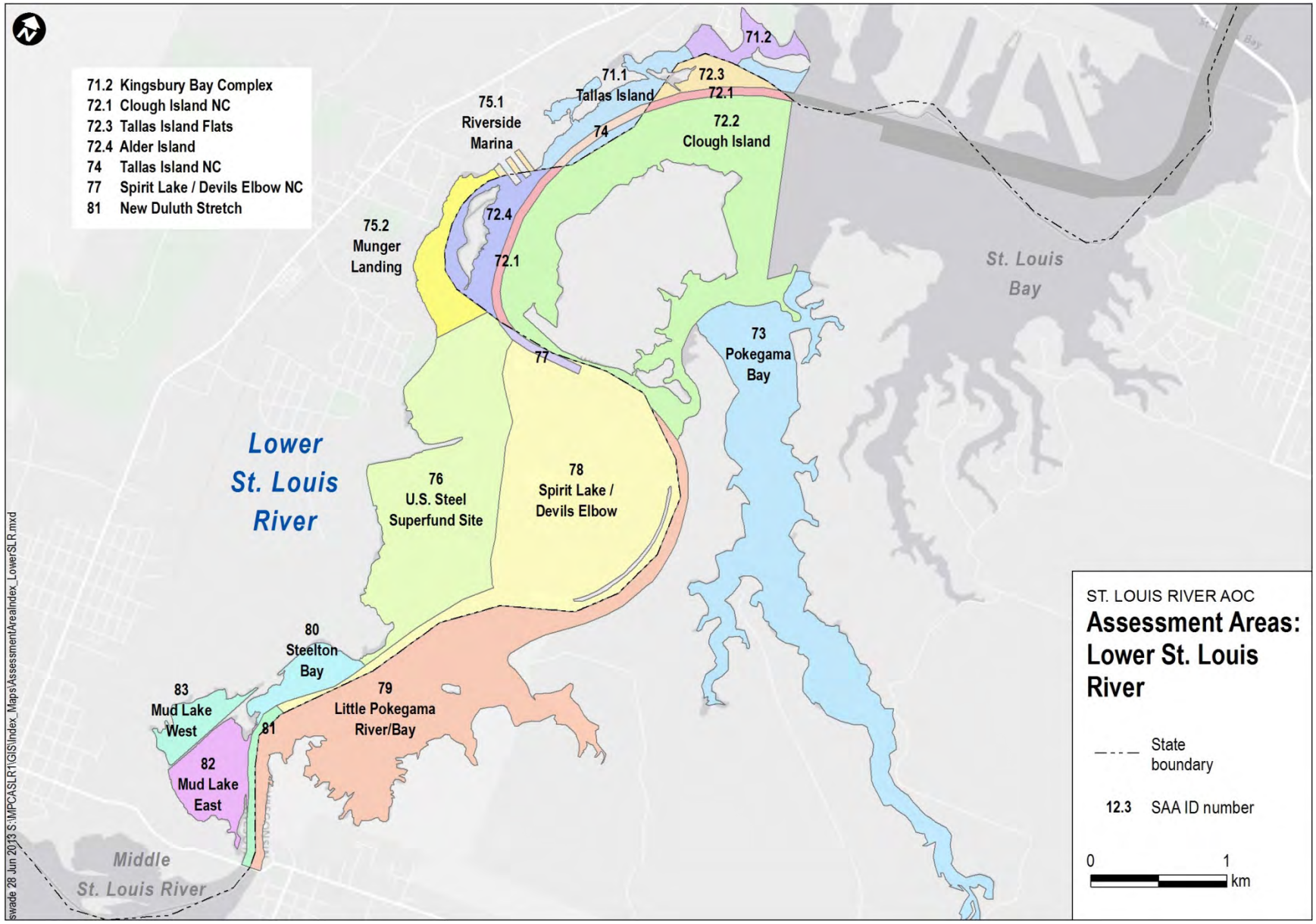
Eisler, Ronald. *Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review.* U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD. Biological Report 85 (1.11). May 1987.

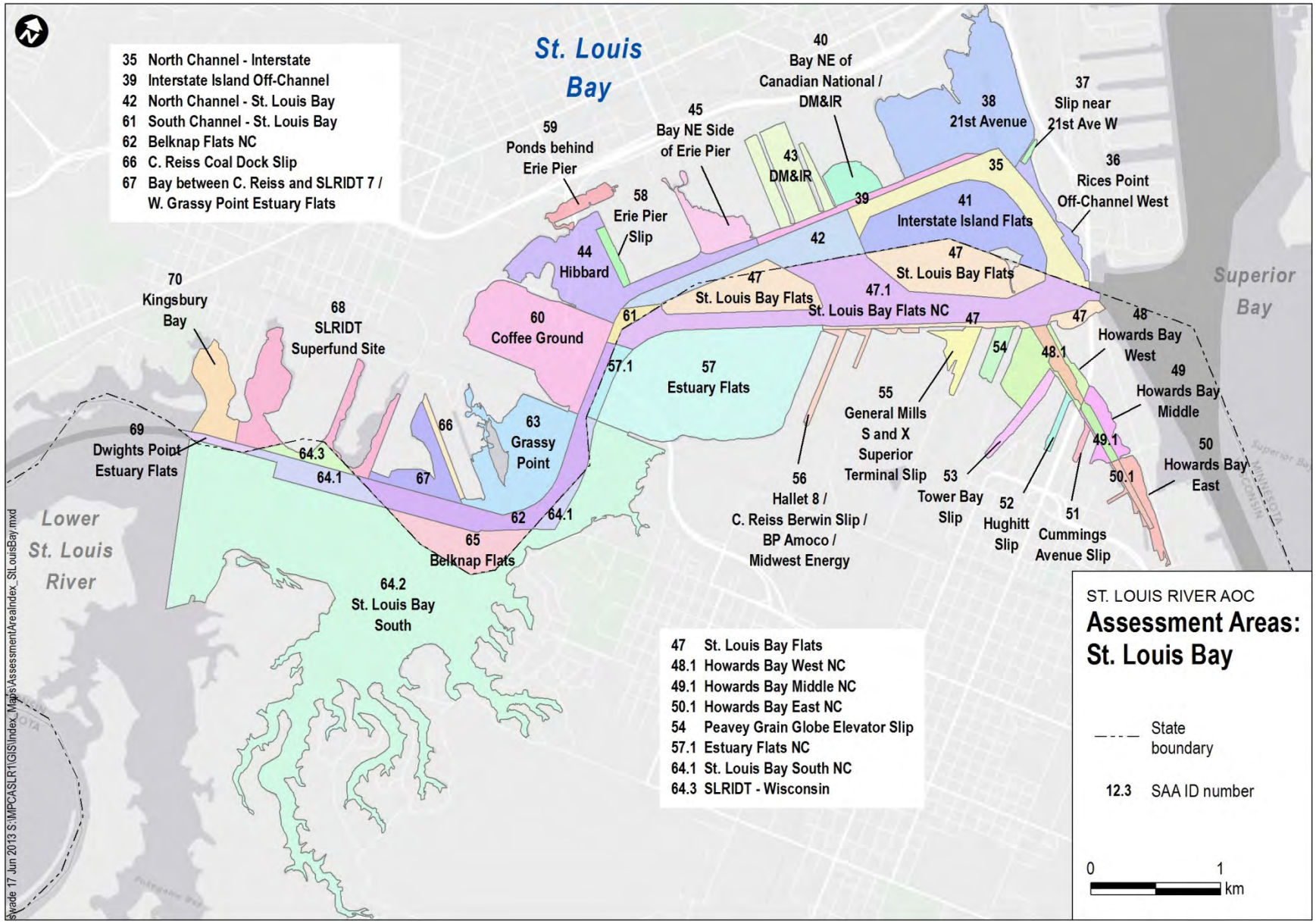
# Appendix G: Sediment Assessment Areas

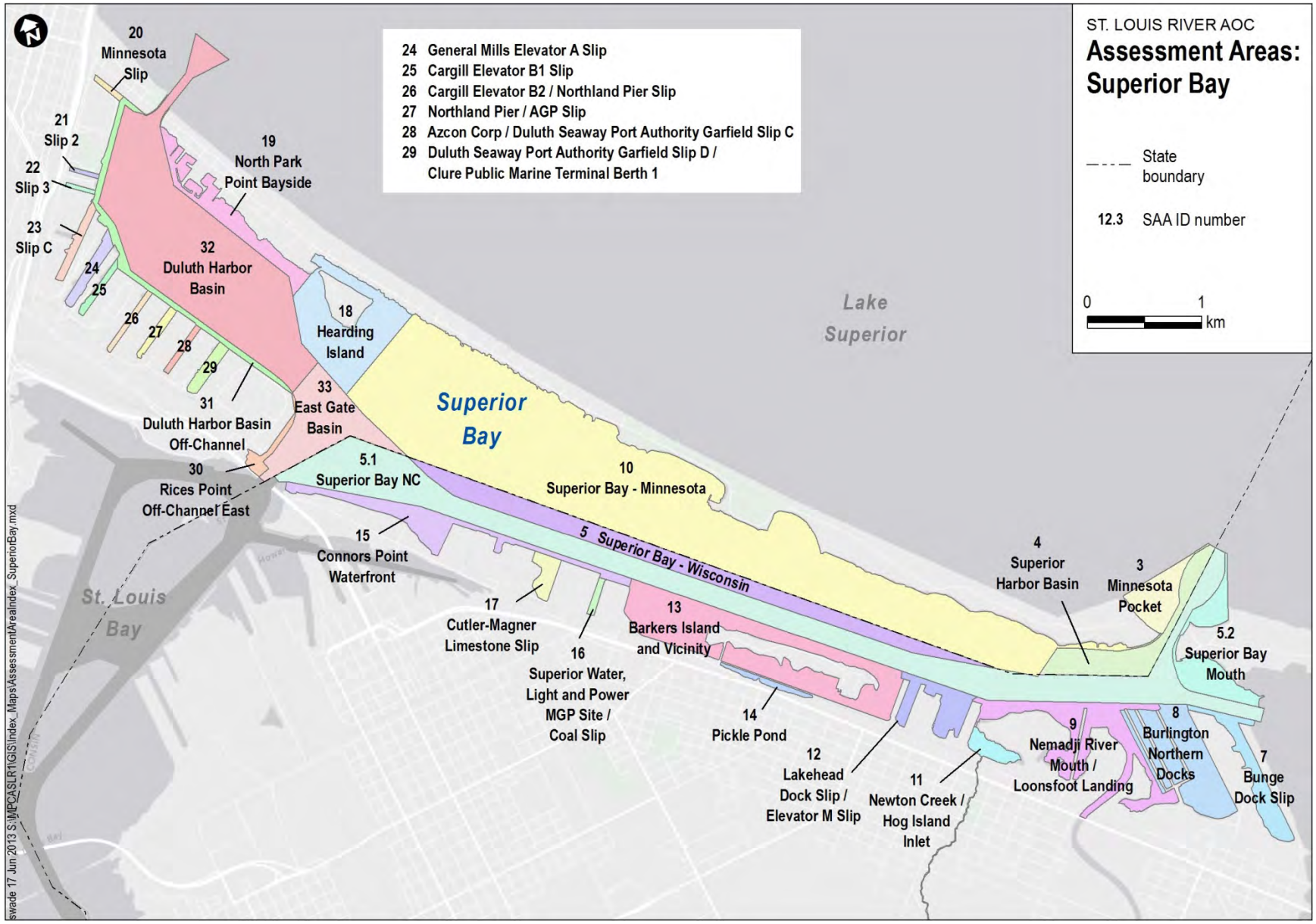
The following series of maps display the sediment assessment areas (SAAs) for the St. Louis River AOC. The SAAs are displayed by geographic zone, starting at the upstream end of the AOC. Each SAA number is given, along with its common place name. SAAs in the navigational channel are denoted with an “NC” in their place name. Colors of the SAAs are only to distinguish one SAA from another.

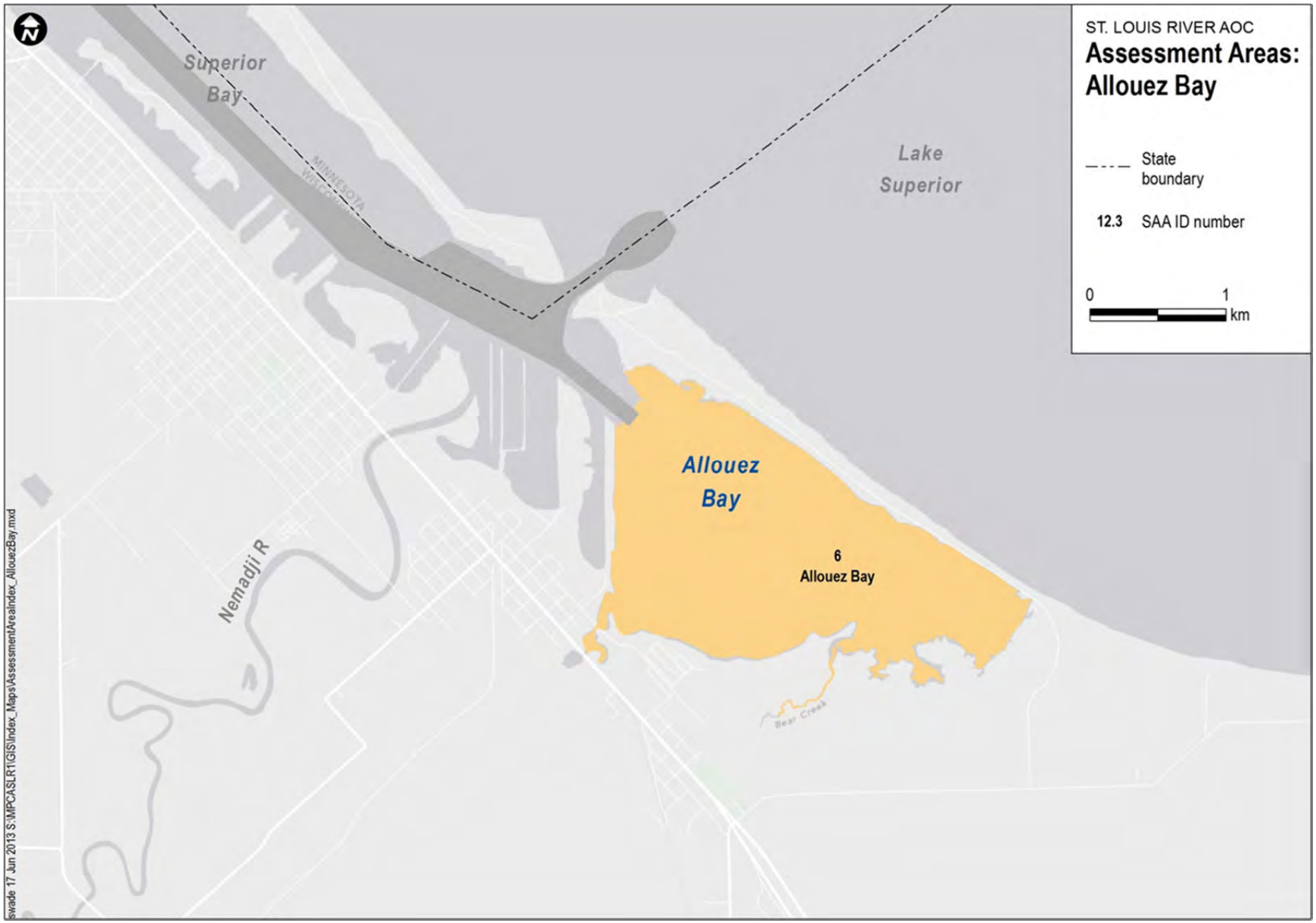

ST. LOUIS RIVER AOC
Assessment Areas: Upper St. Louis River
State boundary
12.3 SAA ID number
0 1 2 km
107 Fond du Lac Indian Reservation Reach
105 Knife Falls Reservoir
104 Cloquet Reservoir
103 NW Paper Company Reach
Upper St. Louis River
106 Spafford Park Reach
102 Scanlon Reservoir
101 Scanlon to Thomson Whitewater Reach
94 Fond du Lac Reservoir
100 Forbay Reservoir
95 Lower Jay Cooke State Park Reach
99 Thomson Reservoir
98 Lower Thomson Reach
97 Oldenburg Point Rapids Reach
96 Middle Jay Cooke State Park Reach
swade 17 Jun 2013 S:\MPCASLR1\GIS\Index_Maps\AssessmentAreaIndex_UpperSLR.mxd


Upper
St. Louis
River
93
Chambers
Grove
Reach
Middle
St. Louis River
91
Perch
Lake
90
Fond du Lac
Stretch
92
Rask
Bay
86
St. Louis River
Upstream of Oliver Bridge
84
M iddle St. Louis
River - Minnesota
89
North Bay
88
New Duluth Bay
85
Cedar Yard Bay
(Radio Tower Bay)
87
Red River
Bay
Lower
St. Louis
River
Spirit Lake
MINNESOTA
WISCONSIN
WISCONSIN
MINNESOTA
swade 13 May 2013 S:\MPCA\SLR1\GIS\Index_Maps\AssessmentAreaIndex_MiddleSLR.mxd
ST. LOUIS RIVER AOC
Assessment Areas:
Middle St. Louis
River
State
boundary
12.3
SAA ID number
0
1
km


71.2 Kingsbury Bay Complex
72.1 Clough Island NC
72.3 Tallas Island Flats
72.4 Alder Island
74 Tallas Island NC
77 Spirit Lake / Devils Elbow NC
81 New Duluth Stretch
71.2
71.1
Tallas Island
72.3
72.1
75.1
Riverside
Marina
74
72.2
Clough Island
72.4
75.2
Munger
Landing
72.1
St. Louis
Bay
73
Pokegama
Bay
77
Lower
St. Louis
River
76
U.S. Steel
Superfund Site
78
Spirit Lake /
Devils Elbow
80
Steelton
Bay
83
Mud Lake
West
79
Little Pokegama
River/Bay
81
82
Mud Lake
East
Middle
St. Louis River
swade 28 Jun 2013 S:\MPCASLR1\GIS\Index_Maps\AssessmentAreaIndex_LowerSLR.mxd
ST. LOUIS RIVER AOC
Assessment Areas:
Lower St. Louis
River
State
boundary
12.3 SAA ID number
0
1
km


35 North Channel - Interstate
39 Interstate Island Off-Channel
42 North Channel - St. Louis Bay
61 South Channel - St. Louis Bay
62 Belknap Flats NC
66 C. Reiss Coal Dock Slip
67 Bay between C. Reiss and SLRIDT 7 / W. Grassy Point Estuary Flats
St. Louis Bay
40 Bay NE of Canadian National / DM&IR
45 Bay NE Side of Erie Pier
59 Ponds behind Erie Pier
58 Erie Pier Slip
43 DM&IR
38 21st Avenue
37 Slip near 21st Ave W
36 Rices Point Off-Channel West
35
39
41 Interstate Island Flats
42
44 Hibbard
47 St. Louis Bay Flats
47 St. Louis Bay Flats
47.1 St. Louis Bay Flats NC
70 Kingsbury Bay
68 SLRIDT Superfund Site
60 Coffee Ground
61
57.1
57 Estuary Flats
47
47
48 Howards Bay West
54
48.1
49 Howards Bay Middle
55 General Mills S and X Superior Terminal Slip
49.1
50 Howards Bay East
50.1
69 Dwights Point Estuary Flats
64.3
64.1
66
63 Grassy Point
67
62
64.1
65 Belknap Flats
56 Hallet 8 / C. Reiss Berwin Slip / BP Amoco / Midwest Energy
53 Tower Bay Slip
52 Hughitt Slip
51 Cummings Avenue Slip
Superior Bay
Lower St. Louis River
64.2 St. Louis Bay South
47 St. Louis Bay Flats
48.1 Howards Bay West NC
49.1 Howards Bay Middle NC
50.1 Howards Bay East NC
54 Peavey Grain Globe Elevator Slip
57.1 Estuary Flats NC
64.1 St. Louis Bay South NC
64.3 SLRIDT - Wisconsin
ST. LOUIS RIVER AOC
Assessment Areas: St. Louis Bay
State boundary
12.3 SAA ID number
0
1
km
S:\wade 17 Jun 2013 S:\MPCA\SLR1\GIS\Index_Maps\AssessmentAreaIndex_StLouisBay.mxd


ST. LOUIS RIVER AOC
Assessment Areas:
Superior Bay
State boundary
12.3 SAA ID number
0
1
km
24 General Mills Elevator A Slip
25 Cargill Elevator B1 Slip
26 Cargill Elevator B2 / Northland Pier Slip
27 Northland Pier / AGP Slip
28 Azcon Corp / Duluth Seaway Port Authority Garfield Slip C
29 Duluth Seaway Port Authority Garfield Slip D / Clure Public Marine Terminal Berth 1
20 Minnesota Slip
21 Slip 2
22 Slip 3
23 Slip C
24
25
26
27
28
29
19 North Park Point Bayside
32 Duluth Harbor Basin
18 Hearding Island
33 East Gate Basin
31 Duluth Harbor Basin Off-Channel
30 Rices Point Off-Channel East
5.1 Superior Bay NC
Superior Bay
10 Superior Bay - Minnesota
5 Superior Bay - Wisconsin
15 Connors Point Waterfront
17 Cutler-Magner Limestone Slip
16 Superior Water, Light and Power MGP Site / Coal Slip
13 Barkers Island and Vicinity
14 Pickle Pond
12 Lakehead Dock Slip / Elevator M Slip
11 Newton Creek / Hog Island Inlet
4 Superior Harbor Basin
3 Minnesota Pocket
5.2 Superior Bay Mouth
9 Nemadji River Mouth / Loonsfoot Landing
8 Burlington Northern Docks
7 Bunge Dock Slip
Lake Superior
St. Louis Bay
swade 17 Jun 2013 S:\MPCA\SLR1\GIS\Index_Maps\AssessmentAreaIndex_SuperiorBay.mxd


ST. LOUIS RIVER AOC
Assessment Areas:
Allouez Bay
State boundary
12.3 SAA ID number
0
1
km
Superior Bay
Lake Superior
Allouez Bay
6
Allouez Bay
Nemadji R
Bear Creek
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Allouez
Bay
Nemadji R.
Bear Creek
Nemadji River
Crawford
Creek
34
Crawford
Creek
ST. LOUIS RIVER AOC
Assessment Areas:
Crawford Creek
State
boundary
12.3 SAA ID number
0
1
km
swade 01 Jul 2013 S:\MPCA\SLR1\GIS\Index_Maps\AssessmentAreaIndex_CrawfordCreek.mxd