St. Louis River/Interlake/Duluth Tar Site
Duluth, Minnesota

REVISED DRAFT FEASIBILITY STUDY

DECEMBER 30, 2003

SERVICE
ENGINEERING
GROUP

REVISED DRAFT FEASIBILITY STUDY
ST. LOUIS RIVER/INTERLAKE/DULUTH TAR SITE
SEDIMENT OPERABLE UNIT

Prepared for:
XIK Corp.
Honeywell International, Inc.
Domtar, Inc.

Prepared by:
SERVICE ENGINEERING GROUP

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIXES

SERVICE ENGINEERING GROUP

LIST OF TECHNICAL TERMS AND ACRONYMS

Agreement	Contract between the MPCA and the Companies reopening the RI/FS and establishing a PRT
ARARs	Applicable or Relevant and Appropriate Requirements under CERCLA
BAZ	Bioactive Zone
BCC	Bioaccumulative Chemicals of Concern
BSIC	Bioaccumulative Substances of Immediate Concern
BT/PT	The Best Technology in Process and Treatment
CAC	St. Louis River Citizen's Action Committee
CAD	Contained Aquatic Disposal - Disposal of dredged material in a laterally and vertically contained system whose cap is under water
Cap	A cap is engineered material placed between contaminated sediment and the overlying environmental media to prevent contact between the aquatic ecosystem and contaminants at concentrations that would cause harm to the population.
CDF	Confined Dredge Facility - Disposal of dredged material in a laterally and vertically contained system whose cap emerges above the water, creating new land area
CERCLA	Comprehensive Environmental Responsibility, Compensation and Liability Act (also known as Superfund)
COC	Contaminants of Concern
COE	US Army Corps of Engineers
cPAHs	Carcinogenic PAHs
Companies	XIK Corp. (formerly The Interlake Corporation), Honeywell International, Inc., and Domtar Inc. These are the three responding Responsible Parties (of the four named Responsible Parties)
Cover	Habitat medium placed on post-dredge surfaces to dilute and/or isolate residue from adversely affecting the aquatic environment or human exposure
CSM	Conceptual Site Model
CWG	Community Work Group – A group of interested parties, which meets regularly for site updates
DGR	Data Gap Report
DNR	Minnesota Department of Natural Resources
Dredge Prism	A dredge prism is a series of three-dimensional geometric sediment volumes that can be removed with mechanized dredges and verified with a survey.
EPA	United States Environmental Protection Agency
ESG	EPA Equilibrium Partitioning Sediment Guidelines

LIST OF TECHNICAL TERMS AND ACRONYMS

FAV	Final Acute Values
FS	Feasibility Study
GAC	Granular Activated Carbon
Hallett	Hallett Dock Company
HBV	Health Based Values for naphthalene in ambient air
HRL	Health Risk Limits (State)
IRA	Interim Response Action
IZ	Isolation Zone
MCL	Maximum Contaminant Level (Federal)
MCLG	Maximum Contaminant Level Goals (Federal)
MERLA	Minnesota Environmental Response and Liability Act
mg/Kg	milligram/kilogram
mg/L	milligram/Liter
MPCA	Minnesota Pollution Control Agency
NAPL	Non-Aqueous Phase Liquid
NCP	National Contingency Plan
neat line	The surface within the sediment above which lies the targeted contaminated sediment
NPL	National Priority List
NRT	Natural Resource Trustees—a group of State, Federal and Tribal entities authorized to seek damages for injuries to natural resources at the Site
OIRWs	Outstanding International Resource Waters
Overdredge	Clean sediment dredged to allow for vertical variability while attempting to remove the entire layer of contamination
PAHs	Polycyclic Aromatic Hydrocarbons
PAC	Powdered Activated Carbon
Parties	The MPCA and the Companies
PEC	Probable Effects Concentration
Permanent Remedy	The MPCA considers an implemented remedy permanent when the remedy allows for unrestricted use of all land and natural resources impacted by the contaminants and, except for the purpose of treatment, does not involve removal of the contaminants to another site and minimizes exchange of the contaminants to other environmental media.

LIST OF TECHNICAL TERMS AND ACRONYMS

PPE	Personal Protection Equipment
PRG	Preliminary Remedial Goal
PRT	Peer Review Team
RAO	Response Action Objective
ROD	Record of Decision
RPs	Responsible Parties (see also Companies)
RFRA	Request for Response Action
RI/FS	Remedial Investigation/Feasibility Study
SDS	State Disposal System
SedOU	Sediment Operable Unit
the Site	The St. Louis River/Interlake/Duluth Tar Site
SOU	Soil Operable Unit
SERVICE	Service Engineering Group
SLRIDT	St. Louis River/Interlake/Duluth Tar Superfund Site
SWQS/C	Surface Water Quality Standards/Criteria
TBC	To be considered
TPAHs	The sum of all of the individual PAH compounds measured
TSOU	Tar Seep Operable Unit
URA	Uniform Relocation Act
USX	United States Steel
WCA	Wetland Conservation Act
WDNR	Wisconsin Department of Natural Resources
WLSSD	Western Lake Superior Sanitary District

1.0 INTRODUCTION

1.1 Report Purpose

In February 2000, the Minnesota Pollution Control Agency (MPCA) and XIK Corp. (formerly The Interlake Corporation), Honeywell International, Inc., and Domtar Inc. (collectively the Companies) entered into an agreement (the Agreement) to reopen the Remedial Investigation/Feasibility Study (RI/FS) for the Sediment Operable Unit (SedOU) of the St. Louis River/Interlake/Duluth Tar (SLRIDT) Site in Duluth, Minnesota (the Site). Pursuant to the Agreement, the Parties also formed a Peer Review Team (PRT), which was charged to, among other things, review the reopened RI/FS and provide comment and advice to the Parties. The PRT is composed of eight members, who represent the four areas of expertise identified by the Agreement, and is administered by a Coordinator. The PRT members and disciplines are summarized in Section 2.3.2. The MPCA and the Companies (collectively, the Parties) identified four alternatives to be evaluated:

- No Action,
- Wetland Cap[1]: Capping contaminated areas of the Site,
- Dredging & On-Site Disposal: Dredging contaminated areas to disposal cells in Slips 6 and 7, and
- Dredging & Off-Site Disposal: Dredging contaminated areas, dewatering the sediment on-Site and transporting the dewatered sediment off-Site to a licensed disposal facility.

These four alternatives were described in detail in the Data Gap Report (DGR) (SERVICE 2002).

The Agreement allowed for modifications of these alternatives where justified by new information or new ideas (Section 1.1 of Agreement). Subsequent to the submission of the DGR and review of the report by MPCA and the PRT; the MPCA staff, the Companies, and the staff of the Minnesota Department of Natural Resources (DNR) engaged in discussions along with other stakeholders to identify additional remedy alternatives. These discussions resulted in identification of a hybrid remedy alternative that employs dredging, capping and containment.

[1] A cap is engineered material placed between contaminated sediment and the overlying environmental mediato prevent contact between the aquatic ecosystem and contaminants at concentrations that would cause harm to the population.

Pursuant to an amendment to the Agreement, the Dredge/Cap Hybrid replaces the Dredging & On-Site Disposal Alternative for comparison to the other three alternatives in this Feasibility Study (FS).

This FS is also submitted in accordance with Exhibit A of the March 22, 1994 and March 26, 1996 Requests for Response Actions (RFRAs) issued by the MPCA, and provides the basis for the MPCA to select a remedy for the SedOU which is consistent with the National Contingency Plan (NCP). The remainder of the FS is organized in accordance with the MPCA's RFRAs and the NCP, and includes discussion of EPA's 11 principles for managing sediment contamination at hazardous waste sites.

1.2 Report Organization

This section presents the Site, the regulatory history, the geologic setting, and a summary characterization of the Site from previous investigations. A conceptual site model (CSM) and summary of risks based on contaminant fate and transport, exposure pathways and potential receptors is also presented. Section 2 presents ARARs, the Response Action Objectives and clean up levels (also known as Preliminary Remedial Goals or PRGs). Section 3 describes the alternatives previously considered in the RI/FS process and the public process that led to the alternatives discussed in this FS. It describes remedial components and the alternatives. Treatability Studies previously conducted are also summarized in Section 3. Section 4 introduces the evaluation criteria and measures each alternative against those criteria. The strengths and weaknesses of those alternatives are compared in Section 5, however, no recommendation is made in this document in accordance with Section 10.4 of the Agreement which provides that the FS "shall not contain a recommendation for selection of a remedy." References cited in this FS are presented in Section 6.

1.3 Background Information

1.3.1 Site Description and History

The Site is within the West Duluth neighborhood of the city of Duluth, on the north bank of the St. Louis River, approximately four river miles upstream of Lake Superior. The Site includes approximately 255 acres of land and river embayments, wetlands, and shipping slips. The land includes the 59th Avenue Peninsula and the 54th Avenue Peninsula. It is bounded on the north by the Burlington Northern right-of-way. The aquatic portion of the Site includes Stryker Bay (approximately 40 acres that defines the western boundary), Slip 6 (about 23 acres), Slip 7 (about 27 acres that defines the eastern boundary), and the St. Louis River to the south. Residences are located west of the Site on the 63rd Avenue Peninsula, and to the north of the railroad tracks. Approximately 800 people live within one mile of the Site. A small portion (approximately 1.5 acres) of the SedOU at the mouth of Slip 6 is within the waters of the State of Wisconsin.

The Site has been used for industrial purposes since at least the 1890s. Prior to industrialization, the Site was predominantly open water called St. Louis Bay, bounded on the west by 63rd Avenue Peninsula. The bay was open to the east. Depth soundings indicate it was consistently 3 to 6 feet deep, except for a shipping channel identified on US Army maps of the area from the early 1900s. **Figure 1-1** shows the historical development of the landforms of the Site from St. Louis Bay in the early 1900s to the current configuration of two shipping slips, Stryker Bay, 59th Avenue peninsula (Hallett Dock 6), and 54th Avenue peninsula. **Figure 1-2** contains alpha area designations, for assistance in identifying where certain activities took place.

In 1904, Zenith Furnace Company began producing coke and byproducts near the north end of what is now the 59th Avenue peninsula (Area D). A water gas manufacturing plant operated intermittently in Area D from 1905 to 1961. Duluth Tar Company began refining tar in 1905 in Area A. Crude coal tar was sold by Zenith Furnace Company to Duluth Tar Company. In 1916, Duluth Tar Company became Barrett Tar Company, which closed in about 1924. A new tar refining operation was built in 1924 in Area E, adjacent to the Duluth Tar Company/Barrett Tar Company facility. The new facility, owned by Dominion Tar Company and American Tar Company, operated until 1948. These facilities purchased coal tar from Zenith (later Interlake), operated batch coal tar stills and manufactured tar products.

Area A is currently owned by LeTourneau and is vacant. The buildings on the property were destroyed by fire on February 20, 1975. Area E was occupied by Duluth Wrecking Company (an automobile salvage company) from 1963 until the late 1990s, when the property was sold to the current owner, EBI (formerly Earthburners, Inc.), a construction and remediation company.

In 1929, Zenith Furnace Company's coking operations were relocated to Area B (the head of the current Hallett Slip 6) and the company became the Interlake Iron Company. Its water gas plant remained in Area D. Crude tar produced from coking operations at the Interlake Iron facility was sold to the tar refineries located in Area E. Other industrial byproducts were used in conjunction with re-deposited native sediment as fill to create new land, including the 59th Avenue Peninsula and the 54th Avenue Peninsula. The primary fill material is slag from on-Site pig iron operations. The second-most common fill material is flue dust from the same operation. Lesser amounts of fill material consist of coal, coke, sand, gravel, and debris. The slag and flue dust are both non-hazardous and granular. Based on soil borings conducted during the remedial investigation of the Soil Operable Unit (SOU), approximately 70% of the fill consists of granular material. The remaining fine-grained material is less continuous and ranges from 1 to 30 feet thick, with the largest single deposit found on 54th Avenue Peninsula in the former Area C Pond. Fine-grained fill also typically includes granular material as well.

The MPCA concluded that Interlake Iron discharged to Stryker Bay, to Slip 7, and to the 48-inch outfall at the southern tip of the 54th Avenue Peninsula.

Interlake Iron's operations ceased in 1961, and the property was idle until 1966, when Hallett Dock Company (Hallett) purchased the former Interlake Iron portion of the Site. Hallett has used the property primarily for bulk storage and handling of coal, coke, bentonite, and other industrial materials, including calcium chloride. Hallett sold a portion of the northernmost part of the Site to Maurices' Inc. (Maurices'), which operated a warehouse at the location until 2000. The warehouse was recently sold.

Hallett also leases portions of the Site to other companies, including an asphalt and concrete crusher (LeTourneau) on the 59th Avenue Peninsula, and a company that sandblasts and paints steel girders at the head of Slip 6. In the late 1990's EBI purchased a large portion or possibly the entire portion of Area E that was occupied by Duluth Wrecking Company and moved its operations from Dock 7 to Area E. Among EBI's business enterprises was a contaminated soil desorber, which operated on Dock 7 and subsequently near the southwest corner of its property adjacent to Stryker Bay. The desorber has since been shutdown and removed.

Historical industrial operations adjacent to the unnamed creek which discharges to the north end of Stryker Bay include the Western Rug Company, later called Klearflax Looms, which was located about 1,500 feet north of the bay and which operated from 1914 to approximately 1953; two rail maintenance facilities which were located about 1,200 feet and 2,000 feet northeast of the bay and which operated from the 1920s until 1958; and a city wastewater treatment plant located about 200 feet north of the bay. American Carbolite Company operated a production facility, which was located 1,200 feet north of Slip 6 adjacent to Keene Creek, from 1914 until at least 1948. Keene Creek discharged to Slip 7 during this time, but was diverted during construction of the Waseca Industrial Road in the 1994.

The sources of PAH releases at the Site were primarily wastewater discharges from facilities formerly located on the Site and possibly from other former sources in the contributing watersheds. The last industrial discharges from facilities at the Site were terminated no later than 1961 when Interlake Iron shut down the last operating facility. Other off-site potential sources cited above have also terminated operations. Urban runoff and atmospheric fallout and the river's wash load continue, but are not likely sources for recontaminating the site.

1.3.2 Regulatory History

In 1979, Polycyclic Aromatic Hydrocarbons (PAHs) were detected in Stryker Bay sediments by the MPCA. An oil slick was noted on the surface of the bay in 1981. The site was nominated to, and listed on, the National Priority List (NPL) in combination with the United States Steel Site, located about four miles upriver. In 1991 and 1993, RFRAs were issued to the Companies for the Tar Seep Operable Unit (TSOU) and SOU. Remediation of the TSOU by excavation and off-site thermal treatment was completed in 1993. In most of the areas of the SOU, soil was excavated and either thermally treated or transported off-site. These activities were completed in 1996 and 1997, with bioventing of Maurices' Parking Lot completed in 2003.

RFRAs for the SedOU were issued to The Interlake Corporation for Stryker Bay, Area F, Slip 6 and Slip 7 on March 22, 1994; and to Domtar, Inc., Allied Signal, Inc. and Beazer East for Stryker Bay and Area F in March 26, 1996. Since that time, The Interlake Corporation changed its name to XIK Corp. and Allied Signal, Inc. merged with, and is now known as, Honeywell International, Inc. This FS has been prepared by XIK, Honeywell International, Inc., and Domtar, Inc. (the Companies). Beazer East has been kept informed of, but has not participated in the reopened RI/FS process. A remedial investigation (RI) and risk assessment was submitted in 1997 (IT 1997a). Four additional studies have been submitted since the RI. A Draft Alternatives Screening Report (IT 1997b), which screened 44 technologies and developed and compared nine alternatives, carried forward six alternatives to a Draft Feasibility Study (IT 1998). One of the alternatives carried forward included a thin cap, which the MPCA found not to be protective. A Focused Feasibility Study Update (SERVICE 1999a) and a Supplemental Detailed Analysis Report (SERVICE 1999b) were submitted that examined an alternative consisting of a thicker cap (2-3 feet thick.) A more complete description of these studies is presented in Section 3.2.

In 2000, the Companies and MPCA entered an agreement to reopen the RI/FS, to gather information to fill 14 data gaps, and to evaluate four alternatives. The Agreement also provided for the creation of a PRT of national experts to review the results collected and render opinions on the 14 issue and on the strengths and weaknesses of the alternatives. The data collected to fill the data gaps was submitted to the MPCA in 2002 in the DGR (SERVICE 2002). Meetings were held during the data gathering period in 2001 and 2002 to discuss the data and associated issues with the PRT. The MPCA facilitated a two-day meeting in February 2003, following completion of the DGR, with the Companies, MPCA staff, the PRT, staff of the DNR and other natural resource managers, a Site property owner, the City of Duluth and other stakeholders. The February 2003 meeting produced a number of new hybrid dredge/cap alternatives and identified unresolved key regulatory issues affecting remedy selection and implementation. Using the information developed at the February 2003 meeting the Companies, the MPCA, and the DNR identified a hybrid alternative to be evaluated in the FS. The Parties then reconvened the stakeholders and sought their reaction to the new hybrid option. As a result, the Companies and the MPCA amended the 2000 Agreement to add, the Dredge/Cap Hybrid Alternative in place of the Dredging & On-Site Disposal Alternative option in this FS.

1.3.3 Hydrogeologic Setting

The St. Louis River watershed drains approximately 4,000 square miles of northeastern Minnesota. The geology of the watershed consists primarily of glacial drift of varying thicknesses and composition overlying igneous and metamorphic bedrock.

The Site is underlain by Precambrian members of the Duluth Complex consisting primarily of gabbro igneous rocks. The Duluth Complex gabbro is overlain by the Fond du Lac Formation, which consists primarily of feldspathic sandstone, with some siltstone and shale. Quaternary glacial sedimentary deposits in the area of the Site consist of red silt and clay deposited in ancestral Glacial Lake Duluth. In the St. Louis River estuary, the bedrock is overlain by 300 to 500 feet of silt and clay lake deposits, with localized saturated glacial lake sands usually less than 10 feet thick. Groundwater development is limited, and primarily restricted to the glacial lake sands and gravels, due to the inadequate quantity of usable groundwater in the gabbro and thick silt and clay. Sediment, soil, and bedrock identified at the Site have been categorized into twelve hydrogeologic layers, with three of the layers further divided into members (SERVICE 2002; Appendix GH, Table GH-2-1). **Figure 1-3** shows the layers in context on the Site.

The Site consists of two peninsulas (59th Avenue and 54th Avenue) constructed of industrial fill, two dredged shipping slips (Slips 6 and 7) and Stryker Bay. A generalized stratigraphy includes: near-surface industrial fill and recent bay sediment underlain by 0 to 25 feet of sandy silt and silty fine to medium sand, then a laterally extensive thick confining layer, which is more than 50 feet thick. A lower sand layer, which has not been identified in all deep on-Site borings, appears to be laterally extensive based on identification in several deep on-Site borings and continuous flow from two on-Site artesian wells. This lower sand layer is isolated within the thick confining layer. The thick confining layer is underlain by a dense to very dense sand and gravel layer identified in one or two on-Site borings. The Duluth Complex is between 100 and 300 feet deeper than the sand and gravel layer. Bedrock has not been encountered in any of the on-Site soil borings.

Shallow groundwater on-Site is located primarily in the fill materials used to construct the peninsulas and flows from groundwater divides on the peninsulas outward to the river. The exception to this is in Areas A and E, and the north end of the site near Maurices', where shallow groundwater is present in a native sand and silt deposit. The shallow groundwater regime is separated from the deep regional aquifer by 50 feet or more of laterally extensive silt and clay (**Figure 1-3**).

Shallow groundwater on each of the Site peninsulas flows from the groundwater divide, which approximately bisects each of the peninsulas, to the Site surface water bodies. Horizontal hydraulic gradients, determined from bimonthly water table elevation measurements in monitoring wells during 2000 to 2001 (SERVICE 2002, Table GH-3-6), are relatively flat on the majority of the peninsulas (SERVICE 2002, Figures GH-3-5 and GH-3-6), except in Areas A & E, where a groundwater seep is present at the shoreline above the elevation of Stryker Bay (SERVICE 2002, Appendix GW-4).

Horizontal hydraulic conductivities were measured using slug tests to determine the groundwater flow rate and contaminant flux (SERVICE 2002, Attachment GH-3-3). Groundwater gradients, conductivities and flow rates increase near the shorelines due to wave-washed sediments with higher conductivities and increased gradients due to seepage faces. Contaminant flux from the peninsula groundwater to the Site surface water bodies was determined using the calculated flow in each groundwater flow tube multiplied by the average contaminant concentration in the shoreline sentinel wells (SERVICE 2002, Appendix GW-3). The contaminant flux was used as one of the inputs to the surface water quality model (SERVICE 2002, Appendix SW-3) to determine whether surface water quality would be impacted above chronic surface water quality standards/criteria (SWQS/C) for each of the potential remedial options.

Vertical hydraulic gradients determined in on-shore monitoring well and piezometer nests are downward in all measured locations except the Slip 6 dockwall cribbing (SERVICE 2002, Figure GH-3-9 and Table GH-3-7). Off-shore vertical hydraulic gradients were determined using vibrating wire piezometer nests in the Slips, and vibrating wire piezometer nests in combination with flux meters in Stryker Bay. Net vertical gradients were upward in the shallow Stryker Bay sediment and downward in the shallow slip sediment (SERVICE 2002, Figure GH-4-6 and Table GH-4-5). Additional hydraulic study is currently underway in Slip 7 to confirm the vertical hydraulic gradients measured in vibrating wire piezometer nest VPZ-8.

1.4 Site Characterization

1.4.1 Nature and Extent of Contamination

In Stryker Bay, contaminated sediment exists in a relatively discreet one- to two-foot-thick layer throughout the bay (Layer 102), with areas up to eight- to ten-feet-thick along the eastern shore **(Figure 1-4)**. The total PAH (TPAH) concentration in Layer 102 averages approximately 3,350 milligrams/kilogram (mg/Kg), with a maximum of more than 35,000 mg/Kg. Layer 101, overlies most of Layer 102 in Stryker Bay. SERVICE has estimated an average TPAH concentration of 34 mg/Kg, with a maximum of 75 mg/Kg. Contaminated sediment exists throughout most of the Slips, except in the north end of Slip 7, and varies from less than one foot thick to more than 10 feet thick **(Figure 1-4)**. The maximum TPAH concentration in Layer 002 of the shallow Slip sediments is more than 340,000 mg/Kg. Geologic layers identified throughout this report are described in Table GH-2-1 of the DGR (SERVICE 2002). Most samples taken outside of the bays and slips and 48 inch outfall area of the Site did not have any visible sign of industrial constituents such as coal, coke, slag, tar, odor, or sawdust; so they were designated as native sediment. A line denoting the lateral extent of observation of non-native sediment is shown in **Figure 1-4**.

1.4.1.1 Sediment

The PRGs were established by the MPCA and are presented in Section 2.2 and Appendix B. The sediment PRG is used here to describe the nature and extent of contamination. The MPCA will present final goals in the Record of Decision (ROD). The MPCA's PRG for remediating sediments at the Site is based on TPAHs at 13.7 mg/Kg. This FS will primarily focus on addressing the PAH concentrations in sediment because if the PAH-contaminated sediment is remediated through removal or isolation, other chemicals of concern (COCs) will also be remediated.

Figure 1-4 shows the lateral extent and thickness of TPAHs greater than 13.7 mg/Kg. Stryker Bay, Slip 6, and Slip 7 all require remediation nearly shore-to-shore, with the exception of their respective northern ends. The volumes for dredging and capping for each of the active remedial alternatives by area are shown in **Table 1-1**. Even though PAHs are naturally occurring in the native sediments at low concentrations, a sharp demarcation exists between the native sediments and overlying industrially influenced sediment.

The non-native sediment, as defined above, terminates just beyond the mouths of Stryker Bay and the Slips (**Figure 1-4**).

1.4.1.2 Surface Water and Groundwater

Table B-1 in Appendix B shows a summary of the results of surface water and groundwater samples measured at the Site, and identifies the number of samples that exceeded established federal or state surface water or groundwater standards (identified as Applicable or Relevant and Appropriate Requirements (ARARs) in **Table B-1**). **Table B-2** in Appendix B refines the ARAR standard list to those chemicals for which the MPCA has proposed Site-specific surface water and groundwater PRGs. These are the parameters the MPCA may require to be monitored in each media. The final list will be established in the Remedial Design and Response Action (RD/RA) Plan and approved by the MPCA as required in the RFRA.

Surface water was tested for metals and PAHs during the initial Remedial Investigation (IT 1997a, Appendix C). Neither of the surface water samples tested at the Site exceeded any of the ARAR standards. Other surface water samples were collected for treatability or bench column tests. However, these samples were gathered on or near the main river system, or at the surface of deep water in Slip 7 to represent ambient river conditions in testing. At 1.7 ng/L, the surface water sample for the dredging elutriate test (SERVICE 2002, Appendix DRET) is consistent with background concentrations found in larger studies (WDNR 1991, MPCA, 1999) that indicate the St. Louis River exceeds or exceeded the chronic wildlife SWQS for mercury with measured concentrations ranging from 0.93 to 17 ng/L compared to a standard of 1.3 ng/L. Measurements and modeling of groundwater and surface water concentrations in the DGR (SERVICE 2002, Appendixes SBLT, DRET, GW-2, GW-3, GW-4 and SW-3) confirm the limited surface water sampling, indicating that contributions of metals and PAHs from contaminated sediment do not exceed SWQSs under existing conditions at the Site, and mercury is at background levels.

In groundwater, sixteen of thirty compounds for which standards have been established were not detected above those standards at the Site. Of the compounds that have been detected above standards, only benzene (52%), naphthalene (36%), and cyanide (17%) have been above standards in more than 10% of the samples. Concentrations of measured compounds in groundwater are highest in the monitoring wells installed in or near sources of contamination on the peninsulas (SERVICE 2002, Figure GH-3-7). The concentrations decrease near Site shorelines, with only a few compounds exceeding chronic SWQS/C in shoreline sentinel wells (SERVICE 2002, Figure GH-3-8). Upland groundwater contaminant flux calculations (SERVICE 2002, Appendix GW-3), used in conjunction with sediment contaminant flux (SERVICE 2002, Appendix GW-2) as inputs to the surface water quality model (SERVICE 2002, Appendix SW-3), did not exceed chronic SWQS/C for existing, capped, or dredged and covered shoreline conditions.

1.4.2 Conceptual Site Model and Summary of Site Risks

An appropriate step in investigating and implementing a remedy is to develop a CSM. The CSM is a three-dimensional representation of Site conditions that conveys what is known or suspected about the sources, releases, release mechanisms, contaminant fate and transport, exposure pathways, potential receptors and risks.

As part of the DGR, a CSM was developed for the site. That report describes it as an Integrated Fate and Transport Model (SERVICE 2002). Its purpose was to summarize the interrelationships of soil, surface and groundwater, sediment, and ecological and human receptors that define the SedOU, as the temporal, physical and chemical forces that affect its stability.

The CSMs for the SedOU's four water bodies are presented in **Figure 1-5** (Stryker Bay), **Figure 1-6** (The Slips), and **Figure 1-7** (The Main Channel) and the primary features of each are described below.

1.4.2.1 Stryker Bay

Stryker Bay is a shallow, flat-bottomed bay of approximately 40 acres with a maximum depth of 5 feet. There are homes to the west and industrial land to the north and east. A wetland is located at the north end where an unnamed stream enters the bay from a steep urban watershed and another wetland is located in the southwest corner near the mouth of the bay.

Contaminated sediment underlies most of Stryker Bay (**Figure 1-4**). Layer 102, which underlies most of the bay, contains relatively high concentrations of TPAHs. In the northeastern portion of the bay only, PAH-bearing material has migrated down to the underlying native peat or clayey silt sediment (Layer 103). The uppermost sediment layer (Layer 101) is a nearly uniform layer averaging six inches thick throughout the bay, except in shallow wave-washed areas. Layer 101 contains much lower levels of PAHs than the industrial discharge era layers as described in greater detail below.

Mercury is elevated above ambient levels in portions of Stryker Bay, but is not elevated in the slips. Due to the high sulfide levels found throughout the sediments of the site (SERVICE 2002; Appendix BT, Table BT-6-2, and IT 1997), almost all mercury in Stryker Bay sediment is expected to be in an insoluble sulfide form, causing the concentration in the leachate to approximate the ambient river water quality (SERVICE 2002; Appendix SBLT, Table SBLT-4-4). Leachate from the dredge prism (including Layers 101, 102 and 103) meets chronic SWQS/C for all other heavy metals (SERVICE 2002; Appendix SBLT, Table SBLT-4-4).

Highly viscous Non-Aqueous Phase Liquid (NAPL) was found in Layers 102 and 103 in a limited area in the northeast corner of Stryker Bay (SERVICE 2002; Appendix GH, Figure GH-6-1 and Appendix BT, Section BT-9.5.1).

Gas bubbles generated by anaerobic biodegradation in Layer 102 during the late summer and early fall when sediments are the warmest, carry contaminated sediment up to the air/water interface; when the bubbles burst, the entrained sediment falls to the sediment surface (SERVICE 2002; Appendix GH, Section GH-6.2). Where NAPL is present, the sediment entrained with bubbles also contains NAPL, which spreads a sheen on the water's surface. The blooms degrade and dissipate after several hours and have been largely contained by oil booms in the past three years.

Numerous processes act on the sediment/water interface and in Layer 101 in Stryker Bay including: upward advection (flow) of groundwater and downward flow of surface water into the sediment, diffusion of chemicals from the sediment to the water, new sediment deposition, bioturbation, biodegradation, mixing, and redistribution from bed shear induced by waves, prop wash, currents, and occasional anchoring. Within the protected shallow bay, ice usually freezes to the bed around the perimeter and thaws in place during the melt (SERVICE 2002, Appendix GT-6). Some of these processes deliver PAHs to the interface; others dilute, degrade, and physically redistribute the PAHs. Layer 101 has a generally consistent thickness and concentration of TPAHs. The net effect of the numerous processes acting on this layer of soft clayey silt is a uniform vertical distribution of PAHs (SERVICE 2002; Appendix BT, Section BT-3-2) at much lower concentrations than the underlying Layer 102 material (about 4% of the underlying concentration). Averaging 34 mg/Kg TPAHs, Layer 101 exceeds the goal of 13.7 mg/Kg. Its high TOC (averaging 13%) provides retardation capacity to upflowing PAHs (SERVICE 2002, Appendix BT, Section BT-10.1.4). Mercury is distributed in Layer 101 at essentially the same concentration as Layer 102.

Groundwater flow from the slag fill of the 59th Avenue Peninsula is primarily through the wave-washed beach material (SERVICE 2002; Appendix GH, Figure GH-3-4). A seasonal groundwater seep on the embankment in the northeast corner of Stryker Bay is caused by a clay-confining layer at the base of the aquifer at an elevation above the river level (SERVICE 2002; Appendix GW4). Groundwater flows both upward and downward beneath the bay. The flow is more often upward than downward, resulting in an intimate exchange of surface water and pore water and a net upward flux of groundwater (SERVICE 2002; Appendix GH, Figure GH-4-9 and Table GH-4-5). Since there is a net upward gradient, dissolved chemicals are carried toward the surface water. Dissolved organic compounds like PAHs attenuate through adsorption and biodegrade as they move with groundwater through the sediments to the surface water. When the flow rate is slow enough as it is at this Site, a cap of sufficient thickness provides a treatment zone where biodegradation effectively destroy the dissolved PAHs, thereby protecting the Bioactive Zone (BAZ) within the sediment and surface water.

1.4.2.2 The Slips

Each of the two slips includes a shipping area where depths range up to 28 feet, a transition slope, and a shallow area. The shallows of Slip 7 are larger than those of Slip 6. The surrounding land use is industrial and the land consists largely of industrial fill. An on-shore wetland is located west of the shallows of Slip 7. A hard slag layer present along the western shore of Slip 7 produces a broad, flat shallow shelf that is overlain by fine-grained contaminated sediment or peat (on-shore).

PAH-contaminated sediment (known as Layer 002 in the slips) is located near the surface throughout most of the slips (**Figure 1-6**). (It is too thin to show in the generalized geologic section of **Figure 1-4**). Mercury levels in slip sediments do not exceed ambient harbor background (SERVICE 2002; Appendix GH, Section GH-7.3.1). Others have observed some sediments produce oil blooms when disturbed. One of eight samples produced a sheen but no free phase was observed when the samples were centrifuged (SERVICE 2002; Appendix GH, Figure GH-6-1). Layer 002 sediments from Slip 7 do not generate gas bubbles at temperatures up to 20 ^{o}C (SERVICE 2002; Appendix BT, Section BT-6.3). Like Stryker Bay, ice typically thaws in place in these protected slips.

Groundwater flows from the slag fill of the 59th and 54th Avenue Peninsulas are primarily through the submerged banks and the wetland. The measured shallow groundwater gradient beneath Slip 6 is more often downward than upward, resulting in an intimate exchange of surface water and pore water and a net downward flux of groundwater. In Slip 7, the gradient is consistently downward (SERVICE 2002; Appendix GH, Figure GH-4-17 and Table GH-4-5).

Upward chemical flux is not expected to occur in the slips because information from ten vibrating wire piezometers indicates downward advection may dominate the diffusion process (SERVICE 2002; Appendix GH, Figure GH-4-17). Additional studies are being conducted with traditional piezometers to confirm the groundwater gradient in these areas.

1.4.2.3 The River Channel Area

The river channel portion of the Site contains the outlets from Stryker Bay and the slips, the shallows between the outlets, and the main navigation channel. This area is subject to a different set of forces than the more protected bay and slips because it is adjacent to the main channel.

The area includes a 23-feet-deep federal navigation channel. Because the channel was dredged, the adjacent waters are much shallower. Slopes as steep as five to one connect the shallows to the deep channel. The adjacent land use is industrial and the adjacent land consists of industrial fill. A wetland is located west of the mouth of Stryker Bay and along the shore of the peninsula between the slips.

An area south of the former industrial discharge point between the slips is known as the 48-inch outfall area because an industrial wastewater discharge occurred here in the late 50's until 1961. As in the shallows of Slip 7, a bed of hard slag caps the shallows between the slips and creates a sandy shallow wave-washed surface. Contaminated material is draped down the slopes, with the most contaminated area to the southeast (**Figure 1-4**).

Mercury does not exceed harbor background in the sediments of the main channel or adjacent shallows. No viscous NAPL was found in the area (SERVICE 2002; Appendix GH, Figure GH-6-1) and native sediments do not generate gas bubbles (SERVICE 2002; Appendix BT, Section BT-6.3).

Processes that act or acted on the sediment/water interface include downward advection, erosion (now stabilized)[2] along the shore of the 54th Avenue Peninsula (SERVICE 2002; Appendix GT1), bioturbation (except on the exposed slag surface), biodegradation in the upper zone

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[2] Most of the Site shoreline has been very stable since 1964. The most significant shoreline changes evident at the Site since 1964 have occurred at the southern tip of the 54th Avenue Peninsula, near the former location of the 48-inch Outfall, which discharged wastewater from the 1940s until 1960. The wastewater discharge produced a broad, flat, shallow delta on the south end of the peninsula comprised primarily of slag with varying degrees of cementation. A diminishing erosional pattern was observed after cessation of the discharged wastewater sediment load. The south end of the peninsula has been stable since approximately 1980 and appears to have reached equilibrium (SERVICE 2002, Appendix GT1).

(except on the slag surface), and redistribution within the shallows from bed shear induced by waves, occasional ship props and side-thruster wash, currents, and occasional anchoring. Ice push occurs occasionally in the shallows in this area. Subsequent wave action then replaces and re-levels the sand (SERVICE 2002; Appendix GT6, Section GT6-3.2). Some of these processes deliver PAHs to the interface; others dilute, degrade, and physically redistribute the PAHs.

There are several pathways by which human and environmental receptors might be exposed to contaminants in the sediment at the Site (**Figure 1-8**). Direct environmental exposure pathways include the consumption of sediment by benthic invertebrates, by shorebirds and waterfowl, by amphibians and by bottom-feeding fish and plant herbivores such as deer, muskrats and beavers, and direct contact with contaminated sediments by benthic invertebrates, amphibians, fish, burrowing organisms, and plants. Direct human exposure pathways include wading in the shallow areas of the site (sediment and water exposure) or contact with sediment on anchors or other equipment placed in the sediment. Swimmers may be exposed via contact with, or incidental consumption of, sediment suspended in water. Indirect exposure to environmental receptors would result if organisms consume plants or benthic invertebrates or fish that have absorbed contaminants from pore water or sediments. Potential bioaccumulation pathways for indirect human exposure include the human consumption of fish and wildlife that have consumed contaminated sediment, invertebrates or plants.

2.0 RESPONSE ACTION OBJECTIVES AND GOALS

Remedial actions for releases and threatened releases of hazardous substances, and pollutants or contaminants, must be selected and carried out in compliance with applicable state and federal legal requirements. The general legal standard that must be met by any remedial action selected and implemented under the Minnesota Environmental Response and Liability Act (MERLA) is that the remedial action must protect public health and welfare and the environment, and the means selected to do so must be reasonable and necessary. Risk-based selection of remedial action, by focusing on reduction of risk to public health and the environment, is intended to ensure that a remedy meets the protectiveness standard of MERLA. In addition, under the 1994 and 1996 RFRAs, any remedial actions selected for the Site must also comply with ARARs, as defined by the Comprehensive Environmental Responsibility, Compensation and Liability Act (CERCLA). Such ARARs, as discussed below, may include air quality, water quality, and waste management laws and rules.

Response Action Objectives (RAOs) are narrative statements that state specifically how the remedy should protect human health and the environment. Each RAO typically addresses a medium, the exposure route and the receptors, and incorporates a cleanup level or performance requirement. The RAOs with their cleanup levels will be set forth in the Record of Decision for the SedOU. For purposes of evaluating alternative remedies in this FS, Preliminary Remedial Goals or PRGs are used. The PRGs define explicit measurements and parameters that must be achieved to ensure the protectiveness of each alternative.

The PRGs for this Site have been developed by the MPCA using environmental criteria, advisories, guidance and ARARs. Discussions of ARARs, including associated permits, and of PRGs are presented in Sections 2.1 and 2.2, respectively.

A small portion (approximately 1.5 acres) of the SedOU, in the main channel of the St. Louis River outside the bay and slips, is within the waters of the State of Wisconsin. MPCA has regularly communicated with WI regarding portions of the site in WI waters.

2.1 Permits and ARARs

2.1.1 Introduction

Under RFRAs for the SedOU issued pursuant to MERLA (Minn. Stat. Ch. 115B) on March 22, 1994 and March 26, 1996, RAOs and cleanup levels are determined by the MPCA using the following sources:

- ARARs as defined in the NCP;
- The document entitled "Compilation of Ground Water Rules and Regulations, MPCA Superfund Program (March 27, 1991);
- The results of human and ecological risk assessments;
- Federal and state sediment guidance; and
- Documented sediment remediation case studies.

This Section 2.1 discusses the ARARs that will apply to remedial action at the SedOU, including those that will be incorporated in the ROD or in separate permits.

Section 2.2 of this FS discusses PRGs, which are based on risk assessments, sediment guidance, or sediment remediation case studies. These PRGs include standards and measures that provide:

1. Definition of the sediment area to be remediated (Sections 2.2.1.1),
2. Protection for Surface Water Quality During Remediation (Section 2.2.1.2),
3. Protection of Ambient Air Quality (Section 2.2.1.3),
4. Dredging-Specific Remedial Goals (Section 2.2.2),
5. Capping-Specific Remedial Goals (Section 2.2.3),
6. Dredging Goals in waters of the State of Wisconsin (Section 2.2.5)

2.1.2 Permits and ARARs: General Discussion

The Site is a State-lead NPL site, and is one of the sites identified in the Deferral Pilot Project agreement between MPCA and U.S. Environmental Protection Agency (EPA) dated June 20, 1995. Therefore, remedial actions at the SedOU will be taken pursuant to MERLA and the Deferral Pilot Project agreement. The remedial actions will be subject to applicable Federal, State and local permit requirements (described in Section 2.1.3 below). With respect to MPCA permit requirements, the agency will exercise its enforcement discretion to incorporate the substantive requirements associated with all MPCA permits (described in Section 2.1.4 below) into the ROD and, where appropriate, into the approved remedial design.

Under the SedOU RFRAs, remedial actions are required to conform with ARARs as defined in the NCP.[3] The ARARs for the SedOUs are described in Sections 2.1.3 (permits by agencies other than the MPCA), 2.1.4 (MPCA permits to be incorporated into its ROD), and 2.1.5 other ARARs not included in any permit.

2.1.2.1 Definitions

Applicable or Relevant and Appropriate Requirements (ARARs) are defined in the NCP as follows:

> "Applicable Requirements" means "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. . ." 40 CFR §300.5.

> "Relevant and Appropriate Requirements" means "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate." Id.

The NCP also recognizes an additional category called "to be considered" or "TBCs."

> "TBCs" means pertinent advisories, criteria, or guidance that may represent materials "to be considered" … "as appropriate" … in fashioning a remedy. 40 CFR §300.430(d)(3). The three types of TBCs contemplated by

[3] Though MERLA does not specifically provide for them, ARARs are one of the ways that the MPCA uses in its RFRAs to determine or measure what is reasonable and necessary to achieve the overall MERLA standard of protection of public health and the environment.

> CERCLA include "health effects information with a high degree of credibility, technical information on how to perform or evaluate site investigations or remedial actions, and policy." 55 Fed. Reg. 8744 (March 8, 1990).

2.1.2.2 Attainment of ARARs

Consistent with Section 121 of CERCLA, MPCA requires that ARARs be attained for hazardous substances, pollutants, or contaminants remaining on a site after the completion of a remedial action. In addition, ARARs include environmental standards and requirements that must be attained during the implementation of remedial actions. (EPA 1988, at pp. xv and 1-8.) TBCs, while not required to be attained, "may, however, be very useful in helping to determine what is protective at a site, or how to carry out certain actions or requirements." (55 Fed. Reg. 8745, March 8, 1990).

2.1.2.3 Types of ARARs

ARARs are classified into three types: chemical-specific, action-specific, and location-specific requirements. The following paragraphs describe the three types of ARARs.

Chemical-specific ARARs are usually health or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of an acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. (EPA 1988 at p. 1-13.) These requirements provide protective site remediation levels for the COCs in the designated media (e.g., water, sediment, or air).

Location-specific ARARs are "restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations." (EPA 1988 at p. 1-25.) Examples of location-specific ARARs include the standards and requirement imposed by the Department of Natural Resources for work in public waters.

Action-specific ARARs are "usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish the remedy. Action-specific requirements do not themselves determine the cleanup alternative, but define how the chosen cleanup alternative should be achieved." (EPA 1988 at p. 1-29.)

2.1.3 ARARs Associated with Non-MPCA Permits

This section discusses federal, state, and local permits, other than MPCA permits, that may apply to remedial action in the SedOU and refers generally to the substantive standards that the permitting agencies may impose. These permits are expected to be issued by the responsible government agencies, rather than incorporated in the SedOU ROD.

2.1.3.1 Section 404 Permit (Clean Water Act)

Required for discharge of dredged or fill material into waters of the United States, this permit may be required for all the alternatives being considered, as both dredging and capping will involve such discharges. The St. Paul District Corps of Engineers (COE) has determined that a Section 404 permit will not be required for on-site activities, but off-site actions such as a related mitigation project would require the permit.[4] Substantive requirements that may be incorporated within a Section 404 permit for off-site activities can be found in 33 CFR Parts 320 and 323.

2.1.3.2 Section 10 Permit (Rivers and Harbors Act of 1899)

A Section 10 permit is required for activities that will obstruct or alter any navigable water of the United States, including the construction of any structure in the water, the excavating from or depositing of any material in the water, or the accomplishment of any other work affecting the course, location, condition, or capacity of the water. A Section 10 permit may be required for all the alternatives being considered, as both dredging and capping may involve such activities. The St. Paul District COE has indicated there are no national exemptions from the Section 10 requirements. The substantive requirements that may be incorporated within a Section 10 permit can be found in 33 CFR Parts 320 and 322.

[4] Email from Robert Whiting to Mike Costello, 11/25/03.

2.1.3.3 Section 401 Certification (Clean Water Act)

Section 401 of the Clean Water Act, 33 U.S.C.§1341, requires that any application for a federal permit that may result in a discharge to a navigable water must be accompanied by a certification from the affected state indicating that the discharge will comply with all applicable water quality standards and effluent limitations of the Act. Thus, a Section 401 certification for remedial action at the Site would be necessary before the COE may issue a Section 404 permit, and a certification may be necessary before the COE may issue a Section 10 permit if that permit authorizes a "discharge."

2.1.3.4 Public Waters Permit (Minn. Stat. §103G.245)

A permit from DNR is necessary for any work in public waters that will change or diminish its course, current, or cross-section. Because all alternatives under consideration will involve such work (including work in public waters wetlands and in public waters that are not wetlands), a permit from the DNR will be required. The substantive requirements that DNR may incorporate within its public waters permit are codified in statute and at Minn. Rules, ch. 6115. These requirements include compensation or mitigation for the detrimental aspects of any major change in the resource. (Minn. Stat. § 103G.245).

2.1.3.5 Pretreatment/Disposal Permit (WLSSD Industrial Pretreatment Ordinance, Revised June, 1999)

A permit from the Western Lake Superior Sanitary District (WLSSD) will be necessary if any dredge water is discharged into the public sewers. Thus, such a permit may be necessary for the two alternatives that involve dredging. The pretreatment standards that would likely apply are set forth in **Table 2-1**. A WLSSD permit would also represent compliance with Minn. Rule 4715.1600 and the MPCA water rules governing indirect discharges.

2.1.3.6 Board of Water and Soil Resources (BWSR) Wetlands Replacement Plan Approval (Minn. Stat. §103G.222); City of Duluth Wetlands Permit (Duluth City Code, § 51-31 et seq.)

Minnesota Statutes §103G.222 provides that a wetland replacement plan must be approved by the Local Governmental Unit, which in this case is the City of Duluth, before any Wetland

Conservation Act (WCA) wetlands may be drained or filled, unless draining or filling falls within the “De Minimis” exemption or another exemption of Minn. Stat. §103G.2241. The applicable Duluth city ordinance is more restrictive and prohibits the dredging or filling of wetlands over which the City has jurisdiction (1) without a special use permit, if the work involves certain types of wetland up to one acre in size, or (2) without a variance, if the work involves other wetlands.

WCA wetlands are those wetlands that are not public water wetlands regulated by the DNR and COE. WCA wetlands would be located above the Ordinary High Water Mark. However, the Ordinary High Water Mark has not yet been determined for the St. Louis River Estuary or for the Site, and both DNR and the City have agreed that it will be difficult to define the line between WCA wetlands and public water wetlands at the Site. On a preliminary basis, the City has verbally indicated that it is likely to delegate its WCA authority for wetlands under its jurisdiction to the DNR pursuant to Minn. Stat. §103G.245, subd. 5. Although each of the alternatives may affect WCA wetlands in Slip 7, it is most likely that those alternatives that involve capping of on-shore areas would impact a greater potential acreage of WCA wetlands.

2.1.3.7 Shoreland Management Permit (Duluth City Code §51-26 et seq.)

The City of Duluth requires a permit for any excavation or grading above the Ordinary High Water Mark within 300 feet of a river. Each alternative will involve some of these activities. The substantive requirements of this permit are found in the ordinance and may govern removal of natural vegetation, grading and filling, placement of roads, sewage and waste disposal, and setbacks. Because the City’s authority over shoreland excavation activities is related to the MPCA’s authority to permit stormwater discharges associated with construction activity greater than one acre, the City is considering deferring to the MPCA in the regulation of such activities at the Site.

2.1.3.8 Other Miscellaneous Permits

Other City permits may be required to route pre-treated dredge water through a force main to the WLSSD lift station. These permits could include approvals to work within City rights-of-way and approvals of pipeline materials and welds.

2.1.4 ARARs Associated with MPCA Permit Requirements; Incorporation in ROD or Design Approval

This section discusses the applicable substantive requirements that would normally be incorporated within MPCA permits required for the remediation, but which instead will be incorporated by the MPCA within the ROD.

2.1.4.1 Surface Water Quality Requirements (Clean Water Act)

All the remedial alternatives under consideration will involve discharges to the St. Louis River that might ordinarily require a National Pollutant Discharge Elimination System (NPDES) permit from the MPCA. These discharges may include the discharge of capping material into the river during capping operations, the discharge of contaminants released and suspended by dredging operations, the discharge of treated dredge water during dredging operations, and the discharge of stormwater runoff from shoreland modifications.[5]

During remediation, the MPCA, in a practical exercise of its enforcement discretion, will consider the areas in which any capping, dredging, or contained aquatic dredge facility (CAD) construction and filling are occurring as "treatment/work zones" to which the surface water quality standards normally applicable to the St. Louis River will temporarily not apply. During remediation, any discharges occurring *within* those treatment/work zones, such as the discharge of capping material during capping operations, the release of contaminants during dredging operations, runoff from disturbed shorelands, or seepage from the active CAD, will not be subject to water quality standards. Rather, those standards will apply outside of the treatment/work zone, beyond the outermost engineering control structure (such as a silt curtain, inflatable dam structure, etc.) where the water from the treatment/work zone is discharged to the river. Other discharges occurring during remediation to parts of the river not included in a treatment/work zone - including discharges of treated dredge water, and discharges of stormwater runoff from shoreland modifications outside of the treatment/work zones, will also be subject to regulation.

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[5] A fifth type of discharge to the river - seepage from the CAD - would be addressed by the MPCA in its State Disposal System (SDS) requirements for the CAD. See Section 2.1.4.2.

The standards that will apply to these discharges are set forth in **Table B-2** of Appendix B. In general the standards that will apply are:

1. Discharges from treatment/work and stormwater runoff zones—The Final Acute Values (FAV) for aquatic life established by Minn. Rules, chs. 7050 and 7052[6], adjusted, as appropriate, to account for significant differences between FAVs and chronic standards (*see* Minn. Rule 7050.0222, subp. 7(E)) and to account for the hardness of the water and the dissolved fraction of relevant metals (*see generally*, Minn. Rules 7052.0360), and
2. Treated water discharge—The Best Technology in Process and Treatment (BT/PT) for discharge of treated dredge water where treatment technology can reduce the concentration of most compounds below their FAVs.[7]

After completion of the remediation, all portions of the St. Louis River on the Site will be once again subject, as they are now, to the surface water quality standards for Class 2B and outstanding international resource waters (OIRWs), as set forth in Minn. Rules, chs. 7050 and 7052, and to the additional surface water quality standards for the St. Louis River set forth in Minn. Rules ch. 7065. Groundwater discharges from the capped and CAD areas that continue to occur after remediation will be regulated to maintain those surface water quality standards.

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6 The standards that will apply also include a site-specific water quality criterion for benzo(a)pyrene established pursuant to Minn. Rule 7050.0218.

7 In addition to the rules cited in the table, discharges of mercury at the Site would also be subject ordinarily to Minn. Rules 7052.0310, subp.2, which regulates new or expanded discharges of bioaccumulative substances of immediate concern (BSICs) and bioaccumulative chemicals of concern (BCC). Under this rule, discharges of mercury would be required to meet the chronic standard of 0.0013 ug/L. (The chronic standard, rather than the maximum standard or FAV, would apply to mercury, because Minn. Rule 7052.0210, subp. 3 prohibits mixing zones for BCCs.) However, Minn. Rules 7052.0310, subp. 7, provides an exemption from this requirement for remedial actions taken pursuant to MERLA, so long as there is a demonstration, under Minn. Rules 7052.0320, subp 2, that the remedial action utilizes the most cost-effective pollution prevention and treatment techniques available and minimizes the necessary lowering of water quality. Here, there is no available treatment technology that can reduce mercury to its chronic standard of 0.0013 ug/L or even to the background concentrations of mercury currently found in the river (estimated to be 0.003 to 0.01 ug/L).

2.1.4.2 State Disposal System Permit Requirements (Minn. Stat. §115.07, subd.1)

The disposal of dredged sediment into a CAD and any subsequent seepage from the CAD would ordinarily be regulated by the MPCA under a State Disposal System (SDS) permit. The standards and requirements that the MPCA's ROD, in lieu of an SDS permit, would impose on a CAD would be similar to the standards and requirements that the MPCA would apply to a cap, as discussed in Section 2.2.3.

2.1.5 Other ARARs

The following substantive standards, though not associated with any permit requirements for any of the remedial alternatives, are either "applicable" or "relevant and appropriate" requirements that may apply to one or more of the alternatives.

2.1.5.1 Ground Water Quality

Section 3.1.2 describes the existing prohibition against construction of wells in the uppermost aquifer at the site. This aquifer is contaminated, but does not adversely affect the surface water or the deeper aquifers. Even if it were not contaminated, the slag aquifer, which constitutes the uppermost aquifer for most of the site (including 59th and 54th Avenue Peninsulas), would be unusable for water supply because of the qualities of its slag matrix. Tests of the deeper aquifer have demonstrated that it is not contaminated and isolated from the uppermost aquifer by a continuous thick confining layer with an upward gradient. None of the remedial alternatives under consideration for the SedOU will affect the deeper aquifer in any manner.

2.1.5.2 Ambient Air Quality Standards

Minn. Rule 7009.0029 provides that "no person shall emit any pollutant in such an amount or in such a manner as to cause or contribute to a violation of any ambient air standard beyond the person's property line." This rule may affect all alternatives under consideration, particularly with respect to particulate matter emissions. It is an applicable requirement.

2.1.5.3 Airborne Particulate Matter

Minn. Rule 7011.0150 provides that "no person shall cause or permit the handling, use, transporting, or storage of any material in a manner which may allow avoidable amounts of particulate matter to become airborne. All persons shall take reasonable precautions to prevent the discharge of visible fugitive dust emissions beyond the lot line of the property on which the emissions originate." This rule would affect all alternatives under consideration. It is an applicable requirement.

2.1.5.4 Noise Control

Minn. Rules ch. 7030 establishes noise standards for various land uses. The noise standards that will apply to all alternative remedial actions at the Site are set forth in **Table 2-2**. They are applicable requirements.

2.1.5.5 Waste Management

Sediments dredged from the Site will likely be solid wastes when disposed of either off-site or on-site.[8] Disposed sediments will be subject to Minn. Rule 7035.0800, which requires that solid wastes be sent to a permitted solid waste disposal facility. If sediments are disposed of off-site, this rule will require those sediments to be sent to an appropriate solid waste disposal facility.[9] If, upon testing, the dredged sediments are determined to be hazardous wastes, then any excavated and disposed wastes would be subject to the Minnesota hazardous waste rules, Minn. Rule, ch. 7045, which would impose certain storage, management, and transportation standards on those wastes and require any off-site disposal to occur at a permitted hazardous waste facility.[10] With respect to sediments disposed of on-site in a CAD, as provided for by the Dredge/Cap Hybrid Alternative, the provisions of the ROD that substitute for an SDS permit will

[8] It is not likely that the sediments would be considered hazardous wastes under either federal or state law. Under the "Contained In Policy," they would not be listed wastes because the precise source of the contaminants contained in the sediments is not known. Moreover, the sediments are unlikely to display any hazardous characteristics because the primary chemicals of concern (PAHs) are not among those included in the TCLP test. The only chemical of concern on the TCLP list is benzene and its concentrations are very low in the sediment. Finally, previous testing of a mixture of sediment from the interim response action at Slip 6 and remediation soils from the Soil Operable Unit showed benzene was not detectable in the TCLP leachate. TCLP metals also were measured at concentrations that are not toxic.

[9] Testing required by such a permitted facility would likely confirm that the sediment to be disposed is not hazardous. Past TCLP testing of sediment investigation wastes (consisting mostly of sediment mixed with some disposable sampling materials), which was undertaken prior to their off-site disposal, indicated they were not toxic.

[10] The cost estimate for the Dredge/Off-Site Disposal Alternative, discussed in Section 4.2.4, assumes that any sediment disposed of off-site will be considered solid, rather than hazardous, wastes. If such sediment was determined to be hazardous wastes, then the cost of that Alternative would increase substantially.

set the applicable requirements for containment, regardless of whether they are solid or hazardous wastes.

If the sediments are disposed of off-site, they would continue to be subject to the applicable management standards of Minn. Rules, ch. 7035 (or to equivalent rules in other states) that govern the solid waste disposal facility or the applicable management standards of Minn. Rules, ch. 7045 (or to the equivalent rules in other states) that govern the hazardous waste disposal facility. If sediment is disposed of on-site in a CAD, appropriate technological, management, and performance standards would be established by the MPCA in the provisions of the ROD that will substitute for an SDS permit.

The CAD and other areas of the Site where contamination will remain in place after remedial construction will be subject to institutional controls (such as easements and restrictive covenants) which are legally binding on current and future owners of the property on the property to assure ongoing protection from disturbance of or exposure to the contamination. (For a discussion of site-specific institutional controls addressing hazardous substances remaining on the Site, see Section 3.1.1.) If ownership of the CAD or of capped areas of the Site is transferred in the future, those transfers would trigger the applicable provisions of Minn. Stat. §115B.16, subd. 2, which requires an Affidavit Concerning Real Property Contaminated with Hazardous Substances to be recorded with the St. Louis County recorder by the owner of the property

2.1.5.6 Well Construction, Maintenance, and Closure

Under all remedial alternatives, ground water monitoring wells used during the investigation of the Site will be sealed during the remediation process. The provisions of Minn. Rules ch. 4725 will apply to such sealing. If any monitoring wells are constructed as a part of the remediation, their construction, maintenance, and use will be subject to the applicable provisions of Minn. Rules 4725.0210 to 4725.3875.

2.1.5.7 Construction and Use of Public Sewers

If any dredge water is disposed of in public sewers under the Dredge/Cap Hybrid or Off-Site Disposal Alternatives, the requirements of Minn. Rules ch. 4715, which pertains to the use of public sewer and waters systems and to plumbing materials and methods, may be applicable.

2.1.5.8 Other

Terrestrial, wetland, and aqueous vegetation mapping has been completed and wildlife and fish surveys have been conducted and documented on the Site. None of these studies has identified any threatened or endangered species on the site. The Minnesota Natural Heritage Information System Database, operated by the DNR, indicated no threatened or endangered species on site. The DNR recommended considering silt curtains to protect sturgeon, a species of special concern, from the effects of suspended sediment. Such silt curtains are a component of each alternative. The DNR has also determined that it would establish no spawning restrictions at the Site.[11]

2.2 Preliminary Remedial Goals

The PRGs to be used in the development of the Alternatives for this Site are presented below. They were provided by the MPCA. Final Remedial Action Objectives and cleanup levels will be established in the ROD.

2.2.1 Preliminary Remedial Goals that Apply to All Alternative Remedies

2.2.1.1 Sediment Area to be Remediated

The lateral extent, or "footprint", of the contaminated sediments that require remediation will be defined by a bulk sediment TPAH concentration of 13.7 mg/Kg. The TPAH concentration, selected by the MPCA, is based on the Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald et al. 2000). MacDonald and others have found that 0.6 of the Probable Effects Concentration (PEC) approximates a 20% probability of observing sediment toxicity and it is recommended (as a "Level II Sediment Quality Target) for use as a sediment

[11] Email from John Lindgren to Tim Rogers, 12/10/03.

quality remedial criterion (Macfarlane and MacDonald 2002; MacDonald and Ingersoll 2002; Crane et al. 2000).

TPAHs: 0.6 of the TPAH PEC value (22.8 mg/Kg) = 13.7 mg/Kg

2.2.1.2 Surface Water Quality During Remedy Construction

To protect the water quality of the St. Louis River during remedy construction, control structures will be utilized to isolate the river from the areas being remediated. The control structures may include individual or multiple full water column silt curtains, temporary dams or other structures. MPCA will designate the water area isolated within these structures to be a remedial "treatment/work zone." The MPCA indicates that SWQS/C would not apply within the treatment/work zone while the control structures are in place. Because the control structures may not be able to completely control surface water flux from the treatment/work zone, SWQS/C will apply outside the outer-most control structure. The applicable standards/criteria will be the FAV listed in Minnesota Rules chs. 7050 and 7052. The FAV for the chemicals at the Site are listed in **Table B-2** in Appendix B.

The water quality compliance sample collection points will be determined based on the type of control structure selected in the final design and its predicted efficiency. Sampling will be conducted at a minimum of one week intervals for the duration of the active remedy construction at the edge of each treatment/work zone. In the event that any FAV is exceeded, further management practices may be required by the MPCA during remedy construction to reduce the amount of suspended contaminants escaping the treatment/work zone.

2.2.1.3 Ambient Air Quality

Air emissions modeling indicated a potential for increased naphthalene emission from sediments with higher naphthalene contamination. In the absence of a Health Risk Value in rule for naphthalene, which is the active substance in mothballs, the Minnesota Department of Health (MDH) developed site-specific acute and chronic Health Based Values (HBVs) for naphthalene (MDH, 2003).

The MDH established a chronic HBV for the average concentration of naphthalene in the air over a seven-month construction period of 9 $\mu g/m^3$. This value was based on two chronic studies in rodents, one on mice (NTP 1992) and one in rats (NTP 2000), involving exposure to naphthalene for 6 hours per day, 5 days per week for 2 years. The Lowest Observed Adverse Effect Level was 10 ppm (52,000 $\mu g/m^3$). MDH converted the test exposure to a 24 hours per day, 7 days per week, annual exposure, and applied an uncertainty factor of 1,000.

Although the MDH considers chronic exposure to be one that occurs on a daily basis over a 70-year lifetime, the MDH recommends that exposures which occur over greater than 10 percent of an individual's lifetime be assessed using chronic values. Although exposures during remediation at the site are likely to occur for a maximum of seven months a year, the MDH recommended the potential for public health impacts be assessed using the chronic HBV (MDH, 2003).

The MDH also established an average one-hour acute HBV of 200 $\mu g/m^3$, which is in the range of estimates of 200 - 440 $\mu g/m^3$ for the odor threshold of naphthalene. In establishing the acute HBV, the MDH cited anecdotal reports of naphthalene toxicity in humans (nausea, vomiting, abdominal pain and hemolytic anemia) at concentrations above the odor threshold, and a four-hour exposure test on rats (Buckpitt 1982). The No Observed Adverse Effect Level in the rat study was 204,000 $\mu g/m^3$. Applying an uncertainty factor of 1,000 gives an acute value of 200 $\mu g/m^3$ for a four-hour exposure. As a precaution recommended by the MDH, the acute HBV will be applied by the MPCA as a one-hour average exposure (MDH, 2003).

2.2.2 Dredging-Specific Preliminary Remedial Goals

2.2.2.1 Sediment, Vertical Extent of Remediation

The vertical limits of dredging will be established during design by developing a dredge prism[12] with slopes and elevations that define the mass of the identified contaminated sediment to be removed. Cores that identify the elevation of the top of native or hard slag substrates would be used in the bay and slips where non-native sediments are associated with the contamination. In the main river channel area beyond the limits of visibly non-native material, chemistry will be

[12] A dredge prism is a series of three-dimensional geometric sediment volumes that can be removed with mechanized dredges and verified with a survey.

used to define the depth of dredging. Dredging would incorporate a six-inch overdredge[13] amount below the dredge prism "neat line."[14]

Environmental dredging may leave residual sediment contamination that may vary from zero to several inches thick. The residue is unpredictable in concentration and extent. The MPCA will require a post-dredge cover[15] to isolate residue from benthic and aquatic receptors. The cover would also be required by the DNR to restore bathymetry and habitat substrate as part of the Public Waters Work permit. The DNR will set the specific cover depth and composition requirements in the permit. Generally, the cover would be approximately two feet thick, and the upper-most layer composed of loosely consolidated organic-rich material to enhance aquatic habitat.

2.2.2.2 Long-term Performance of Dredged Areas

The MPCA indicates no long-term compliance monitoring will be required by the MPCA or DNR for areas that are dredged and covered because the remedy relies on contaminant mass removal to the extent possible by current environmental dredging technology.

2.2.3 Capping-Specific Preliminary Remedial Goals

2.2.3.1 Long-Term Performance of Caps

PRGs for determining compliance for any area where contaminated sediments are capped will be applied to three separate media: Bulk Sediment, Pore Water, and Biota.

As shown in **Table B-2** of Appendix B, the MPCA plans to establish final remedial goals for bulk sediment in the BAZ of caps based on Site-specific toxicity testing conducted by the MPCA. They expect the goals to be protective of aquatic, semi-aquatic, and terrestrial plant and

13 Clean sediment dredged to allow for vertical variability while attempting to remove the entire layer of contamination.

14 The surface within the sediment above which lies the targeted contaminated sediment.

15 Habitat medium placed on post-dredge surfaces to dilute and/or isolate residue from adversely affecting the aquatic environment or human exposure.

animal communities. The Site-specific bulk sediment goal would be provided in the MPCA's Proposed Plan and ROD.

In the absence of final Site-specific bulk sediment remedial goals for capping, the MPCA provided the following interim goals to the Companies in order to facilitate the evaluation of the remedies in this FS:

TPAHs	0.6 of the TPAH PEC value (22.8 mg/Kg) = 13.7 mg/Kg
Metals	0.6 of the mean PEC Quotient
Mercury	MPCA-calculated ambient St. Louis River concentration = 0.3 mg/Kg

The MPCA based the interim goals for TPAHs on the Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald et al. 2000). MacDonald and others estimate that 0.6 of the PEC approximates a 20% probability of observing sediment toxicity and, with qualification, the authors recommend the mean PEC Quotient for use as a sediment quality remedial criterion for sediment (Macfarlane and MacDonald 2002; MacDonald and Ingersoll 2002; Crane et al. 2000). The MPCA calculated an ambient mercury concentration by using all available St. Louis River sediment data and the State of Washington's methodology for determining a background concentration (Washington State 1992).

The pore water PRGs for PAHs would be based on the Toxic Unit additive model approach set forth in the EPA's draft Equilibrium Partitioning Sediment Guidelines (ESGs) for the Protection of Benthic Organisms (EPA 2002b). Because sampling and measuring PAHs in porewater is problematic, porewater concentrations of PAHs would be calculated from measured sediment concentrations by using EPA's carbon-normalized equilibrium partitioning model. Toxic Units (the ratios of predicted pore water concentrations of individual PAHs to their respective EPA Final Chronic Value water concentrations) would be calculated and summed. A sum of toxic units greater than 1.0 implies that toxic effects are likely due to the mixture of PAHs. Therefore, the MPCA's PRG for PAHs in pore water is: the sum of PAH Toxic Units must be less than or equal to 1.0. The MPCA would use the same PRG for metals in pore water as would be used for bulk sediment.

The PRGs for bulk sediment and pore water would be applied within the cap at the base of the BAZ, in its lowermost six inches. The compliance point within the cap was selected by the MPCA based on its view of the potential for benthic, semi-aquatic, terrestrial, and plant species to be exposed to, uptake, or transfer contaminants, and/or create breaches or conduits within the cap material of the BAZ. The compliance point for the bulk sediment and pore water Response Action Objective and Cleanup Levels will be:

- 1 meter below the cap surface in post cap surface elevations greater than 593 feet MSL (~8 foot post cap water depth), or shallower where a root barrier is approved by the MPCA.
- 0.5 meter below the surface in post cap surface elevations less than 593 feet MSL (~8 foot post cap water depth)

The monitoring approach may be modified or updated as results of monitoring events are evaluated (i.e., The bulk sediment and pore water PRGs may be consolidated into a single goal upon review of monitoring results and approval of the MPCA).

The number, distribution, and frequency of the cap compliance monitoring points for bulk sediment and pore water would be determined in the design phase. The MPCA has established the following cap compliance monitoring criteria:

- A mean (simple mean or 95% upper confidence level of the mean is yet to be determined) of the compliance monitoring samples must not exceed the bulk sediment or pore water PRGs.
- No more than 20% of the compliance monitoring samples may exceed the bulk sediment or pore water PRGs.
- No individual compliance monitoring sample may exceed 4 times the bulk sediment or pore water PRGs.

If the bulk sediment and pore water compliance monitoring fails the above criteria, the following actions would be implemented:

- A work plan to further determine the extent and magnitude of the exceedance would be submitted to the MPCA within 30 days of documented noncompliance.
- A remedial plan to bring the sediment remedy back into long-term compliance would be submitted to the MPCA within 90 days of documented noncompliance. The plan must consider potential DNR permitting and mitigation issues for the recommended actions.

The number, distribution, and frequency of the cap compliance monitoring points for biota PRGs will be determined in the design phase. The MPCA plans to compare either fish or benthic invertebrate tissue residue concentrations of carcinogenic PAHs (cPAHs) and mercury to either reference area results or criteria that are protective of human health and ecological receptors through the food chain pathway. If the biota monitoring within capped areas of the site indicate that cPAHs or mercury are being transferred up the food chain at levels above reference area concentrations or above human health and ecological based criteria, a plan to bring the remedy back into compliance would be required by the MPCA.

2.2.4 Minnesota Environmental Response and Liability Act Property Use Consideration

In a section entitled "Cleanup Standards" (Minn. Stat. 115B.17, subd. 2a), MERLA provides that in determining the appropriate standards to be achieved by response actions taken to protect public health and welfare and the environment from a release of hazardous substances, the planned use of the property where the release is located shall be considered. The future planned use of the property within the SedOU includes restoration and preservation of natural habitat, especially in Stryker Bay, and recreational, navigational and other uses associated with the use of the adjacent land for residential, shipping and industrial purposes. The cleanup standards described in this FS are based on protection of aquatic and semi-aquatic life and associated habitat, and protection of human health as affected by the food chain. These cleanup standards will also provide protection consistent with other planned or potential future uses of the property within the SedOU.[16]

[16] However, remedy alternatives that achieve cleanup standards by capping or on-site consolidation and containment of contaminated sediments will preclude some otherwise possible uses of the property, will affect the type of habitat that is restored, and will require institutional controls that will restrict some future activities in portions of the Site.

2.2.5 Dredging Goals Within State of Wisconsin Waters

The State of Wisconsin has indicated to the MPCA that, consistent with policies of the Wisconsin Department of Natural Resources, contaminated sediment above 13.7 mg/Kg TPAH within Wisconsin waters will need to be dredged. The vertical limits of dredging will be defined as described in Section 2.2.2.1. No post-dredging cover, armoring material or habitat substrate will be included in this area as per the request of the Wisconsin Department of Natural Resources (WDNR).

2.3 United States Environmental Protection Agency's 11 Principles

On February 12, 2002, EPA issued a memorandum outlining 11 "Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites" (EPA 2002a). These Risk Management Principles are summarized below along with a brief description of how each principle has been applied throughout this RI/FS process.

Principle 1—Control Sources Early

As early in the process as possible, site managers should try to identify all direct and indirect continuing sources of significant contamination to the sediments under investigation.

The sources of PAH releases at the site were primarily wastewater discharges from facilities formerly located on the Site and possibly from other sources in the contributing watersheds. The last industrial discharges from facilities at the site were terminated no later than 1961 when Interlake Iron shut down the last operating facility. The TSOU removed the tar area at the 48-inch outfall to prevent additional contamination from seeping into the water south of the 54th Avenue Peninsula. Remediation completed for the SOU reduced the potential for surface soil contaminants from eroding to the surface waters. The 48-inch outfall line was also cleaned or removed to reduce runoff sources. In addition, the high strength sediments at the north end of Slip 6 were dredged and disposed of by thermal treatment or off-site landfill to reduce impacts to environment. Urban runoff and atmospheric fallout and the river's wash load continue, but are not likely sources for recontaminating the site at concentrations above ambient background.

Principle 2—Involve the Community Early and Often

Contaminated sediments sites often involve difficult technical and social issues. As such, it is especially important to ensure early and meaningful community involvement by providing community members with technical information needed for their informed participation. In accordance with EPA guidance, site managers and community involvement coordinators should take into consideration the following six practices: Energize the community involvement plan; provide early, proactive, community support; get the community more involved in the risk assessment; seek early community input on the scope of the RI/FS; encourage community involvement in identification of future property use, do more to involve communities during removals.

The Duluth community has been extensively involved throughout the RI/FS process. In the early 1990s, a Community Work Group (CWG) was formed for the site. The CWG continues to meet regularly and participants were encouraged to participate in work plans and alternatives development, and they have been informed of all technical results from remedial investigation studies. While deliberating the remedial options, the MPCA Board heard two days of comments from the public in 1999. The CWG, state, federal and tribal natural resource trustees (NRTs) and managers, and numerous additional stakeholders were also involved in two stakeholder meetings during the most recent development of the Remedial Alternatives. During the stakeholders' meetings, local uses of the land and water areas of the site were discussed at length. Websites are maintained by one of the Companies and by the MPCA that offer internet access to key studies and information. All reports are available in the local library and at the office of the MPCA.

CWG meetings, which occur whenever there is progress to report, are open to the public. As part of the community input and consensus development effort of the Parties in 2003, numerous stakeholders (described in Principle 3) were invited to two key day-long meetings to express their interests and to propose, discuss, and review alternatives for consideration in this FS.

Principle 3—Coordinate with States, Local Governments, Tribes and Natural Resource Trustees

Site managers should communicate and coordinate early with states, local governments, tribes and all NRTs.

The SLRIDT Site is a State-lead site and is part of a Deferral Pilot Program agreed to by MPCA and EPA. EPA has been kept informed about the Reopened RI/FS process pursuant to the Deferral Pilot Program, and participated in identifying Data Gaps for the Reopened RI/FS. EPA staff attended the stakeholder meetings in 2003 that discussed the new hybrid remedy alternative.

Throughout the RI/FS and reopened RI/FS process, the MPCA and Companies coordinated with local entities and organizations including:

- The City of Duluth, including the Mayor, City Council Members, Housing and Redevelopment Authority, Planning and Development, and Engineering
- The Metropolitan Interstate Committee through its Harbor Technical Advisory Committee, which includes:
    - DNR
    - WDNR
    - The Minnesota Department of Transportation
    - The Wisconsin Department of Transportation
    - The Seaway Port Authority of Duluth
    - Save Lake Superior Association
    - Audubon Society
    - Port User Representatives
    - EPA
    - US Coast Guard
    - US Army COE
    - US Fish and Wildlife Service
    - Cities of Duluth and Superior
    - MPCA
    - Douglas County, WI

  - The Western Lake Superior Sanitary District (WLSSD)
- MDH
- Spirit Valley Citizens Neighborhood Development Association
- Neighborhood Planning District 2
- The Contaminated Sediments Workgroup of the St. Louis River Citizen's Action Committee (CAC), which helps to implement the St. Louis River Remedial Action Plan.[17] Members include private citizens, as well as representatives from industries (e.g., Georgia-Pacific Corp., Minnesota Power, Potlatch Corporation), nonprofit organizations (e.g., Muskies, Inc.), the WLSSD, universities, the Fond du Lac Band of Lake Superior Chippewa, consultants and local, state, tribal and federal government agencies.
- The CWG; including representatives of many of the entities listed above and:
  - Residents of the neighborhoods near the site, and
  - Interested current land owners, including Hallett

The Companies and MPCA coordinate, communicate and exchange data with the NRTs. The NRTs prepared a Comparative Preliminary Estimate of Damages that reflected their thinking on natural resources restoration, and the Parties considered the trustees' views during their deliberations on alternatives. This FS and the MPCA's Proposed Plan are expected to facilitate settlement discussions with the NRTs concerning natural resource restoration and damages. All studies prepared under the Agreement between the Parties have been provided to the NRTs and the NRTs have often shared their plans and data as they became available.

The DNR is an NRT and also regulates dredging and filling in public waters, such as those at this Site. The DNR participated extensively in technical discussions with the Parties that were intended to formulate a permittable remedy and define mitigation requirements. DNR's approval of a Work in Public Waters Permit for the remedy, including mitigation requirements also is an ARAR which must be met for the remedy.

[17] In an effort to clean up the most polluted areas in the Great Lakes, the United States and Canada, in Annex 2 of the Great Lakes Water Quality Agreement, committed to cooperate with State and Provincial Governments to ensure that Remedial Action Plans are developed and implemented for all designated Areas of Concern in the Great Lakes basin.

Principle 4—Develop and Refine a Conceptual Site Model that Considers Sediment Stability

A CSM identifies all known and suspected sources of contamination, the type of contaminants and affected media, existing and potential exposure pathways, and the known or potential human and ecological receptors that may be threatened. A CSM is especially important at sediment sites because the interrelationship of soil, surface and groundwater, sediment, and ecological and human receptors is often complex.

As part of the DGR, a CSM was developed for the site. In that report it is described as an Integrated Fate and Transport Model (SERVICE 2002). Its purpose was to summarize the interrelationships of soil, surface and groundwater, sediment, and ecological and human receptors that define the SedOU, and the temporal, physical and chemical forces that affect its stability. Numerous potential transport mechanisms were identified in the model and subsequently studied and evaluated in the DGR and reviewed by the PRT and the MPCA (see Section 1.4.2).

Principle 5—Use an Iterative Approach in a Risk-Based Framework

Although there is no universally accepted, well-defined risk-based framework or strategy for remedy evaluation at sediment sites, there is wide-spread agreement that risk assessment should play a critical role in evaluating options for sediment remediation. Each iteration might provide additional certainty and information to support further risk-management decisions, or it might require a course correction. An iterative approach may also incorporate the use of phased, early, or interim actions.

Risks have been iteratively evaluated at this Site since the initial Ecological and Human Health risk assessments in 1997. That data was reevaluated by the MPCA in 1999, and EPA Region 5 evaluated the studies in 2000 as part of the data gap review. In 2001, the MPCA gathered more ecological risk information as did the NRTs. In 2003, the MPCA will be presenting its analysis of this data. Those analyses are reflected in the PRGs in this FS. After critical review, the final RAOs and cleanup levels will be established in the ROD for the site.

PAHs and metals are naturally occurring, so the Companies and MPCA have statistically analyzed the ambient levels, using EPA's and MPCA's R-EMAP data randomly collected from throughout the estuary.

Testing and modeling recommended by the PRT were conducted on all potential transport pathways to project the effects of remedial actions on the short- and long-term fate of contaminants in light of risk reduction goals. These models were iteratively run and presented by the Companies to the MPCA and PRT in a series of meetings to refine the results.

During the remediation of the SOU, approximately 4,200 cubic yards of contaminated sediment was dredged at the head of Slip 6 as an Interim Response Action (IRA). This area contained high concentrations of PAHs including naphthalene. This IRA was taken to remove the most contaminated material from Slip 6. The sediment was mechanically dredged using a backhoe and conveyed to the dock area where it was spread and mixed over a three-acre pad in order to evaporate the moisture from the sediment prior to on-Site thermal desorption. During the approximately five weeks of this operation, the MPCA received three complaints about odors from residents located west and south of the operation. In addition to removing some of the most contaminated sediments, this IRA provided anecdotal experience with mechanical and passive dewatering, naphthalene air emissions and dredging residue that has informed this FS.

Principle 6—Carefully Evaluate the Assumptions and Uncertainties Associated with Site Characterization Data and Site Models

The uncertainties and limitations of site characterization data, and qualitative or quantitative models (e.g., hydrodynamic, sediment stability, contaminant fate and transport, or food-chain models) used to extrapolate site data to future conditions should be carefully evaluated and described. Due to the complex nature of many large sediment sites, a quantitative model is often used to help estimate and understand the current and future risks at the site and to predict the efficacy of various remedial alternatives. All new models and the calibration of models at large or complex sites should be peer reviewed consistent with EPA's peer review process.

The Parties sought the opinion of EPA Region 5, the COE and the PRT[18] in developing the scope of studies for the re-opened RI/FS. Numerous new studies were undertaken at their suggestion, specifically to quantify and model potential future remedial activities where earlier studies had made qualitative estimates. A series of seven 1- or 2-day meetings over a year's time were held between the Parties and the PRT to discuss, evaluate and resolve uncertainties inherent in the models. Other outside experts were also consulted on specific modeling issues. Where data does not exist, the Parties and PRT agreed upon assumptions to use, based largely on the experience and judgment of the PRT. Models were revised and rerun to reflect changes recommended at these meetings to generate results in the full light of the assumptions and uncertainties.

The PRT Coordinator and members are as follows:

DISCIPLINE	MEMBERS
Coordinator	Ms. Nancy Musgrove, Management of Environmental Resources
Dredging	Dr. Michael Palermo, USACE, Waterways Experiment Station Dr. Donald Hayes, University of Utah, Dept. of Civil and Env. Engineering
Capping	Dr. Ram Mohan, Blasland, Bouck and Lee, Inc Dr. Thomas Fredette, USACE, New England District
Hydrogeology	Dr. Donald Rosenberry, U.S. Geological Survey Dr. Stanley Feenstra, Applied Groundwater Research, Ltd.
Cost Estimating	Mr. Alex Sumeri, USACE, Seattle District (retired) Mr. John Henningson, P.E., Henningson Environmental Services, Inc.

Principle 7—Select Site-specific, Project-specific, and Sediment-specific Risk Management Approaches that will Achieve Risk-based Goals

EPA's policy has been and continues to be that there is no presumptive remedy for any contaminated sediment site, regardless of the contaminant or level of risk. All remedies that may potentially meet the removal or remedial action objectives (e.g. dredging or excavation, in-situ

[18] The PRT was selected and tasked in accordance with EPA's "Peer Review Handbook" (EPA 100-B-00-001, http://www.epa.gov/ORD/spc/2peerrev.htm)

capping, in-situ treatment, monitored natural recovery) should be evaluated prior to selecting the remedy.

As described in Section 3.0 below, a wide range of remedial alternatives were evaluated for the SedOU. No presumptive remedy has been identified for SedOU at the site. Approximately 12 alternatives were described in RI/FS documents. These alternatives were compared pursuant to the process required under the MPCA RFRA and were eliminated. After submission of the DGR and before commencing this FS, the Parties, the DNR, the PRT, and other stakeholders formulated and discussed at least seven additional hybrid remedy options, all of which were intended to combine previously identified remedial technologies to balance a broad set of environmental, natural resource, property use and other goals and interests expressed at two all-day stakeholder meetings. This process led to the inclusion of the Dredge/Cap Hybrid Alternative in this FS.

Principle 8—Ensure that Sediment PRGs are Clearly Tied to Risk Management Goals

Sediment cleanup levels have often been used as surrogates for actual remediation goals (e.g. fish tissue concentrations or other measurable indicators of exposure relating to levels of acceptable risk). While it is generally more practical to use measures such as contaminant concentrations in sediment to identify areas to be remediated, other measures should be used to ensure that human health and/or ecological risk reduction goals are being met. Such measures may include direct measurements of indigenous fish tissue concentrations, estimates of wildlife reproduction, benthic macroinvertebrate indices, or other "effects endpoints" as identified in the baseline risk assessment. For many sites, achieving remediation goals, especially for bioaccumulative contaminants in biota, may take many years. Site monitoring data and new scientific information should be considered in future reviews of the site (e.g., the Superfund five-year review) to ensure that the remedy remains protective of human health and the environment.

As discussed under Principle 5, an iterative approach has been used to evaluate risk, and the uncertainty of those risks has been addressed via an iterative discussion of modeling results. The Parties and PRT have concluded that both capping and dredging technologies are capable of protecting human health and the environment when prudently applied. Human uses of the Site include swimming in Stryker Bay, recreational boating or maritime shipping, and fishing. If capping is used, the risk management goal to protect the aquatic plant and animal community and to protect those human uses that are associated with the site would be accomplished by isolating contaminants from the BAZ. If dredging is used, in addition to protecting from exposure by removing most of the mass of contamination, a post-dredging cover would dilute the residue to protective levels or isolate human uses from any residual contaminants.

Site-specific PRGs are presented in Section 2.2 above and listed in **Table B-2** of Appendix B. The MPCA will establish final remedial goals for the selected remedy in the ROD. This will include a concentration of TPAHs that will define the limits of required remediation. In addition, for capping, concentration goals of PAHs and other compounds listed in **Table B-2** will be established for the base of the BAZ based on EPA's equilibrium partitioning methodology and site specific effects levels using values that are protective of aquatic life (including aquatic plants and the benthic community). Post-remediation biota sampling would be required to demonstrate protection against bioaccumulation in biota at concentrations that would adversely affect humans who consume fish. In total, these goals set standards for the extent of remediation and the protection of all pathways of potential significant exposure.

Discharge of contaminants in pore water to the surface water will be controlled to protect aquatic life and surface waters by the MPCA requiring that the capping material meet the PRGs in at the base of the BAZ. Bulk sediment monitoring to meet PRGs will provide an early warning system to prevent contaminants from entering the water column and protecting human health and environment.

Principle 9—Maximize the Effectiveness of Institutional Controls and Recognize their Limitations

Institutional controls, such as fish consumption advisories and waterway use restrictions, are often used as a component of remedial decisions at sediments sites to limit human exposure and to prevent further spreading of contamination until remedial action objectives are met. While these controls can be an important component of a sediment remedy, site managers should recognize that they may not be very effective in eliminating or significantly reducing all *exposures. Site managers should also recognize that institutional controls seldom limit ecological exposures. If additional monitoring data or other site information indicates that institutional controls are not effective, additional actions may be necessary.*

Institutional controls will be used to enhance and support active remedial measures such as dredging, containment, and capping, which will be the primary means of limiting exposure at the Site. The remedial alternatives would include conservation easements along Site shorelines **(Figures 3-7, 3-9,** and **3-11)** to enhance natural resources. If the property is purchased, a deed restriction will be recorded, which will provide buffer zones along Site shorelines, similar to the conservation easements.

Potential institutional controls are discussed in Section 3.1.1. Institutional controls for the SedOU remedy may be established by the MPCA in its ROD. At that time, their effectiveness will be maximized and limitations recognized.

Principle 10—Design Remedies to Minimize Short-term Risks while Achieving Long-term Protection

Sediment cleanups should be designed to minimize short-term impacts to the extent practicable, even though some increases in short-term risk may be necessary in order to achieve a long-lasting solution that is protective. In addition to considering the impacts of each alternative on human health and ecological risks, the short-term and long-term impacts of each alternative on societal and cultural practices should be identified and considered, as appropriate.

This analysis has been completed and is presented in Section 4.0 under each evaluated alternative.

Principle 11—Monitor During and After Sediment Remediation to Assess and Document Remedy Effectiveness

A physical, chemical, and/or biological monitoring program should be established for sediment sites in order to determine if short-term and long-term health and ecological risks are being adequately mitigated at the site and to evaluate how well all remedial action objectives are being *met. Monitoring should normally be conducted during remedy implementation and as long as necessary thereafter to ensure that all sediment risks have been adequately managed. Baseline data needed for interpretation of the monitoring data should be collected during the remedial investigation.*

Depending on the risk management approach selected, monitoring should be conducted during implementation in order to determine whether the action meets design requirements and sediment cleanup levels, and to assess the nature and extent of any short-term impacts of remedy implementation. This information can also be used to modify construction activities to assure that remediation is proceeding in a safe and effective manner. Long-term monitoring of indicators such as contaminant concentration reductions in fish tissue should be designed to determine the success of a remedy in meeting broader remedial action objectives. Monitoring is generally needed to verify the continued long-term effectiveness of any remedy in protecting human health and the environment and, at some sites, to verify the continuing performance and structural integrity of barriers to contaminant transport.

Environmental monitoring that may be conducted at the Site is discussed in Section 3.1.2. A detailed monitoring plan is required as part of the Remedial Design/Remedial Action Plan after remedy selection. The remedy alternatives in this FS include long-term post-remediation maintenance and monitoring appropriate to the remedial technologies and residual risks associated with each alternative, and with the risk management goals set for the site. The BAZ of capped areas would be sampled to assess and document that the expected isolation of contaminants is occurring. In addition, samples of aquatic biota would be collected to determine the effectiveness of the remedy in preventing the migration of contaminants from sediment into the biota at concentrations that would adversely affect humans who consume fish. Consistent with EPA's principle 11, this monitoring would be conducted until the data demonstrates that all sediment risks have been adequately managed. Additionally, for aquatic habitat mitigation, inspections of restored habitat would be conducted to document the mitigation required in the DNR's permit.

3.0 IDENTIFICATION, SCREENING OF TECHNOLOGIES, AND RESPONSE ACTION COMPONENTS AND TREATABILITY STUDIES

The first step in developing a list of alternatives is to identify technologies and response action components, which are then screened for their suitability. This section describes the technologies and response action components, a history of alternative development, and a detailed description of each alternative that was retained for further analysis in Sections 4 and 5. This section also discusses treatability studies conducted to further evaluate and develop alternatives.

3.1 Technologies and Response Action Components

3.1.1 Institutional Controls

Institutional controls would be used for all alternatives except the No Action Alternative. Institutional controls will be needed to insure remedies that rely on long-term isolation of contaminated material remain protective over time. The following institutional controls may be required by the MPCA in some areas of the Site:

- Shorelands at the Site may be protected by conservation easements to prevent activities disruptive to aquatic habitat.
- Anchoring or other disturbances, temporary or permanent, will be prohibited within the footprint of a CAD cell or *in situ* capped area. The MPCA is evaluating under what authority anchoring can be prohibited and who would enforce the restriction. Anchoring restrictions would be communicated with signs on shore.
- A restrictive covenant or similar instrument will be required in order to impose the following restrictions on use in areas where contaminated sediments have been covered, capped or contained. The restrictions may need to be recorded not just on the submerged beds of the bay and slips (to the extent those lands are privately titled) but also on the lands adjacent to the submerged beds to the extent that the restrictions affect the riparian property rights of those adjacent property owners. For example:
    - Docks, piers, or other temporary or permanent structures could not be constructed within the footprint of a CAD cell or in situ capped area without a construction plan approved by the MPCA. In some circumstances, DNR and COE approval may also be necessary.

- Dredging would be prohibited within the site remediation boundaries, with the exception of approved maintenance activities that are part of the remedy, or
- Maintenance dredging in Slip 6 and the portion of Slip 7 that remains open to ship and/or barge traffic, done in compliance with a dredge plan approved by the MPCA.

3.1.2 Environmental and Physical Monitoring

The RFRA calls for the RD/RA Plan that is submitted after remedy selection to specify the monitoring proposed during remedy construction and the long-term monitoring required to assure that the completed remedy is protective. The MPCA then reviews and approves the RD/RA Plan. Consequently, this discussion is separated into monitoring during remediation and monitoring after remediation.

3.1.2.1 Potential Monitoring

According to the RFRA, the RD/RA Plan shall restate the RAOs and cleanup levels of the ROD that are assumed, for this FS, to be like the PRGs of Section 2.2. The Monitoring Plan would include sampling and analysis plans, laboratory QA/QC plan, an environmental media and analytical parameter list, monitoring facility locations and design, sampling schedule, and reporting plan.

The MPCA has considered all of the compounds tested in each media at the site. They are listed in **Table B-1** of Appendix B. After eliminating those that were not detected at concentrations of concern, and eliminating those that were only infrequently measured and which are common laboratory contaminants, the MPCA arrived at a set of goals for the compounds and media listed in **Table B-2** of Appendix B. The final list of analytes for each media will be determined in the RD/RA Plan and approved by the MPCA.

For consideration and costing in this FS, a variety of monitoring methods were evaluated on a preliminary basis. Each are discussed below.

Bathymetry and other surveying could be used to: verify dredging depths, monitor settlement and erosion of caps and covers placed at the Site, evaluate actual water depths, and monitor habitat potential in post-remediation water depths. Settlement plates may be used in conjunction with surveying to monitor settlement and erosion of caps and covers. This method could be useful during and after remediation.

Benthic monitoring could be used to evaluate if contaminants are entering into the base of the food chain from sediment, especially if contaminants bioaccumulate. Since the benthic community is likely to be destroyed during remediation by capping or dredging, this method is only useful to monitor recovery and performance after remediation.

Other biota such as birds and fish have been sampled at the Site and could serve as endpoints to monitor performance during or after remediation. With the development of treatment/work zones, it is expected that fish will mostly avoid the areas. While there may be some utility in measuring a specific contaminant such as benzo(a)pyrene in fish, since its most sensitive endpoint is human consumption of fish, interpretation of fish and bird data can be complicated by other sources in their diets or other stressors. Also, more direct measurements of potential contributions from remediation (surface water quality measurements) and post-remediation (sediment or benthic sampling), are available, likely making these measurements redundant.

Air monitoring is necessary during remediation to determine if naphthalene would be emitted at such a rate that it would exceed PRGs for ambient air conditions and to protect remediation workers. After verification with such sampling, the MPCA may conclude that monitoring is necessary for only certain operations.

Surface water monitoring is effective in measuring compliance with SWQS/Cs during remediation. It could also be used to verify the effectiveness of remediation in protecting the water column, but would not indicate if the sediment-dwelling organisms are also protected from upward flux of contaminants.

Groundwater monitoring with chemical sampling can be used to measure flux from adjacent uplands and sometimes from upward flowing conditions beneath the sediment, and to evaluate the effect on surface water environments. At this site, flux from uplands and from sediments have already been made and shown by modeling of current, dredged (and covered) and capped conditions, to be protective of human health and the environment.

Measurement of groundwater pressure distribution can also be made to determine the rate and direction of groundwater flow, and its interrelationship with surface water. Many of these measurements have also already been made. These measurements have provided a good understanding of the interrelationships of groundwater and surface water and have allowed the development of reliable models to project future conditions. Pressure transducers may also be used to measure transient excess pore water pressure during consolidation of sediments. Such measurements have been useful elsewhere to protect against foundation failures during dike building, capping or surcharging.

Visual examination of sediment cores could be used to determine the thickness of dredge residue, caps, and cover; and to determine if mixing has reduced the effective thickness of a cap or has helped dilute contaminants in a cover. With settling caps, bathymetry alone cannot confirm the thickness of the cap. Coring can determine the cap thickness directly, as well as recover samples for chemical or physical analysis that would be more quantitative and provide more confirmation of non-visible features. Coring, and subsequent analyses could be used both during and after remediation. For example, chemical analysis of a placed cap could confirm the presence or absence of a zone mixed with contaminated sediment and capping material. After capping, the analysis could monitor for migration of significant contaminants back into the BAZ at concentrations above their acceptable level. Bulk sediment chemistry can be used for PAHs and sometimes for metals to approximate the pore water concentrations using sediment/pore water partitioning coefficients. The bulk sediment/pore water conversion is as reliable as the partitioning coefficients. For metals, these coefficients can vary widely, and may not be reliable if backfilling material (either cap or cover) comes from a variety of settings or is otherwise heterogeneous.

Pore water sampling is a way to monitor the most bioavailable portion of the contaminants in the benthic environment. Unfortunately, collection of representative samples of pore water is problematic. Throughout the literature, it is generally agreed that this type of sampling is, at best, difficult. While conducting at least three types of pore water sampling at this Site, SERVICE found significant problems with each. These problems usually involve the sensitive colloidal particles, including difficulty in filtering them, segregating them by centrifugation and emulsifying them when disturbed during testing. This is also a problem with well sampling at the site because most of the wells are finished in a media that contains large amounts of fine-grained material.

Physical, biological, and chemical analysis of potential capping material could be used to determine if off-site material is suitable for its intended purpose as a dike, cap or cover material. It is necessary to test this material to be sure that new or similar problems are not imported to the site. For example, the Corps' Great Lakes Testing Manual uses a tiered approach initially focusing on elutriate toxicity tests to assess the potential of fill material to affect biota. Chemical testing could be used to make sure the imported material at least met the PRGs and contains the desired amount of carbon, and grain size analysis could demonstrate if the material will cause turbidity problems or meets the armoring requirements.

Wetland vegetation surveys will likely be required by the DNR to monitor the minimization and mitigation measures required in their permit. Such techniques are useful to evaluate the success of wetland restoration and to manage exotic species infestation.

3.1.2.2 Monitoring During Remediation

Considering the range of monitoring methods summarized above, the PRGs presented in Section 2.2, and depending on the alternative selected; the Monitoring Plan in the future RD/RA Plan would likely address imported borrow material for dikes, caps, and covers; ambient air monitoring; discharge monitoring; surface water monitoring beyond the outermost engineering control structure; and coring and settlement monitoring in the cap and surcharge areas for comparison to expected settlement. Wetland vegetation surveys would also likely be required by the DNR. It may also include other construction QA/QC measures. The specifics of this plan would be developed during the RD/RA Plan.

3.1.2.3 Post-Remediation Monitoring

The RFRA also calls for the RD/RA Plan to include plans for monitoring post-remediation conditions. The plan is to define methods and a schedule for such monitoring. A preliminary scope has been developed in Section 2.12 of Appendix A. For alternatives in which contaminated sediment is capped or contained in a CAD, monitoring would be required by the MPCA in the BAZ for COCs and in aquatic biota as described in Section 2.2. The bathymetry in the areas of the CAD, caps and post-dredging cover would be monitored for erosion and settlement, and repaired as necessary. This monitoring would be conducted until the data demonstrate that all sediment risks have been satisfactorily managed. A federally mandated review of the selected remedial actions would be conducted every five years if contamination remains in place. Additional monitoring requirements such as vegetation evaluation may also be specified in the DNR permit.

Groundwater monitoring would not be required for capped areas of the SedOU because potential groundwater contaminant flux to surface water will be measured as part of the cap compliance monitoring, and groundwater monitoring performed for a full year, approximately four years after completion of the SOU remedy, identified that chronic SWQS/C are not exceeded for any of the constituents modeled[19] by the shallow groundwater flux to the river (SERVICE 2002; Appendixes SW-3, GW-2, GW-3). The MPCA may rely on the same models, which showed that a 1-foot thick cover on dredge residue will dilute or adequately isolate dredging residue from affecting surface water, or require groundwater monitoring where there is groundwater discharged to surface water in uncapped or uncovered areas (i.e, southeastern end of Stryker Bay). Laboratory analysis of deep groundwater samples collected from the regional aquifer via on-Site artesian wells identified no elevated concentrations of any of the chemicals for which PRGs have been established. This deeper aquifer is separated from the contaminated uppermost aquifer by a thick, continuous confining layer with an upward gradient **(Figure 1-3)**.

[19] PAHs with SWQS/Cs and mercury were modeled. Other metals were not modeled because their leachate from source areas did not exceed SWQSs.

Surface water monitoring after remediation would not be required by the MPCA for the SedOU. Since monitoring the capped sediment will detect any contaminants before release to the surface water, testing the surface water is not necessary, and may be less complex to interpret.

3.1.3 Dredging

Twenty types of environmental dredge technologies were evaluated in the Alternatives Screening Report (IT 1997). Detailed descriptions of the issues associated with dredging design are discussed in the DGR (SERVICE 2002) Appendix D3. In addition, for purposes of this FS, SERVICE has made the following assumptions (based on the DGR, discussions with the MPCA, PRT and best professional judgment) about dredging technologies evaluated in this FS :

- Mechanical dredging using environmental dredge technology such as the environmental bucket shown in the cover of the FS, is assumed because the receiving pools do not appear to have enough retention time for clarification of dredge water from most hydraulic dredges. If hydraulic dredge water were recycled, hydraulic dredging would be feasible too.
- Transportation of dredged material is assumed to be by pipeline, which is expected to minimize air emissions and odor.
- All dredging would be conducted in one dredge event to the neat line of a defined dredge prism elevation targeted to remove contaminated sediment which has concentrations of greater than 13.7 mg/Kg PAH and is located above the pre-industrial sediments at the Site.
- For purposes of sizing the CAD, it is assumed the sediments may be overdredged (below the neat line) by an average 6 inches.
- Post-dredge contaminated residue would typically be managed using a substrate cover of environmental media or armoring material to control erosion (except where dredging occurs in Wisconsin waters).
- Dredging production is assumed to be 50 cubic yards per hour, 24 hours per day, 5 days per week, during a seven-month construction season.
- Slip(s) maintained for ship loading would be dredged to accommodate a finished depth (after the post-dredge cover is added) of 25 feet and to a depth of 23 feet in the navigation channel.

Dredging volumes for each of the alternatives are summarized in **Table 3-1**.

3.1.4 Air Emissions Control

Air emissions bench testing and modeling were conducted and the results are described in the DGR (SERVICE 2002; Appendixes A1 through A4). In reviewing the DGR and model modifications described in Appendix C, the MPCA and MDH concluded that although testing and modeling suggest a correlation between contaminant concentration in the sediment and chemical volatilization upon disturbance of the sediments, limitations and uncertainties pertaining to the model and inputs restricts use of the data to a qualitative assessment. The key finding of the modeling results reported in the DGR and Appendix C is that dredging of sediment with the highest naphthalene concentrations was projected to cause most potential for emission of naphthalene at levels exceeding PRGs. The greatest potentials for naphthalene emissions during placement of dredged material into a CAD or during dewatering of sediment were also projected to occur when the sediment from the areas of highest naphthalene concentrations is dredged. The areas of highest naphthalene concentrations (in mg/Kg dry weight) in the sediment are shown in **Figure 3-1**.

Control technologies that constitute Best Management Practices including floating covers, spray mists, floating plastic balls, and foam were reviewed during preparation of the DGR for their ability to control emissions in an active dredge area and in the CAD. Based on air emissions testing, (SERVICE 2002, Appendixes A1 through A4) it was determined that dissolved naphthalene in the water was the major source of potential emissions. Almost all control measures were focused on eliminating the water to air exchange with some type of physical barrier. For example, a floating cover system would be effective in reducing naphthalene emissions by 70-90% in contained dredge water areas such as in a CAD or enclosed storage impoundment, but would not be effective in the active dredging area where equipment is regularly moving through and around in the water/air interface, disrupting the emission control device. Powdered Activated Carbon (PAC) has been used at USX Gary Works in a dredged material impoundment to reduce naphthalene emissions. A PAC slurry was introduced into the discharge to the impoundment, thereby absorbing a portion of the soluble fraction from the water to reduce the aqueous concentration at the air/water interface. The result was reduced air emissions. This offers an alternative to a cover in a CAD if emissions exceed PRGs. Each dredging alternative assumes enclosed conveyance of dredged sediment to treatment areas to reduce emissions. The alternatives descriptions in Section 3.3 detail other potential emission controls unique to each dredging alternative.

3.1.5 Capping and Surcharging

The capping techniques for this Site are detailed in the DGR (SERVICE 2002, Appendix D4.) The design of caps followed the guidance procedures outlined by the USEPA and Corps (Palermo, et. al. 1998a and 1998b). Important cap features for this Site are:

- Control of contaminant transport through the cap,
- Protection of aquatic ecology,
- Erosion control for the surface of the cap,
- Cap stability during placement on slopes and flat areas,
- Sediment gas management, and
- Maintenance of existing water depths wherever possible.

Based on experience during past projects and the geotechnical analysis of Site conditions, the caps designed for this FS will provide these protections if constructed using:

- Thin initial lifts (6 to 12 inch thickness) placed evenly across the capping area. These thin and uniform lifts prevent significant mixing with contaminated sediment and prevent foundation failures so all the material remains in place.
- A base cap of fine to medium sand and armoring with larger sized material where necessary to protect against potential erosive forces such as ice in the main channel, currents, and propeller wash. Sand was selected for its weight to compress and strengthen the underlying sediment. It also reduces advection through the cap by reducing the permeability of the underlying sediments by 100-fold and thereby increasing the time of travel and reducing the mass flux for any upward flowing water. This allows for biodegradation over a shorter distance (Costello 2003). Sand will also help drain the excess pore water pressure more

quickly, preventing NAPL from migrating. The sand will also insulate the underlying sediments, preventing gas generation and terminating ebullition, close fracture channels that allowed gas escape and strip any solids or NAPL entrained with any escaping gas (Van Kesteren 2003). It has less impact on turbidity when applied, and is easier to handle.

- Environmental media placed on top of the sand in areas that do not require armoring to mitigate for habitat, as requested by the DNR.

The DGR identified two techniques capable of placing caps in this way using hydraulic placement and mechanical placement. In each case, the caps would be placed in uniform lifts whose thickness would be dictated by the strength of the underlying sediment. SERVICE made the following assumptions about both types of capping.

For hydraulic placement, a temporary offload station would be constructed on Site. Seven dolphin pilings on 50-foot centers would be driven just north of the channel line in the deepest area. These piles would serve as temporary moorage for both the material barges and offloading equipment. The offloading equipment would be moored on the other side of the dolphins. A 40-ton crane with a 3 to 4 cubic yards clamshell bucket would offload the material from the barges. Offloaded material would be placed into a partially submerged hopper where cap material and river water would form a slurry. A pump would deliver the slurry through the pipeline to a diffuser barge. In front of the barge would be a diffuser box measuring 8 to 12 feet long and 6 to 8 feet wide like the one shown on the cover of this FS. The slurry would be discharged from the pipeline into the diffuser box. Panels within the diffuser box would reduce the energy of the slurry allowing it to settle out gently. This type of diffuser box was used for the placement of a cap at the Simpson Tacoma Kraft site in Tacoma, Washington (Sumeri 1996).

To cap the sloped and deeper areas, a mechanical method could also be used. This cap would be placed mechanically with a 3 to 5 cubic yard “rehandling” bucket like the one shown on the cover of this FS. The derrick crane would cast the material from a scow barge into the water, spreading the material evenly by slowly opening its jaws while swinging over the area. On slopes, the cap would be placed from the toe upward to prevent potential slumping. This capping approach was used successfully on a number of projects (Verduin et al 1998; Verduin et al 2001; Verduin et al 2002).

Cap designs are intended to provide protection while minimizing loss in water depth. Cap thicknesses evaluated in this FS are shown in **Figure 3-2**. In post-remediation water depths less than eight feet deep, the cap would be approximately four feet thick. This would include a BAZ where post-remediation aquatic communities reside, and an isolation zone (IZ) where dissolved PAHs in upward flowing groundwater would attenuate to protective levels before entering the BAZ. The uppermost part of the BAZ would contain environmental media appropriate to the habitats being created and the need for erosion controls. There may be two exceptions to a 4-foot cap requirement in shallow water. They are:

- An integrated root barrier and three foot cap may be utilized in areas where necessary to create the depths required in the DNR permit.
- In areas with confirmed consistent downward groundwater gradients that dominate diffusion mechanisms of transport, the IZ shown in **Figure 3-2** may be reduced to the thickness required to prevent mixing of initial cap layers within the BAZ. The purposes of the IZ are to attenuate upward flowing dissolved PAHs, isolate contaminants from the BAZ, and separate mixed cap/sediment from the BAZ. If the groundwater gradient is downward, there would be no upward flowing PAH mass to attenuate or isolate.

These conditions are designed to prevent contaminant exposure to ecological and human receptors at concentrations above the PRGs. Since plants do not root in water deeper than 8 feet, a thinner BAZ is protective. The caps in the deeper area will be between 2 and 2.5 feet thick when they include an IZ.

Clean capping material would be obtained from pre-tested, pre-approved borrow areas and delivered to the Site. Borrow areas could be upland pits or harbor dredged materials. The Site would be designated in the ROD as an approved alternative dredged material disposal site so long as the dredge material is acceptable to the MPCA and DNR. The cap would be mostly sand with the top portion consisting of (1) armoring where needed against erosion or (2) environmental media appropriate to the habitat goals of the area. The makeup of the post-dredging cover is yet to be determined, but it would be no less than one-foot thick or as thick as necessary to restore the pre-dredging bathymetry.

An important consideration in designing the cap is the final water depth, which is influenced by consolidation under the cap. The DGR estimated (SERVICE 2002; Appendix GT-3) and Bay West confirmed (Bay West 2003) the projected consolidation of sediment in Stryker Bay for a range of sand cap thicknesses. Anchor later refined these estimates for 3- and 4-foot caps at five locations in Stryker Bay representing three subgrade substrates: sand, silt and peat (Anchor 2003a). A map of the extent of the three substrates for Stryker Bay is shown in **Figure 3-3** along with a chart showing the calculated settlement for a 4-foot cap. The data show that the peat is most compressible.

Surcharging of capped areas in Stryker Bay was also evaluated. Surcharging is the placement of additional sand on top of the sand needed to construct the cap. The extra weight of the surcharged material accelerates and increases the consolidation of underlying sediments. After sufficient consolidation, the extra thickness of sand is removed, leaving a cap in place with the water depth restored. The calculated amount of settlement achieved with a variety of surcharge thicknesses is shown in **Figure 3-4**. These settlement calculations are based on data from five study locations (Anchor 2003b). The amount of surcharging needed depends on the substrate and its properties of consolidation. The calculations indicate that the top of a cap constructed on the peat sediment substrate would settle to the pre-cap depth with a small surcharge. A cap on the silty substrate areas would require an estimated five to six feet of surcharge for the cap to settle to original depth (assuming a 3-foot cap with root barrier), and a cap on the sandy areas would require eight feet of surcharge to cause a 3-foot cap with a root barrier to settle to within about a half a foot of original water depth. Even with this amount of surcharge material it would not return a sandy substrate to existing bathymetry. Surcharge material could be re-used to cap other areas on the site. Either a hydraulic dredge or a mechanical dredge with barges would be used to remove and transport the surcharge material to the Slip 7 area for capping.

Capping and surcharge material volumes for each of the alternatives are summarized in **Table 3-1**.

3.1.6 Confined Aquatic Disposal

A CAD would be constructed in Slip 7 for disposal of dredged sediments in the Dredge/Cap Hybrid Alternative. A lateral containment dike for the CAD would be located about 800 feet north of the south end of the dock wall with the final location to be determined during design. The conceptual design includes:

(1) Overexcavation at the dike footprint due to structural soil conditions,
(2) A dike liner (60 mil) installed on the top and containment side of the dike,
(3) Side slopes with 2:1 (horizontal:vertical) slopes, and
(4) Riprap placed along the outer dike face to protect against erosion.

These details are subject to change during design.

Sheet piling or an earth dike would be used on the west and north sides of the CAD to segregate dredge water in the CAD from surface water and the adjacent wetlands. The construction of the sheet piling and dike are described in the DGR (SERVICE 2002; Appendix D3). A 5-foot thick cap is assumed for the top of the CAD and additional material may be added after settlement.

3.1.7 Sediment Dewatering for Transportation

Mechanically dredged sediment would be off-loaded into a dewatering pond for treatment prior to off-site disposal. Overexcavation of about one foot would be used for containment dikes around the 3-acre lined pond on the 59th Avenue Peninsula to be used for initial passive dewatering. A high solids slurry dredge pump system could also be used for delivery of the sediment. A pressure dewatering filter press would be used to remove free liquids and reduce sediment volume for transport and disposal. The sediments would be fed from the pond into the press where they would be dewatered to about 35% moisture, stockpiled and trucked to an off-site disposal facility. The filter water would be recirculated to the dewatering pond and the excess water bled off for treatment and discharge to the sewer or the river. For a slurry transport system, pond water may also be circulated back to the pump for carry water make-up.

3.1.8 Dredge Water Treatment and Disposal

Mechanical dredging has been assumed for this FS. For reasons discussed in the DGR (SERVICE 2002, Section 3.8), the dredge slurry solids content is assumed to be 16 %. Based on dewatering studies listed in Section 3.4, this FS assumes that flocculation with chemicals would be used in a CAD or dewatering pond to settle solids. Sand filtration would be used to further reduce solids to meet pre-treatment standards before discharge of the water to the WLSSD sewer system. An additional pump lift station would likely be required to handle the 250-500 gallons per minute flow for discharge to the WLSSD. Water treatment chemicals may be used as filter aids to improve the solids removal to help meet WLSSD standards for sewer discharge. The possibility of treatment and discharge to the river would be considered during design. Direct river discharge would likely require the use of granular activated carbon (GAC) to meet BT/PT requirements.

3.1.9 Transportation and Disposal of Dewatered Sediment

Contaminated sediment would be transported by truck (assumed for cost estimates) or rail to a solid waste landfill approved for industrial wastes as discussed in the DGR (SERVICE 2002) and the Draft Feasibility Study (IT 1998) for the Dredge/Off-Site Disposal Alternative.

3.1.10 Public Waters Mitigation

Minnesota law requires that a DNR permit be obtained when the course, current, or cross section of public waters (open water and wetlands) is altered through filling or excavation, including actions to restore those waters. As a condition of the DNR permit, feasible and practical measures must be undertaken to minimize adverse impacts from altering the cross sections, and mitigation must be provided to replace any lost water and habitat values with equal or greater values. This permit requirement forms the basis of the Public Waters minimization and mitigation measures described in connection with the alternatives examined in detail in this FS. Both dredging and capping trigger this requirement. Public Waters minimization and mitigation features are included in all three of the remedial alternatives detailed below. Minimization measures could include restoration of pre-remediation depths, where possible, shortening the duration of disturbance, while mitigation measures that replace lost values might include restoring wetlands and the removal or isolation of the contaminants. Minimization and mitigation measures for each alternative are shown in Section 3.3.

It is also likely that the WCA implemented locally by the City of Duluth will require mitigation for wetlands located above the ordinary high water mark. DNR has initiated discussions with the city of Duluth concerning a joint approach to public waters permitting mitigation and wetland replacement under the WCA. The state law and rules provide for such an approach. It is likely that all of the alternatives will trigger the DNR and WCA ARAR's described in greater detail in Sections 2.1.3.4 and 2.1.3.6 respectively.

3.1.11 Land Acquisition and Hallett Relocation

Costs for land acquisition and relocation have been estimated based on the requirements of the Uniform Relocation and Real Property Acquisition Policies Act (URA) and EPA relocation policies (EPA 1999) and their state equivalents. At this time, negotiations between XIK and the property owner are proceeding.

3.2 History of Evaluation of Alternatives

This study of remedy technologies and alternatives builds on the previous RI/FS evaluations conducted on the SedOU of the SLRIDT Site. Previous studies are briefly described below. Studies completed prior to the 2000 Agreement between the Parties are presented first, followed by a description of the DGR that was prepared pursuant to the Agreement. The alternatives described in each are listed in **Figure 3-5**.

3.2.1 Pre-Agreement Studies

3.2.1.1 Draft Alternatives Screening Report (IT 1997)

This report screened 44 technologies (including dredging, containment systems for dredging, treatment of dredged material and dredge water, air emissions controls, *in situ* treatment, capping and public waters mitigation methods). Of the 44 evaluated technologies, 25 were integrated into 9 remedy alternatives and compared. Six remedy alternatives were carried forward to the 1998 FS. The following alternatives were dropped:

- Dredging with disposal in both Stryker Bay and Slip 7. Storage of sediment in Stryker Bay was less efficient than other alternatives, requiring a relatively large area and large dikes for limited storage.
- *In situ* biotreatment was dropped because biodegradation was not achieved in treatability studies performed on Slip 7 sediment, and because the sediments would require numerous deliveries of nutrients over an extended treatment period. This delivery mechanism is not proven and adding nutrients to aquatic systems creates a risk of disrupting habitats both on and off-site for an extended period. Both technical uncertainty and cost were high.

3.2.1.2 Draft Feasibility Study (IT 1998)

The 1998 Draft FS compared the six alternatives identified from the 1997 screening report (and in **Table 3-5)** in accordance with the MPCA's RFRA and the NCP. Several alternatives that provided for the construction of thin (six inches to one foot) caps were not carried forward after the 1998 Draft FS because the MPCA concluded they were not protective. One alternative that included a thin, variable thickness cap was carried forward from the Alternatives Screening Report to IT's draft FS. The cap thickness variability in this alternative was based on different uses of areas of the site. Dredging to a sub-aqueous CAD storage unit in Slip 7 was rejected in favor of a similar approach using Slip 6 for storage in an above-water Confined Dredge Facility (CDF). The dredge and thermal treatment option in the Alternatives Screening Report was changed in IT's FS to dredge with off-site disposal due to the failure of thermal desorption to successfully meet the cleanup goals required for backfilling during the SOU remediation and IRA, where about 4,200 cubic yards of sediment from Slip 6 was dredged and thermally treated. Relatively high cost was also a factor in the MPCA's approval to change the scope of this alternative.

3.2.1.3 Focused Feasibility Study Update (SERVICE 1999a) and Supplemental Detailed Analysis Report (SERVICE 1999b)

These reports were submitted by the Companies after the 1998 FS, and dealt exclusively with a new alternative that featured a 2-3 foot thick cap instead of the thinner caps previously eliminated from further consideration. Formerly known as the Thick Cap or Wetland Cap Alternative, this alternative has been carried forward in this FS as the *In Situ* Cap Alternative.

3.2.2 Studies Required in the Agreement

In 2000, the Parties entered the Agreement described in Section 1.0, which reopened the RI/FS process for the SedOU. Data gaps were then identified by the EPA, COE, and the PRT pursuant to the Agreement. These data gaps, including costs, and the issues related to the four remedy alternatives identified in the Agreement were further addressed in the DGR. During the preparation of the DGR, the Parties met with the PRT on October 30, 2001, and on May 9, August 27 and 28, September 10, October 2, and December 9 and 10 in 2002 to review the preliminary findings. The Parties then assembled the PRT and approximately 50 stakeholders (including state, federal and tribal natural resource managers, local government representatives, property owners, neighbors, and others) to discuss their interests in the remedy and, using the remedial technologies and new information available from the DGR and other sources, to identify a number of hybrid remedy alternatives.

Using suggestions and comments from the stakeholders and the PRT, the Parties and the DNR worked to identify a hybrid alternative that would meet key regulatory requirements, mitigate the impacts of remediation on public waters and associated habitat, and accommodate existing and planned property uses. The Parties then reconvened the stakeholders and sought their reaction to the hybrid option. The new alternative identified by this process combines capping from the *In Situ* Cap Alternative with dredging and containment from the Dredging & On-Site Disposal Alternative. By amendment of the 2000 Agreement, the Parties substituted the Dredge/Cap Hybrid Alternative for the Dredging & On-Site Disposal Alternative in this FS.

3.3 Summary of Retained Alternatives

This FS is based primarily on information developed and refined since the 2000 Agreement, including the DGR and other information gathered and provided by MPCA and the DNR, advice of the PRT, and comments of those who participated in the stakeholder meetings in 2003. It also takes into account previous feasibility studies on the SedOU of the SLRIDT site. It evaluates the No Action Alternative as a benchmark and three other Alternatives specified in Amendment

No. 1 to the Agreement between the MPCA and the Companies. The evaluation is in accordance with process set forth in the Agreement between the MPCA and the Companies.

The four Alternatives to be analyzed in Sections 4 and 5, the Detailed Analysis of Alternatives and Comparative Analysis of Alternatives, are:

- Alternative 1—No Action
- Alternative 2—*In Situ* Cap
- Alternative 3—Dredge/Cap Hybrid
- Alternative 4—Dredge/Off-Site Disposal

3.3.1 Alternative 1 – No Further Action

Under the No Action Alternative no actions would be taken to alter existing site conditions. The No Action Alternative does not include any treatment, engineering controls, or institutional controls. This alternative does not include long-term groundwater monitoring. All existing monitoring wells for the No Action Alternative would be abandoned as shown in **Figure 3-6**.

3.3.2 Alternative 2 – *In Situ* Cap

This remedial action alternative would consist primarily of capping Stryker Bay, portions of the on-shore wetlands in Slip 7, and the two slips; with a limited amount of dredging within the federal navigation channel near the 48-inch outfall and in the portion of the site located in Wisconsin waters; dredged sediment would be placed at the head of Slip 6 and capped.

The *In Situ* Cap is predicted to:

- Provide protection of human health and the environment, by contaminant isolation,
- Accommodate 18-foot draft (barge) shipping in Slips 6 and 7,
- Modify Stryker Bay by creating shallower depths and more prominent emergent wetland than exists under current conditions,
- Establish transitional habitats in Slip 7, and
- Allow for potential site redevelopment.

<u>Dredging</u> – Alt. 2

Under the *In Situ* Cap Alternative, contaminated sediments located within the federal navigation channel near the 48-inch outfall may be dredged or, if acceptable to the COE, capped in place. About 3,600 cubic yards with sediments containing more than 13.7 mg/Kg TPAHs would be dredged from the Wisconsin part of the Site (**Figure 3-7**). All dredged material would be placed in the deep portion of Slip 6 at its northern end where it would be capped along with the rest of the slip.

<u>Dredge Water Management</u> – Alt. 2

Assuming the sediment is mechanically dredged, the deposition area at the head of Slip 6 would be segregated into a treatment/work zone using a full length silt curtain. The deposited dredge material will displace some surface water, but no water would be removed from the treatment zone or treated. The displaced river water would be monitored beyond the outermost engineering control structure to meet FAVs in accordance with the PRGs.

<u>Capping</u> – Alt. 2

The *In Situ* Cap Alternative would consist of capping the contaminated sediments in Stryker Bay and in the boat slips as described in Section 3.1.5, thus isolating the contaminants in place (SERVICE 2002). *In Situ* capping would make the bay and slips shallower, reducing or eliminating boat access to Stryker Bay and converting open water to wetlands and some on-shore wetlands to uplands. Capping would cause the slips to be too shallow for deep draft ships and require compensation to, or relocation of Hallett's current deep draft dock, but would allow for barge dock activities. The entrance from the river channel to Stryker Bay and the continued flow of its tributary would be maintained to connect open waters.

This alternative would include placing a cap over the areas to be remediated as follows and illustrated in **Figure 3-7**:

- Caps located on the on-shore side of the new shoreline would have a 4-foot cap.
- Off-shore areas with post-remediation depths less than 8 feet deep would have a 4-foot cap. If the DNR required depth cannot be achieved with a surcharged cap, the MPCA indicates a 3-foot cap with a root barrier as described in Section 3.1.5, may be utilized.

- Off-shore areas with post-remediation depths deeper than 8 feet would have a 2- to 2.5-foot cap.
- As described in Section 3.1.5, caps in areas with confirmed consistent downward gradients may be thinner.

<u>Monitoring</u> - Alt. 2

The *In Situ* Cap Alternative would involve monitoring imported borrow material for caps, ambient air monitoring, surface water monitoring beyond the outermost engineering control structure, and coring and settlement monitoring in the cap areas for comparison to expected settlement. Wetland vegetation surveys would also likely be required by the DNR. Details would be developed in the RD/RA Plan for the selected alternative. Ambient air and surface water quality monitoring would be conducted during in-water construction activities until the MPCA allows termination of testing based on the monitoring results.

Because this alternative involves no post-dredging covers, groundwater monitoring would not be performed in the *In Situ* Cap Alternative, as discussed in Section 3.1.2.

During the remediation, surface water would be monitored outside the outermost engineering control structure for compliance with PRGs. Surface water monitoring after remediation would not be required because monitoring the capped sediment would detect any contaminants arising from sediment capped before release to the surface water.

After remedial construction is complete, the MPCA has proposed requirements to monitor the BAZ in capped areas and to monitor for potential accumulation of cPAHs and possibly mercury in biota samples as described in Section 2.2. Sediment and biota samples would be collected in capped areas to measure compliance. The caps and post-dredging environmental medium would be monitored for erosion and repaired as necessary. This monitoring would be conducted until the data demonstrate that all sediment risks have been satisfactorily managed.

A federally mandated review will be conducted every five years because contamination remains in place after completion of this remedial alternative.

<u>Property Acquisition and Hallett Relocation</u> - Alt. 2

Under the *In Situ* Cap Alternative, Hallett would be due compensation for property acquisition and relocation as part of the remedial action, because the caps would reduce the navigational depth of Slips 6 and 7 to a point where ships could no longer load. The docks could potentially remain available for barge traffic.

<u>Changes to Existing Property Use</u> - Alt. 2

The *In Situ* Cap Alternative may have the following effect on current property use:

- Conservation easements would be established along Site shorelines (**Figure 3-7**) to enhance existing and re-established natural resources.
- Stryker Bay landowners with riparian rights would be affected because they potentially would no longer have boat access at their property. This may require compensation or a dock located elsewhere.
- Slips 6 and 7 would not support deep draft shipping, but would still be accessible for barge traffic.

<u>Minimization of Impacts to and Mitigation for Public Waters and Protected Wetlands</u> - Alt. 2

This alternative would include the following minimization and Public Waters mitigation:

- Isolation of the contaminated sediment,
- Placement of environmental medium throughout the remediated areas,
- Modify Stryker Bay by creating shallower depths and more prominent emergent wetland than exists under current conditions,
-
- Maintenance of a hydraulic connection between Stryker Bay, its unnamed tributary, and the St. Louis River (The details of this connection would be developed in the RD/RA Plan if this alternative is selected.),
- Shoreland buffers including softened shorelines and reduced upland erosion along Stryker Bay and Slip 6,

- Enhanced fringe wetlands on the western edge of Slip 7,
- A variety of transition zones from wetlands to deep water habitat,
- Diverse substrate for fish habitat, and

The DNR estimates that approximately 52 acres of Public Waters mitigation for sheltered bays and wetlands may be needed to replace public water and wetlands functions and values. (DNR 2003b).

Institutional Controls - Alt. 2

Institutional controls will be needed to assure the *In Situ* Cap Alternative isolates the contaminated material long-term and remains protective over time. The following institutional controls may be required for this alternative:

- Anchoring or other disturbance, temporary or permanent, will be prohibited within the footprint of the *in situ* capped areas. Anchoring restrictions would be communicated with signs on shore.
- Docks, piers, or other temporary or permanent structures could not be constructed within the footprint of the *in situ* capped area without a construction plan approved by the MPCA. In some circumstances, DNR and COE approval may also be necessary.
- Dredging would be prohibited without MPCA approval within the site remediation boundaries.
- There would be no institutional controls in the Wisconsin portion of the remediated area.

Schedule and Time Until RAOs and Cleanup Levels are Achieved - Alt. 2

Dredging operations would occur early in the remediation so that the dredged material could be placed at the head of Slip 6 before capping the Slip 6 area. Capping is expected to take about one construction season **(Figure 3-8)**. All of the known response RAOs and cleanup levels would be met at the conclusion of capping. Sequencing and duration of this alternative would be refined in the RD/RA Plan should this alternative be selected.

3.3.3 Alternative 3 – Dredge/Cap Hybrid

This remedial alternative would consist of a combination of dredging in Stryker Bay, Slip 6 and the Wisconsin portion of the Site, capping in each bay and slip of the Site, on-Site containment of dredged material in a CAD in Slip 7 with wastewater discharged either to the WLSSD or to the river, and related minimization and mitigation measures as described below.

Implementation of the Dredge/Cap Hybrid would:

- Provide protection of human health and the environment through contaminant mass removal and isolation,
- Accommodate continued 23-foot draft shipping in Slip 6,
- Maintain a sheltered bay condition in Stryker Bay at existing depths wherever feasible,
- Provide, via the CAD area of Slip 7, a deep to shallow transition with wetland habitat while allowing docking for barges in the southern portion of the slip,
- Preclude deep draft shipping in Slip 7, but potentially allow docking for barges in the southern portion of the slip, and
- Allow for potential site redevelopment.

Dredging – Alt. 3

Dredging would be conducted in about 70% of Stryker Bay (see **Figure 4-4**). This would include most of the silty and sandy substrate areas (**Figure 3-4**), not associated with the highest concentrations of naphthalene. These areas would be dredged in order to achieve mass removal of most of the contaminated sediment layer and maximize restoration of pre-remedy water depth. The entrance to Stryker Bay would also be dredged to maintain adequate water flow into the bay and recreational navigation access for shoreline owners, and other users. In the northernmost contaminated area, the DNR requested dredging to create a sediment trap for detritus delivered by the unnamed tributary stream.

Except for the areas of highest naphthalene concentrations in the northernmost 100 feet of Slip 6, sediment from the entrance channel and along the dock wall of Slip 6 would be dredged to provide a 90-foot-wide, 25-foot-deep berth. Contaminated sediments located within the federal navigation channel near the 48-inch outfall would be dredged or, if acceptable to the COE, capped in place. All areas with sediment exceeding 13.7 mg/kg TPAH within Wisconsin waters in Slip 6 and the navigation channel would be dredged at the request of the Wisconsin DNR. Two pockets of contamination in the on-shore wetlands of Slip 7 would also be excavated.

Dredge Water Management – Alt. 3

Based on dewatering studies listed in Section 3.4, this FS assumes that flocculation with chemicals would be used in a CAD to settle solids. Sand filtration would be used to further reduce solids to meet pre-treatment standards before discharge to the WLSSD sewer system. Backwash water would be returned to the inlet of the CAD. An additional pump lift station would likely be required to handle the 250 gallons per minute flow (per dredge) for discharge to the WLSSD and a pipeline dedicated to access the WLSSD force main lift station. To minimize the discharge, a dredge slurry system could be used which would recirculate settled water from the CAD to makeup a slurry of about 16% solids to transport dredged sediment. To discharge directly to the river would require additional treatment using GAC System to meet PRGs.

Air Emission Controls – Alt. 3

Air emission modeling, discussed in Section 3.1.4, indicated a potential for increased naphthalene emission during dredging of sediments in the areas of highest naphthalene concentrations.

Capping areas of highest naphthalene concentrations (shown in mg/Kg dry weight in **Figure 3-2**) instead of dredging them would decrease the likelihood of exceeding ambient air quality PRGs. Locating the CAD in Slip 7, rather than Slip 6, would reduce ambient air impacts because Slip 7 is farther from the residential receptors. PAC, cover or other approved mitigation measures would be applied in the CAD if air monitoring indicates air emissions from the CAD fail to meet PRGs. If the controls do not satisfactorily reduce the risk, the MPCA would temporarily relocate affected residents and businesses.

Capping – Alt. 3

Capping and surcharging would be conducted in the remaining undredged portions of Stryker Bay (**Figure 3-9**) to isolate contaminants without reducing water depths significantly, reduce potential air impacts, restore substrate, improve ecological edge conditions, and diversify habitat. This would include:

- The areas of highest naphthalene concentrations on the east side of Stryker Bay,
- The peat areas shown in the substrate map (**Figure 3-4**) as this substrate is predicted to compress with minimal additional surcharge material,
- All remaining undredged areas in Slips 6 and 7 and one area of on-shore wetlands of Slip 7 that exceed PRGs as shown in **Figure 3.9**, including those areas with the highest naphthalene concentrations.

<u>Containment</u> – Alt. 3

A CAD would be constructed in Slip 7 for disposal of dredged sediments. The lateral containment dike of the CAD would be located about 800 feet north of the south end of the dock wall with the final location to be determined during design. The Slip 7 location was selected to:

- Allow Hallett to continue to operate its outbound dock at Slip 6 for deep draft shipping,
- Maximize the distance from this potential naphthelene emission source to residential receptors, and
- Maximize the habitat potential of the subaqueous cap that would result after remediation by locating it near the existing wetlands in this slip.

An earthen dike or sheet piling would be used around the west and north edges of the CAD to segregate dredge water in the CAD from surface water and the adjacent wetlands. The construction of the sheet piling and end dike are described in the DGR (SERVICE 2002; Appendix D3). The end dike would likely have 2:1 slopes and be constructed of granular fill. Operating water levels and details of the dikes and sheet piles will be developed in the RD/RA Plan should this alternative be selected by the MPCA. A 5-foot thick cap is assumed for the CAD (**Figure 3-3**) and additional material may be added after settlement. All of the dredge water in the CAD would be pre-treated and pumped to the WLSSD sewer system as described in Section 3.1.6 or treated for release to the river.

<u>Monitoring</u> – Alt. 3

The Dredge/Cap Hybrid Alternative would involve monitoring imported borrow material for dikes, caps, and covers; ambient air monitoring; discharge monitoring; surface water monitoring beyond the outermost engineering control structure; and coring and settlement monitoring in the cap and surcharge areas for comparison to expected settlement. Wetland vegetation surveys would also likely be required by the DNR. Details would be developed in the RD/RA Plan for the selected alternative. Ambient air and surface water quality monitoring would be conducted during all in-water construction activities and dewatering of the CAD until the MPCA allows termination of testing based on the monitoring results.

Limited groundwater monitoring may be performed if required by the MPCA as part of the Dredge/Cap Hybrid Alternative, as discussed in Section 3.1.2.

During remediation, surface water would be monitored outside the outermost engineering control structure and at the point of discharge to the river for treated dredge water (if any) for compliance with PRGs. Surface water monitoring would not be required after completion of this remedy because monitoring the CAD and *in situ* capped sediment would detect any contaminants arising from capped sediment before release to the surface water.

After remedial construction is complete, the MPCA has proposed requirements to monitor the BAZ in capped areas and to monitor for potential accumulation of cPAHs and possibly mercury in biota samples as described in Section 2.2. Sediment and biota samples would be collected in capped areas to measure compliance. The caps and post-dredging environmental medium would be monitored for erosion and repaired as necessary. This monitoring would be conducted until the data demonstrate that all sediment risks have been satisfactorily managed.

A federally mandated review will be conducted every five years because contamination remains in place after completion of this remedial alternative.

<u>Property Acquisition and Hallett Relocation</u> – Alt. 3

Compensation would be required for the placement of a CAD in Slip 7, and for acquisition of property or an easement in the riparian and wetland buffer areas shown on **Figure 3-9**.

<u>Changes to Existing Property Use</u> – Alt. 3

The Dredge/Cap Hybrid Alternative may have the following effects on current property use:

- Conservation easements will be established along Site shorelines (**Figure 3-9**) to enhance existing and re-established natural resources.
- Slip 7 would be too short and shallow to support existing deep draft shipping due to a CAD located in the north end of the slip. The southern portion of the slip would be accessible to barge traffic.

<u>Minimization of Impacts to and Mitigation for Public Waters and Protected Wetlands</u> – Alt. 3

This alternative would include the following minimization and Public Waters mitigation:

- Removal and isolation of contaminated sediment,
- Surcharging to maintain water depth in capped areas of Stryker Bay,
- Placement of environmental medium throughout the remediated areas,
- Maintenance of river access for shoreline owners, and other recreational users.
- Maintenance of a shallow sheltered bay in Stryker Bay,
- Enhancement of the hydraulic connection between Stryker Bay, its unnamed tributary and the St. Louis River,
- Management of upland runoff with conservation easements along many shorelines of the Site,
- Softened shorelines along Stryker Bay and Slip 6,
- Enhanced and diversified fringe wetlands on the western edge of Slip 7,
- A variety of transition zones from wetlands to deep water habitat, and
- Diverse substrate for fish habitat.

Depending on design-level analyses of post-remediation configurations in the existing wetlands of Slip 7 and Stryker Bay, DNR estimates approximately 13 acres of additional Public Waters mitigation may be required to replace lost public water and wetlands functions and values (DNR 2003b).

<u>Institutional Controls</u> – Alt. 3

Institutional controls will be needed to assure the Dredge/Cap Hybrid Alternative isolates the contaminated material long-term and remains protective over time. The following institutional controls may be required by the MPCA for this alternative:

- Anchoring or other disturbances, temporary or permanent, would be prohibited within the footprint of the remediated areas. Anchoring restrictions would be communicated with signs on shore.
- Docks, piers, or other temporary or permanent structures could not be constructed within the footprint of the CAD or *in situ* capped areas without a construction plan approved by the MPCA. In some circumstances, DNR and COE approval may also be necessary.
- Dredging would be prohibited within the site remediation boundaries, with the exception of maintenance dredging in Slip 6 and the portion of Slip 7 that remains open to ship and/or barge traffic.
- Maintenance dredging in Slip 6 and Slip 7 would be done in compliance with a dredge plan approved by the MPCA.

<u>Schedule and Time until RAOs and Cleanup Levels are Achieved</u> – Alt. 3

Construction of the Slip 7 CAD would be required before dredging and take about 45 days. Dredging would require 7 to 8 months or the equivalent of one full construction season to complete, assuming a 24 hours per day, 5 days per week dredging schedule. Surcharging would likely begin after dredging so that this cap material would not be contaminated from dredge residue and take about two years to achieve the desired settlement (**Figure 3-10**). Although construction sequencing is subject to change, total construction time is estimated to be about three years before the cap is placed on Slip 7 or the CAD due to prior use of the capping sand as surcharge material for Stryker Bay. This remedy would meet the PRGs after the CAD is completed in about a total of four years for the project, with RAOs and Cleanup Levels met in about three years in Stryker Bay and two years in Slip 6. Sequencing and duration of this alternative would be refined in the RD/RA Plan should this alternative be selected.

3.3.4 Alternative 4 – Dredge/Off-Site Disposal

This remedial action would consist of dredging, on-site dewatering and off-site disposal of contaminated sediment from throughout the Site.

The Dredge/Off-Site Disposal Alternative is predicted to:

- Provide protection of human health and the environment through contaminant mass removal and isolation within an off-site landfill,
- Accommodate continued 23-foot draft shipping in Slips 6 and 7,
- Maintain a sheltered bay condition in Stryker Bay at existing depths,
- Establish transitional habitats in Slip 7, and
- Allow for potential site redevelopment.

The areas to be dredged are shown in **Figure 3-11**.

Dredging – Alt. 4

Dredging would be conducted in all contaminated portions of the Site. Sediment from the entrance channel and along the dock wall of Slips 6 and 7 would be dredged to provide a 90-foot wide berth. Dredging would be conducted in the shallow areas of Slip 7 and some of its adjacent on-shore wetlands to the top of the slag layer found in this area.

Dredge Water Management – Alt. 4

Based on dewatering studies listed in Section 3.4, this FS assumes that flocculation with chemicals would be used in a dewatering impoundment on the 59th Avenue Peninsula to settle solids. Sand filtration would be used to further reduce solids to meet pre-treatment standards before discharge to the WLSSD sewer system. Backwash water would be returned to the inlet of the impoundment. With two dredges operating an additional pump lift station would likely be required to handle 500 gallons per minute flow for discharge to the WLSSD and a pipeline dedicated to access the WLSSD force main lift station. The sediment dewatering filter press would also recirculate the water back to the dewatering impoundment or to the sand filter. Discharge directly to the river would require additional treatment using a GAC System after the sand filter.

Air Emissions Control – Alt. 4

Air emission modeling discussed in Section 3.1.4, indicated a likely increase of naphthalene emissions during dredging of sediments in the areas of highest naphthalene concentrations, with the potential to exceed the PRGs for ambient air. The best available control technology for this evaporative release is a cover placed on the sediment receiving pond and load out stockpile areas on the 59th Avenue peninsula during dredging and dewatering operations. If, air emissions exceed the PRGs, the control measures described above would be taken to reduce air emissions and/or exposure. Additionally, dredging of areas of highest naphthalene concentrations would likely be scheduled during colder weather. Should these control efforts fail to abate the risk, the MPCA would temporarily relocate affected residents and businesses.

Dewatering and Disposal – Alt. 4

Active dewatering of dredged sediments would be required for the Dredge/Off-Site Disposal Alternative to facilitate off-site transport and disposal as a solid. A pressure dewater filter press would be used to remove free liquids and reduce sediment volume for transport and disposal. The sediments would be placed in a holding pond prior to feeding into the press where they would be dewatered to about 35% solids before being trucked to an off-site disposal facility. This process is discussed further in the Draft Alternatives Screening Report (IT 1997b) and Draft Feasibility Study (IT 1998).

All dredged sediments would be pumped to the receiving pond on 59th Avenue Peninsula and processed using the dewatering methods described above. The dewatered sediments would be stockpiled in the load out area. Water removed from the sediments would be treated and disposed as described in Section 3.1.7. The backwash water would be returned to the receiving pond for additional filtration. The dewatered sediments would be trucked off-site to a permitted solid waste landfill as discussed in Section 3.1.9.

<u>Monitoring</u> – Alt. 4

The Dredge/Off-Site Disposal Alternative would involve monitoring imported borrow material for covers, ambient air monitoring, discharge monitoring, and surface water monitoring beyond the outermost engineering control structure. Wetland vegetation surveys would also likely be required by the DNR. Details will be developed in the RD/RA Plan for the selected alternative. Ambient air and surface water quality monitoring would be conducted during in-water construction activities and dewatering until the MPCA allows termination of testing based on the monitoring results.

Limited groundwater monitoring may be performed as part of the Dredge/Off-Site Disposal Alternative, as discussed in Section 3.1.2.

During remediation, surface water would be monitored outside the outermost engineering control structure and at the point of discharge to the river for treated dredge water (if any) for compliance with PRGs. Surface water monitoring would not be required by the MPCA after placement of the post-dredging cover.

After remedial construction is complete, the post-dredging cover and environmental medium would be monitored for erosion and repaired as necessary. This monitoring would be conducted until the data demonstrate that all sediment risks have been satisfactorily managed.

A federally mandated review will be conducted every five years because contamination remains in place after completion of this remedial alternative.

<u>Land Acquisition and Hallett Relocation</u> – Alt. 4

Relocation of Hallett would not be required since the slips post-dredge would meet the 25-foot depth preference for loading deep draft vessels and dredging would be managed around Hallett's shipping schedules. Other than the possible purchase of shoreland buffers, no land acquisition would be required for this alternative.

<u>Changes to Existing Land Use</u> – Alt. 4

The Dredge/Off-Site Disposal Alternative may have the following effect on current land use:

- Conservation easements would be established along Site shorelines (**Figure 3-9**) to enhance existing and re-established natural resources.

<u>Minimization of Impacts to and Mitigation for Public Waters and Protected Wetlands</u> – Alt. 4

This alternative would include the following minimization and Public Waters Mitigation:

- Removal and isolation of contaminated sediment,
- Placement of environmental medium throughout the remediated areas,
- Maintenance of a shallow sheltered bay in Stryker Bay,
- Enhanced hydraulic connection between Stryker Bay, its unnamed tributary, and the St. Louis River,
- Emergent wetlands on the western edge of Slip 7,
- A variety of transition zones from wetlands to deep water habitat, and
- Diverse substrate for fish habitat.

The DNR indicates that because Stryker Bay and the slips would be as deep or deeper than they are today, it is likely that no further Public Waters mitigation would be required for this alternative (DNR 2003b).

<u>Institutional Controls</u> – Alt. 4

Institutional controls will be needed to assure the Dredge/Off-Site Disposal Alternative isolates the contaminated residue long-term and remains protective over time. The following institutional controls may be required by the MPCA for this alternative:

- Anchoring, temporary or permanent, will be prohibited within the footprint of the remediated areas. Anchoring restrictions would be communicated with signs on shore.
- Docks, piers, or other temporary or permanent structures could not be constructed within the footprint of the remediated areas without a construction plan approved by the MPCA. In some circumstances, DNR and COE approval may also be necessary.

- Dredging would be prohibited within the site remediation boundaries, with the exception of maintenance dredging in Slips 6 and 7.
- Maintenance dredging in Slip 6 and Slip 7 will be done in compliance with a dredge plan approved by the MPCA.

Schedule and Time until RAOs and Cleanup Levels are Achieved – Alt. 4

It will take about two months to mobilize and construct the dewatering and water treatment system. Dredging would be completed within approximately two to three years, if two mechanical dredges would operate at the same time in different areas of the site 24 hours per day, 5 days per week during a 7-month construction season. While such dual dredging may increase the level of the ambient naphthalene emissions, it can reduce the duration of the emissions by half (**Figure 3-12**). Post dredge capping and armoring would take about three to four months to complete and would start in each area (i.e. Stryker Bay, Slip 6 and Slip 7) upon completion of the dredging. The remedy will take about three years to complete and will then meet RAOs and Cleanup Levels after the post-dredge cover is completed. Sequencing and duration of this alternative would be refined in the RD/RA Plan should this alternative be selected.

3.4 Treatability Studies

Previous reports describe a wide range of treatability studies that have been undertaken in the process of refining remedial alternatives. These studies, listed below, form some of the bases for describing the short-term impacts from dredging and for the water treatment approach included within several of the alternatives that involve dredging.

- Draft Alternatives Screening Report, Appendix B1, Final Report on Biodegradation, 1997. (IT 1997b)
- Draft Alternatives Screening Report, Treatment Study and Appendix B2, Report of Sediment Treatability, 1997. (IT 1997b)
- Draft Feasibility Study, Appendix A, Elutriate Toxicity Testing, 1998. (IT 1998)
- Draft Feasibility Study, Appendix B, Report of Sediment and Dredge Water Treatability, 1998. (IT 1998)
- Draft Feasibility Study, Appendix C, Mechanical Dewatering Studies, 1998. (IT 1998)

- Dredge Water Treatability Test Study Results, 1999. (SERVICE 1999c)
- DGR, Appendix DRET, Dredging Elutriate Test, 2002. (SERVICE 2002)
- DGR, Appendix SBLT, Sequential Batch Leaching Test, 2002. (SERVICE 2002)
- DGR, Appendix BT, Bench Test, 2002. (SERVICE 2002)

4.0 DETAILED ANALYSIS OF RESPONSE ACTION ALTERNATIVES

This section presents a detailed evaluation of the alternatives, consisting of an assessment of individual alternatives against the remedy selection criteria in the RFRAs issued by the MPCA.

4.1 Remedy Selection Criteria

The purpose of implementing any response action is to protect the public health, welfare, and the environment by preventing, minimizing or eliminating the release(s), or threatened release(s) of hazardous substances, pollutants, or contaminants. The MPCA believes protection of public health, welfare, and the environment is best achieved by implementing a permanent remedy for the Site. An implemented remedy is considered permanent when it allows for unrestricted use of all land and natural resources impacted by the contaminants and, except for the purpose of treatment, does not involve removal of the contaminants to another site and minimizes exchange of the contaminants to other environmental media.

The remedy selection criteria are divided into three categories (threshold, balancing, and modifying [community acceptance]) and are described in detail below. The MPCA Commissioner will apply the threshold, balancing criteria and community acceptance to select a final response action from amongst alternatives evaluated in this FS.

4.1.1 Threshold Criteria

Each alternative must meet the threshold criterion of providing overall protection for the public health and welfare, and the environment. For the purposes of this FS this criterion is met if the alternative achieves the PRGs identified in Section 2.2 or provides for a permanent remedy. A remedial action is permanent if it provides absolute long-term effectiveness as described above. None of the remedies evaluated in this FS are considered permanent. Alternatives must also meet ARARs.

4.1.2 Balancing Criteria

Alternatives that meet the threshold criteria are evaluated using the Balancing Criteria listed below. The alternative that provides the best balance among the Balancing Criteria in consideration of the Site-specific circumstances shall be selected by the MPCA as the final response action. The Balancing Criteria are listed in order of priority (established by the MPCA in its RFRA) with Long-Term Effectiveness being most important.

Long-term Effectiveness

Long-term effectiveness is the ability of an alternative to maintain the desired level of protection of public health and welfare, and the environment over time. Permanent remedies provide absolute long-term effectiveness. In the event a permanent remedy is not feasible, alternatives that significantly alter the hazardous substances or pollutants or contaminants to produce significant reductions in toxicity, mobility, or volume through treatment will be preferred. In addition, the ability of the alternative to manage treatment residuals, minimize transfer of contaminants to another environmental media, and meet established RAOs and cleanup levels over time is a major consideration of the MPCA.

Implementability

The technical and administrative feasibility of implementing the alternative and the availability of goods and services needed to implement the alternative is considered.

Short-term Risks

The short-term risks that may be posed as a result of implementing an alternative is considered and weighed against the ultimate long-term benefits of implementing that alternative.

Total/Present Value Cost

Total cost includes the sum of construction costs, mitigation costs, design costs, and property costs. Added to these costs are the present value of future costs of monitoring and maintenance. Natural resource damages that may be recoverable by natural resource trustees are not included here because they are costs determined by a separate, parallel process after issuance of the ROD. They are not to be included in the FS. Total cost includes costs for maintenance and repair, but does not include the cost of complete remedy failure and replacement.

4.1.3 Community Acceptance

The degree of community acceptance will be determined by the MPCA for each alternative during the process that follows this FS. The community has been consulted regularly in regard to the alternatives available for remediation at the Site. The MPCA will prepare a proposed plan incorporating the SedOU remedy that MPCA proposes to select for the Site. The MPCA will make the proposed plan available to the public, hold a public meeting in the Site area, and provide for a 30-day comment period for community response. The community's comments will be considered by the MPCA in its final decision to select a remedy and the MPCA's response to the comments will be documented in the ROD for the Site.

4.2 Detailed Analysis of Alternatives

The MPCA has concluded none of the alternative meet the RFRA's definition of permanence described in Section 4.1. Like those that are permanent, alternatives failing to meet the definition of permanent may continue to be evaluated if they meet the threshold criteria.

4.2.1 Alternative 1 - No Further Action

The No Action Alternative reflects existing site conditions. The No Action Alternative does not include any treatment, engineering controls, or institutional controls. This alternative does not include long-term groundwater monitoring. All existing monitoring wells for the No Action Alternative would be abandoned as shown in **Figure 3-6.**

4.2.1.1 Threshold Criteria

The No Action Alternative would not be protective of human health because the contaminated material is located at a shallow depth in the sediment column and can come into contact with a person wading, swimming or standing. The No Action Alternative would not be protective of the environment because contaminated material, at concentrations exceeding the MPCA's PRGs, is located in the BAZ. The No Action Alternative will not be carried forward in the remainder of the analysis of alternatives because it does not meet the threshold criterion of protection of human health and the environment established by the RFRAs.

4.2.2 Alternative 2 – *In Situ* Cap

This remedial action would consist primarily of capping Stryker Bay, portions of the on-shore wetlands in Slip 7, and the two slips; with a limited amount of dredging within the federal navigation channel near the 48-inch outfall and in the portion of the site located in Wisconsin. The components of Alternative 2 are described in greater detail in Section 3.3.2 and shown in **Figure 3-7**.

4.2.2.1 Threshold Criteria – Alt. 2

The *In Situ* Cap is predicted to be protective of human health and the environment through isolation of contaminated sediment. Capping is predicted to be effective, providing the long-term protection through isolation of the contaminated sediment (SERVICE 2002). After installation of the *In Situ* Cap, the contaminated sediments would remain in place, be inaccessible to humans and would be isolated below the BAZ. Groundwater transported through the sediment would meet RAOs and Cleanup Levels for protection of the organisms living in the BAZ, as well as for the aquatic community in the water column, and for human consumption of fish (SERVICE 2002; Appendix GW, Section GW2-6.1).

Table 4-1 identifies the permits, requirements and ARARs introduced in Section 2.0 that are applicable to the *In Situ* Cap Alternative. The *In Situ* Cap Alternative may not comply with ARARs because the "DNR would likely not be able to issue a public waters work permit for the *In Situ* Cap Alternative" (DNR 2003a). However, this determination cannot be definitively made until the DNR receives a permit application and rules on it. Since no permit application is pending at the DNR, a conclusion on ARARs compliance is uncertain at this time. This alternative is carried forward for evaluation in recognition of the uncertainty of its permittability.

4.2.2.2 Balancing Criteria – Alt. 2

Long-Term Effectiveness – Alt. 2

The *In Situ* Cap Alternative is predicted to be effective in the long-term with appropriate cap maintenance. The contaminants are predicted to be isolated from the BAZ and surface water by the cap material. The contaminated sediments are underlain by a site-wide, 50-foot-thick, silt and clay confining layer, which prevents downward migration of the contaminants to the regional aquifer (**Figure 1-3**). Modeling of contaminant transport upward into the *In Situ* cap predicts that the cap would be effective in the long-term (SERVICE 2002; Appendix GW2). Since the Site consists mostly of quiescent backwaters and slips (except during ship maneuvering into and out of the slips); armoring, erosion monitoring and maintenance would be expected to ensure long-term compliance and permanence (SERVICE 2002; Appendixes GT5 and GT6). Additional remedial measures are predicted to be unlikely because systematic failures of these *In Situ* caps would not be expected. Should erosion appear during monitoring and maintenance, the eroded area would be expected to be limited in extent and repaired as part of the cap maintenance. The residual risk is predicted to meet RAOs and cleanup levels.

The *In Situ* Cap Alternative would not reduce the toxicity, mobility or volume of contaminants through treatment other than the passive treatment that occurs during consolidation beneath a cap.

<u>Implementability</u> – Alt. 2

The *In Situ* Cap Alternative would be technically implementable. Capping is an established, proven technology, which could be implemented on-Site, including in shallow water over soft sediments (SERVICE 2002; Appendixes D4 and GT4). Cap material is readily available in the area from commercial sand operations, the harbor's CDF (Erie Pier), or possibly delivered directly from other navigational dredging projects. Erie Pier sand and washed sand from a commercial operation (Omar Sand) were demonstrated to be suitable during bench scale cap testing (SERVICE 2002; Appendix BT). Environmental and physical monitoring of the *In Situ* cap could be accomplished using a combination of techniques, including settlement plates, bathymetric surveys, visual inspection and coring, and surface water and air samples.

The DNR has indicated approximately 52 acres of open water and wetlands mitigation may be necessary if the *In Situ* Cap Alternative is to be permittable (DNR 2003b). Finding such large mitigation opportunities may be difficult within the estuary and therefore raises uncertainty about the implementability of this alternative.

<u>Short-term Risks</u> – Alt. 2

The *In Situ* Cap Alternative is predicted to have minimal short-term risks, which could be reduced or eliminated through careful adherence to specifications requiring thin uniform lifts of appropriate capping material, which will limit mixing of contaminants and capping material to the immediate interface (SERVICE 2002; Appendixes GT4, D4). No odor or air emission risks are predicted from capping activities. On-Site workers would not be expected to be exposed to any adverse short-term chemical risks from cap installation activities.

Short term adverse effects to aquatic habitat and biota would include displacement of fish, and smothering of aquatic vegetation and benthic organisms. Aquatic vegetation and benthic organisms are expected to be re-established in several growing seasons.

<u>Total/Present Value Cost</u> – Alt. 2

Costs are detailed in Appendix A and summarized in **Table 4-2**. The *In Situ* Cap Alternative ($22.2-32.5 million) appears to be least costly, although the high end of the cost range intersects with the cost range for the hybrid alternative. The cost range reflects the uncertainty in unscoped mitigation estimates provided by the DNR.

<u>Other Considerations—Property Use</u> – Alt. 2

The *In Situ* Cap permanently modifies the current and planned riparian/property use of the Boat Slip 6, Boat Slip 7, and Stryker Bay.

<u>4.2.3 Alternative 3 – Dredge/Cap Hybrid</u>

This remedial alternative would consist of a combination of dredging, capping, and on-Site containment. The components of Alternative 3 are described in greater detail in Section 3.3.3 and shown in **Figure 3-9**.

<u>4.2.3.1 Threshold Criteria</u> – Alt. 3

The Dredge/Cap Hybrid Alternative is predicted to be protective of human health and the environment through a combination of mass removal by dredging and isolation of the contaminated sediment by capping, surcharging, and containment; which prevents exposure to organisms in the BAZ and to aquatic life and humans in the surface water and food chain.

Table 4-1 identifies the permits and ARARs introduced in Section 2.1 that are applicable to the Dredge/Cap Hybrid Alternative. The Dredge/Cap Hybrid Alternative would comply with ARARs.

4.2.3.2 Balancing Criteria – Alt. 3

Long-term Effectiveness – Alt. 3

The Dredge/Cap Hybrid Alternative is predicted to be effective in the long-term, with appropriate cap maintenance. The contaminated sediment that is removed by dredging would be consolidated and isolated in an on-site CAD, with contaminated post-dredge residue isolated by cover. Undredged contaminated sediment would be isolated by an *In Situ* cap. This alternative would provide long-term protection of the regional aquifer and surface water as discussed in Section 3.1.2. Since the site consists mostly of backwaters and slips, erosion monitoring and maintenance of the caps and covers would be expected to ensure long-term compliance. Residual contaminants remaining after dredging (SERVICE 2002; Appendix D2), would be diluted and isolated by a post-dredging cover to protect the BAZ and water quality. The bulk of the dredged contaminants would be isolated in the CAD. Additional remedial measures are unlikely, but would involve repair of cap erosion as part of a routine monitoring and maintenance program. The residual risk is predicted to meet RAOs and Cleanup Levels.

This Alternative would not reduce the toxicity, mobility or volume of contaminants through treatment other than the passive treatment that occurs during consolidation beneath the caps and surcharge, and in the CAD.

Implementability – Alt. 3

The Dredge/Cap Hybrid Alternative would be technically implementable. Environmental dredging is an established, proven technology, which can be implemented on-Site as described in the DGR (SERVICE 2002; Appendixes D1, D3). *In Situ* capping, CADs, and post-dredge cover are proven technologies, which can be implemented on-Site (SERVICE 2002; Appendixes GT-4 and D-4). Equipment and contractors are available to perform these activities. Environmental and physical monitoring of the caps and CAD installed for this remedy could be accomplished using a combination of techniques, including settlement plates, bathymetric surveys, visual inspection and coring, and surface water and air samples.

It would be administratively implementable and permittable by the DNR. Depending on design-level analyses of post-remediation configurations in the existing wetlands of Slip 7 and Stryker Bay, DNR estimates approximately 13 acres of wetlands mitigation may be required (DNR 2003b).

<u>Short-term Risks</u> – Alt. 3

The potential for short-term air quality risks associated with the Dredge/Cap Hybrid Alternative are predicted to be reduced because areas of high naphthalene concentrations would be capped rather than dredged, and because dredge material would be deposited approximately 3,000 feet from the potentially affected residents. Dredging of contaminated sediment outside the high naphthalene concentration areas is not anticipated to result in exceedances of the acute or chronic HBVs established by the MDH. Air monitoring will be conducted during all in-water construction activities and dredge water treatment until the MPCA allows termination of testing based on the monitoring results. On-Site workers would be required to wear appropriate personal protection equipment (PPE), including air-purifying respirators when so specified in the safety program.

Short term adverse effects to aquatic habitat and biota would include displacement of fish, and smothering of aquatic vegetation and benthic organisms. Aquatic vegetation and benthic organisms are expected to re-establish in several growing seasons. The adverse effects of dredging include displacement of fish and removal of aquatic vegetation and benthic organisms and negative impacts to the water column due to increased turbidity from suspended solids, and temporary release of higher levels of contaminants and nutrients. Aquatic vegetation and benthic organisms are expected to be re-established within several growing seasons. No significant adverse short-term risks to aquatic habitat and biota outside of the treatment/work zone are anticipated.

Total/Present Value Cost – Alt. 3

Costs are detailed in Appendix A and summarized in **Table 4-2**. The Dredge/Cap Hybrid Alternative is anticipated to cost approximately $31.9-33.5 million with the range reflecting only uncertainty for the DNR provided estimates for additional mitigation. These estimated costs could increase due to delays, changes to operations, or temporary relocations associated with possible air impacts. These potential air-related costs area not included in the estimate because they are unlikely.

Other Considerations—Property Use – Alt. 3

The Dredge/Cap Hybrid permanently modifies the current and planned riparian/property use of Boat Slip 7 and modifies the current and planned riparian/property use of Stryker Bay for about three years while it is dredged and consolidation occurs in the surcharged areas.

4.2.4 Alternative 4 – Dredge/Off-Site Disposal

This remedial action would consist of dredging, on-site dewatering and off-site disposal of contaminated sediment. The components of Alternative 4 are described in greater detail in Section 3.3.4 and shown in **Figure 3-11**.

4.2.4.1 Threshold Criteria – Alt. 4

Based on air emission modeling, the Dredge/Off-Site Disposal Alternative may produce temporary emissions above the HBVs during dredging of sediments in the areas of highest naphthalene concentrations. Although there is a large degree of uncertainty in the modeling, during active dredging of the areas of highest naphthalene concentrations, air concentrations of naphthalene may exceed HBVs in the area of homes west of Stryker Bay as well as north of the railroad tracks, which may result in temporary relocation of some residents and businesses.

With provision for air monitoring and for temporarily relocating residents and businesses, this alternative could be protective against long-term unacceptable risks through mass removal of the contaminated sediment to an approved off-site disposal facility, and isolation of contaminated post-dredge residue. Due to the dredging of areas of highest naphthalene concentrations, some residue may be of higher concentration in this alternative compared to the Dredge/Cap Hybrid

Alternative. The contaminated sediment may not be accessible to human contact below a post-dredge cover or within a permitted landfill.

Table 4-1 identifies the permits and ARARs introduced in Section 2.1 that are applicable to this alternative. The Dredge/Off-Site Disposal Alternative would comply with permits and ARARs.

4.2.4.2 Balancing Criteria – Alt. 4

Long-term Effectiveness – Alt. 4

The Dredge/Off-Site Disposal Alternative would be effective in the long-term, with appropriate maintenance of the post-dredging cover and use of a properly permitted and operated landfill. Long-term effectiveness and permanence on site is attained by mass removal and off-site disposal of contaminated sediment in a permitted landfill. Where residual contaminants remain, potential receptors would be protected by immobilization, dilution, and isolation with a post-dredging cover. Because most of the mass of PAHs would be removed, the MPCA has concluded that a long-term monitoring and maintenance program for dredged areas would not be required. Residual risk is predicted to meet RAOs and cleanup levels.

This alternative would reduce the volume of contaminants through active dewatering prior to off-site disposal.

Implementability – Alt. 4

The Dredge/Off-Site Alternative would be technically implementable. Environmental dredging is an established, proven technology, which can be implemented on-Site as described in the DGR (SERVICE 2002; Appendixes D1, D3). *In Situ* capping, CADs, and post-dredge cover are proven technologies, which can be implemented on-Site (SERVICE 2002; Appendixes GT-4 and D-4). Although there is a high level of uncertainty in the models, air emission modeling suggests naphthalene emission during dredging and containment of sediments from the areas of highest naphthalene concentration may result in air concentrations of naphthalene above the HBV near some area residences and businesses, which may require temporary relocation. The frequency and scale of this potential relocation is unknown and may affect its implementability. Best management practices such as floating covers and sequenced dredging would be used to the extent possible to reduce the potential emissions of naphthalene and the need for relocation.

Dredging equipment and contractors are available to perform the dredging required for this alternative. Monitoring of bathymetric surveys, visual inspections, and surface water smples during implementation of the remedy would be implementable. Real-time air monitoring for naphthalene has not been demonstrated at the levels and for the periods specified by the HBVs, but methods with a 4- or 8-hour turn-around-time are feasible.

Since all areas would be dredged and only Stryker Bay has been screened for removal of all debris prior to dredging is a concern. Debris could interfere with the productivity of the dredging operation.

The DNR indicates that because Stryker Bay and the slips would be as deep or deeper than they are today, no further Public Waters mitigation would be required (DNR 2003b). Administrative implementablity also hinges on the expected air emissions. The mechanism and decision-making process for the MPCA to temporarily relocate residents and businesses has not yet been defined, so its administrative implementability cannot be examined at this time.

<u>Short-term Risks</u> – Alt. 4

Based on air emission modeling, the Dredge/Off-Site Disposal Alternative may produce temporary emissions above the HBVs during dredging and containment of sediments, most likely when dredging in the areas of highest naphthalene concentrations. Although there is a large degree of uncertainty in the modeling, during active dredging of the areas of highest naphthalene concentrations, air concentrations of naphthalene may exceed HBVs in the area of homes west of Stryker Bay as well as north of the railroad tracks, which may result in temporary relocation of some residents and businesses. Air monitoring will be conducted during all in-water construction activities and dewatering. On-site workers would be required to wear appropriate PPE, including air-purifying respirators when so specified in the safety program.

Modeling indicates dredging of the areas of highest PAH concentrations may also cause temporary surface water quality impacts above chronic standards, but not above FAVs at the designated discharge point of compliance. Treatment/work areas would be contained with engineering control structures. Adverse effects to aquatic habitat and biota in the treatment/work zones would be temporary. The adverse effects of dredging include displacement and injury of fish, removal of aquatic vegetation and benthic organisms, negative impacts to the water column due to increased turbidity by suspended solids, and increased release of contaminants and nutrients. All of these effects would be temporary if a post-dredging cover is placed on dredge residue as described above. No significant adverse short-term risks to aquatic habitat and biota outside of the treatment/work zone are anticipated.

Total/Present Value Cost – Alt. 4

Costs are detailed in Appendix A and summarized in **Table 4-2**. The most costly of the alternatives is the Dredge/Off-Site Disposal Alternative at $93.9 million. These estimated costs could increase substantially due to delays, changes to operations, or temporary relocations associated with potential air impacts beyond the mitigating measures such as a cover on the CAD that are included with the estimate. These potential additional costs area not included in the estimate because they are unquantifiable.

Other Considerations – Property Use – Alt. 4

The Dredge/Off-Site Disposal does not permanently modify planned riparian/property use. However, it would temporarily modify current use for approximately three years during remedy implementation.

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative (summarized in **Table 5-1**). The community acceptance of each alternative will be evaluated and compared by the MPCA after public comments on its Proposed Plan are received.

Only those alternatives that passed the Threshold Criteria of providing overall protection for the public health and welfare and the environment and meeting ARARs were retained for the comparative analysis. The No Action Alternative was not retained because it would not achieve the Threshold Criteria. The *In Situ* Cap Alternative may not meet the threshold criterion because of issues with DNR permits but was carried forward while recognizing the uncertainties. The Dredge/Off Site Disposal Alternatives (assuming relocation is implementable and effective) and Dredge/Cap Hybrid Alternative achieve the Threshold Criteria.

Pursuant to the February 22, 2000, Agreement between the MPCA and the Companies, no recommendations are made on behalf of the Companies in this document.

5.1 Long-Term Effectiveness

Each of the alternatives being evaluated for balancing criteria would be an effective long-term remedy. Caps installed for Alternatives 2 and 3 would be designed to reliably isolate contaminants from potential receptors. The MPCA has indicated a post-dredge cover proposed under Alternatives 3 and 4 would provide protection from potential receptors where contaminated residue remains. The long-term effectiveness of a constructed on-Site CAD or *in situ* cap with appropriate maintenance would be similar to the effectiveness of contaminated sediment placed in an off-site landfill.

None of the alternatives would substantially reduce the toxicity, mobility or volume of contaminants through treatment. Except for the No Action Alternative, each would dewater sediments, reducing their volume. Alternative 2 and 3 would reduce the mobility of the contaminated sediments through capping or placing them into a CAD. Off-site disposal would reduce the volume of contaminants in the aquatic environment by placing them in an off-site upland disposal facility.

Additional remedial measures are unlikely for each of the alternatives and, if required, could be incorporated in the monitoring and maintenance plans or developed in the 5-year review.

5.2 Implementability

Dredging, capping, and containment as well as the monitoring described in this FS under Alternatives 2, 3, and 4, are proven technologies, which could be readily implemented at the Site. While there is large uncertainty in the air modeling, the predicted air impacts for Alternative 4 exceed RAOs that may require shutdowns, delays, changes or temporary relocation of residents and businesses. The effectiveness and administrative implementability of efforts to voluntarily relocate are unknown.

The DNR has provided the following estimates for additional compensatory public waters mitigation under each alternative subject to refinement during design:

Alternative	Estimated Public Waters Mitigation (Acres)
Alternative 1: No Further Action	Not Evaluated
Alternative 2: *In Situ* Cap	52
Alternative 3: Dredge/Cap Hybrid	13
Alternative 4: Dredge/Off-Site Disposal	0

The DNR has indicated that finding such large mitigation opportunities for the *In Situ* Cap Alternative would be difficult within the estuary and therefore Alternative 2 would not likely be administratively implementable.

5.3 Short-term Risks

All alternatives would have short-term risks of adverse effects to benthic and aquatic communities living in the sediment being remediated. Adverse effects to aquatic habitat and biota would be similar among the alternatives being compared, and would include displacement of fish, and smothering or destruction of aquatic vegetation and benthic organisms. Aquatic vegetation and benthic organisms are expected to be re-established within several growing seasons. The *In Situ* Cap and Dredge/Cap Hybrid Alternatives are not predicted to have other significant short-term risks. The Dredge/Off-Site Disposal Alternative is more likely to have short-term risks associated with air impacts based on modeling results.

5.4 Total/Present Value Cost

The estimated costs for each alternative (**Table 4.2**, and detailed in Appendix A) were calculated using the same costing method, hourly production rates, efficiencies, labor rates and fixed costs as the cost estimates in the DGR (SERVICE 2002, Appendix C1). Costs include both indirect and direct capital costs, and the present value of monitoring and maintenance costs. Necessary property acquisition and public waters mitigation costs are also included. Natural resource damages, which may be recoverable by natural resource trustees, are not included.

Of the evaluated alternatives;

- The *In Situ* Cap Alternative ($22.2-32.5 million could be the least costly, but has high cost uncertainty and the high end of the cost range intersects with the cost range for the hybrid alternative.
- The Dredge/Cap Hybrid Alternative is anticipated to cost approximately $31.9 – 33.5 million with low potential for higher costs due to air emissions, and
- The most costly is the Dredge/Off-Site Disposal Alternative, which is anticipated to cost approximately $93.9 million and represent the highest potential for additional costs if the ambient air quality PRGs are exceeded. In such case, costs would be higher due to delays, changes and temporary relocations of residents and businesses.

5.5 Other Considerations—Property Use

The *In Situ* Cap permanently modifies the current and planned riparian/property use of the Boat Sip 6, Boat Slip 7, and Stryker Bay.

The Dredge/Cap Hybrid permanently modifies the current and planned riparian/property use of Boat Slip 7 and modifies the current and planned riparian/property use of Stryker Bay for about three years while it is dredged and consolidation occurs in the surcharged areas.

The Dredge/Off-Site Disposal does not permanently modify current and planned riparian/property use. However, it would temporarily modify current use for a total of approximately 3 years during remedy implementation.

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Table 1-1
Dredge and Cap Volumes
SLRIDT Site 14 ppm TPAH Goal
In Situ Cubic Yards

	Area		Dredge* Volume	Cover/Env. Media Volume	Cap Volume	Armor Volume	Surcharge Volume
Location	sq ft	Acres	cy	cy	cy	cy	cy
***In Situ* Cap**							
Slip 6 Berth and transition zones	320,170	7.4		See cap & armor	17,787	11,858	
Slip 6 West Bank (MN)	12,704	0.3		See cap & armor	706	471	
Slip 6 Shallows	256,028	5.9		4,741	33,189	-	
Slip 6 West Bank (WI)	28,640	0.7	2,121	No cover or armor in WI	-	-	
Slip 6 Total	**617,542**	**14**	**2,121**	**4,741**	**51,682**	**12,329**	
Slip 7 Berth armoring area	300,395	6.9		See cap & armor	16,689	11,126	
Slip 7 cobbles	128,228	2.9		See cap & armor	7,124	4,749	
Slip 7 Shallows	706,369	16.2		13,081	65,405	-	
Slip 7 WI Cobbles	21,398	0.5		See cap & armor	1,189	793	
48 inch outfall Federal Channel (WI)	20,239	0.5	1,499	No cover or armor in WI	-	-	
48 inch outfall Federal Channel (Assumed Cap)	45,134	1.0		See cap & armor	2,507	1,672	
Slip 7 Total and Channel	**1,221,763**	**28**	**1,499**	**13,081**	**92,913**	**18,339**	
Total Slips and Channel	**1,839,305**	**42**	**3,621**	**17,822**	**144,595**	**30,668**	
Stryker Bay	1,705,880	39.2		29,694	157,952	3,793	
Northern Wetland	41,385	1.0		766	3,832	-	
Stryker Bay Mouth (may not be required)	97,260	2.2		1,801	5,403	3,602	
Total Stryker Bay	**1,844,525**	**42**	**-**	**32,261**	**167,187**	**7,395**	
Total Site	**3,683,830**	**85**	**3,621**	**50,084**	**311,782**	**38,063**	

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Table 1-1
Dredge and Cap Volumes
SLRIDT Site 14 ppm TPAH Goal
In Situ Cubic Yards

	Area		Dredge* Volume	Cover/Env. Media Volume	Cap Volume	Armor Volume	Surcharge Volume
Location	sq ft	Acres	cy	cy	cy	cy	cy
Dredge/Cap Hybrid							
Slip 6 Berth @ 1930 ft & 25 ft deep armored	211,560	4.9	40,444	See cap & armor	7,836	7,836	
Slip 6 Transition armored	161,324	3.7		See cap & armor	8,962	5,975	
Slip 6 Shallows	271,552	6.2		5,029	35,201	-	
Slip 6 SW beyond dock (MN)	12,815	0.3		See cap & armor	712	475	
Slip 6 SW beyond dock (WI)	21,717	0.5	1,609	No cover or armor in WI	-	-	
Slip 6 Total	**678,968**	**16**	**42,053**	**5,029**	**52,711**	**14,285**	
Slip 7 Deep area to CAD	143,217	3.3		-	10,609	2,652	
Slip 7 CAD	277,655	6.4			51,418	See below	
Slip 7 Shallows unarmored	599,226	13.8		11,096.78	55,484	-	
Armored Areas (MN)	192,045	4.4		See cap & armor	14,226	3,556	
Armored Areas (WI)	41,637	1.0	3,084	No cover or armor in WI	-	-	
Slip 7 Total and Channel	**1,253,780**	**29**	**3,084**	**11,097**	**131,736**	**6,209**	
Total Slips and Channel	**1,932,748**	**44**	**45,137**	**16,126**	**184,447**	**20,494**	
Stryker Bay Entrance	102,410	2.4	10,241	See cap & armor	5,689	3,793	
Sand Zone	281,544	6.5	30,240	29,197			
South Clay Zone	403,749	9.3	43,366	43,366			
North Clay Zone	397,638	9.1	42,709	42,709			
Peaty Area (former wetlands)	206,891	4.7		7,663	-		22,988
Northern Wetland (Assumed Dredged)	41,385	1.0	3,066	1,533			
Hot Spots Volumes SW (In South Clay Zone)		0.0					
Hot Spots Volumes NE	277,881	6.4		5,146	25,730		51,459
Stryker Bay Mouth (may not be required)	97,260	2.2	3,602	1,801	5,403	-	
Total Stryker Bay	**1,808,758**	**42**	**133,224**	**131,415**	**36,823**	**3,793**	**74,447**
Total Site	**3,741,506**	**86**	**178,361**	**147,540**	**221,269**	**24,287**	**74,447**

Table 1-1
Dredge and Cap Volumes
SLRIDT Site 14 ppm TPAH Goal
In Situ Cubic Yards

	Area		Dredge* Volume	Cover/Env. Media Volume	Cap Volume	Armor Volume	Surcharge Volume
Location	sq ft	Acres	cy	cy	cy	cy	cy
Dredge/Off-Site Disposal							
Slip 6 Berth and transition zones	320,170	7.4		See cap & armor	11,858	11,858	
Slip 6 West Bank (MN)	12,704	0.3		See cap & armor	706	471	
Slip 6 Shallows	256,028	5.9		23,706	-	-	
Slip 6 West Bank (WI)	28,640	0.7		No cover or armor in WI	-	-	
Slilp 6 Total	**617,542**	**14**	**100,000**	**23,706**	**12,564**	**12,329**	
Slip 7 Berth armoring area	300,395	6.9		See cap & armor	11,126	11,126	
Slip 7 cobbles	128,228	2.9		See cap & armor	7,124	4,749	
Slip 7 Shallows	706,369	16.2		52,324	-	-	
WI Cobbles	21,398	0.5		No cover or armor in WI	-	-	
48 inch outfall Federal Channel	65,373	1.5		See cap & armor	2,421	2,421	
Slip 7 Total and Channel	**1,221,763**	**28**	**190,500**	**52,324**	**20,671**	**18,296**	
Total Slips and Channel	**1,839,305**	**42**	**290,500**	**76,030**	**33,235**	**30,625**	
Stryker Bay Entrance	102,410	2.4	10,241	1,341	3,793	3,793	
Sand Zone	281,544	6.5	30,240	29,197		-	
South Clay Zone	403,749	9.3	43,366	43,366		-	
North Clay Zone	397,638	9.1	42,709	42,709		-	
Peaty Area (former wetlands)	206,891	4.7	24,520	24,520		-	
Northern Wetland (Assumed Dredged)	41,385	1.0	3,066	1,533		-	
Hot Spots Volumes SW (In South Clay Zone)							
Hot Spots Volumes NE	277,881	6.4	46,314	46,314		-	
Stryker Bay Mouth (may not be required)	97,260	2.2	3,602	1,801	5,403	-	
Total Stryker Bay	**1,808,758**	**42**	**204,058**	**190,781**	**9,196**	**3,793**	
Total Site	**3,648,063**	**84**	**494,558**	**266,811**	**42,431**	**34,418**	

Navigation depths are from LWD at 601.0 NGVD or 600 ILDW

* Dredge volumes are subject to change in design and will then be based on the dredge prisms

Table 2-1
Pretreatment Standards for Discharge to Sewer
Western Lake Superior Sanitary District, Duluth, MN

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Pollutant	Units	Limitation
Copper	ug/L	260
Zinc	ug/L	1600
Nickel	ug/L	1500
Cadmium	ug/L	30
Chromium	ug/L	1000
Lead	ug/L	220
Mercury	ug/L	0.3
Mineral Oil	mg/L	100
pH	Std Units	>5.5
PAHs	mg/L	*

*PAHs are on the Toxic Pollutant List in the Industrial Pretreatment Ordinance and standards will be determined based on the treatment processes interference or toxic effect in their disharge. Previous limits from this site were set at 1 mg/l for each PAH and 3 mg/L for total PAHs for those PAHs listed in the Ordinance. Standards have not yet been set for this project by the WLSSD.

Table 2-2
Minnesota Noise Standards

Noise Area Classification	Daytime		Nighttime	
	L_{50}	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

1. Includes homes
2. Includes most businesses
3. Includes railroad tracks and maritime shipping

For details on Noise Area Classification, see Minn. Rule ch. 7030.0050
"L_{10}" means the sound level, expressed in dB(A), which is exceeded ten percent of the time for a one hour survey, as measured by test procedures approved by the commissioner.
"L_{50}" means the sound level, expressed in dB(A), which is exceeded 50 percent of the time for a one hour survey, as measured by test procedures approved by the commissioner.
"Daytime" means those hours from 7:00 a.m. to 10:00 p.m.
"Nighttime" means those hours from 10:00 p.m. to 7:00 a.m.

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Table 4-1
Summary of Compliance with Permits and ARARs

ARAR	*In Situ* Cap	Dredge/Cap Hybrid	Dredge/Off-Site Disposal
Section 404 Permit **COE** Required to place material in waters of the US	A permit was obtained in 1996 for an IRA that involved dredging in Slip 6. It is likely that each alternative could comply with the requirements of this COE permit. The applicability of possible exemptions for such permit is under consideration at the St. Paul District COE. Mitigation requirements of the COE are unknown for all alternatives. They may or may not be similar to those of the Public Water Permit.		
Section 10 Permit **COE** Required for activities that will alter waters of the US	Each alternative would require such a permit and would likely meet its requirements.		
Public Waters Permit **DNR** Permit to work the beds of public waters	This alternative may not be permittable, or the DNR estimates it may require ~53 acres of off-site Public Waters mitigation due to effects of reduced water depth, on preferred habitat and recreational navigation	This alternative is likely permittable. It contains mitigation features requested by the DNR. Depending on design analyses, the DNR estimates an additional ~13 acres of mitigation may be required.	This alternative is likely permittable and is likely self-mitigating due to the depths of water achieved by dredging the shallow areas and slips.
Pretreatment/ Disposal Permit **WLSSD** To receive dredge water for treatment	Not Applicable because no dredge water will be generated.	PAH standard unknown. If the same as used in 1996 IRA, should meet standards with flocculation and sand filtration	
Wetlands Permit **City of Duluth** Wetlands above the Ordinary High Water Mark	The City has indicated it is likely to delegate its jurisdiction over WCA wetlands to the DNR, folding their approval into the Public Waters Permit.		
Shoreland Management Permit **City of Duluth** Regulates activities near the shore.	Greatest amount of shoreline activity associated with this alternative since caps integrate into the existing shoreline throughout most of the site. Authority might cede to MPCA if greater than 1 acre.	Some shoreline activity associated with this alternative where caps integrate into the existing shoreline. Authority might cede to MPCA if greater than 1 acre.	Limited or no on-shore activity when dredging up to shore. Permit may not be required with this alternative.

Table 4-1
Summary of Compliance with Permits and ARARs

ARAR	*In Situ* Cap	Dredge/Cap Hybrid	Dredge/Off-Site Disposal
Section 401 Certification **MPCA** Certifies the 404 Permit	If the COE requests certification from the MPCA, it will be provided along with the MPCA's overall design approval.		
NPDES Permit **MPCA** Permits discharges to Public Waters	Discharges from treatment/work zones and stormwater runoff can meet permit requirements.	Discharges from treatment/work zones, stormwater runoff, and treated dredge water can meet permit requirements, but may require an exemption or variance for mercury.	
State Disposal System Permit **MPCA** For disposal of dredged material.	Not applicable. No on-site disposal.	Applies to disposal in on-site CAD. Dike and sheet pile containment and placement of clean capping and cover materials are expected to meet SDS permit requirements.	Not applicable since disposal would be off-site in a permitted solid waste facility.
Groundwater Quality Standards **MPCA** Drinking water standards from groundwater	Not applicable. Groundwater standards apply to drinking water. Wells cannot be developed in the uppermost aquifer. The deeper aquifer has not and will not be affected due to separation by a continuous thick confining layer.		
Chronic Surface Water Quality Standards/Criteria **MPCA** Post-remediation standards for the St. Louis River.	Since the St. Louis River is not currently in compliance with the mercury standard, it is not likely to be in compliance after remediation. Modeling shows that capped sediments, covered dredge residue, and a CAD do not cause an exceedance of mercury standards and that any of these remedies would result in long-term compliance with chronic SWQS/Cs.		
Ambient Air and Airborne Particulate Matter Standards **MPCA**	Standards for particulate emissions apply, but the wet nature of dredging and capping are not likely to cause a problem.		
Noise Control **MPCA**	Each alternative is expected to meet noise requirements for dredging and/or capping 24 hours per day, 5 days per week, by use of mufflers on heavy equipment.		

Table 4-1
Summary of Compliance with Permits and ARARs

ARAR	*In Situ* Cap	Dredge/Cap Hybrid	Dredge/Off-Site Disposal
Waste Management **MPCA**	There is no waste disposal with this alternative since the contaminated sediment remains in place.	Dredged sediment will likely be a solid waste, disposed in an on-site permitted (SDS via the ROD) waste facility.	Dredged sediment will likely be a solid waste, disposed in an off-site permitted solid waste facility. If future testing shows toxic characteristics, disposal would be in a permitted hazardous waste facility.
Well Construction, Maintenance, and Closure **MDH**	Under each alternative, all on-site monitoring wells will be sealed in accordance with these requirements.		
Construction and Use of Public Sewers **MDH**	No sewers needed.	Based on discussions with the City and WLSSD, permits for routing pre-treated dredge water to WLSSD via force mains and lift stations are feasible.	
Rare and Endangered Species	No rare or endangered species have been observed on Site and are not likely to be affected by any alternative.		

Table 4-2
Alternatives Cost Summary

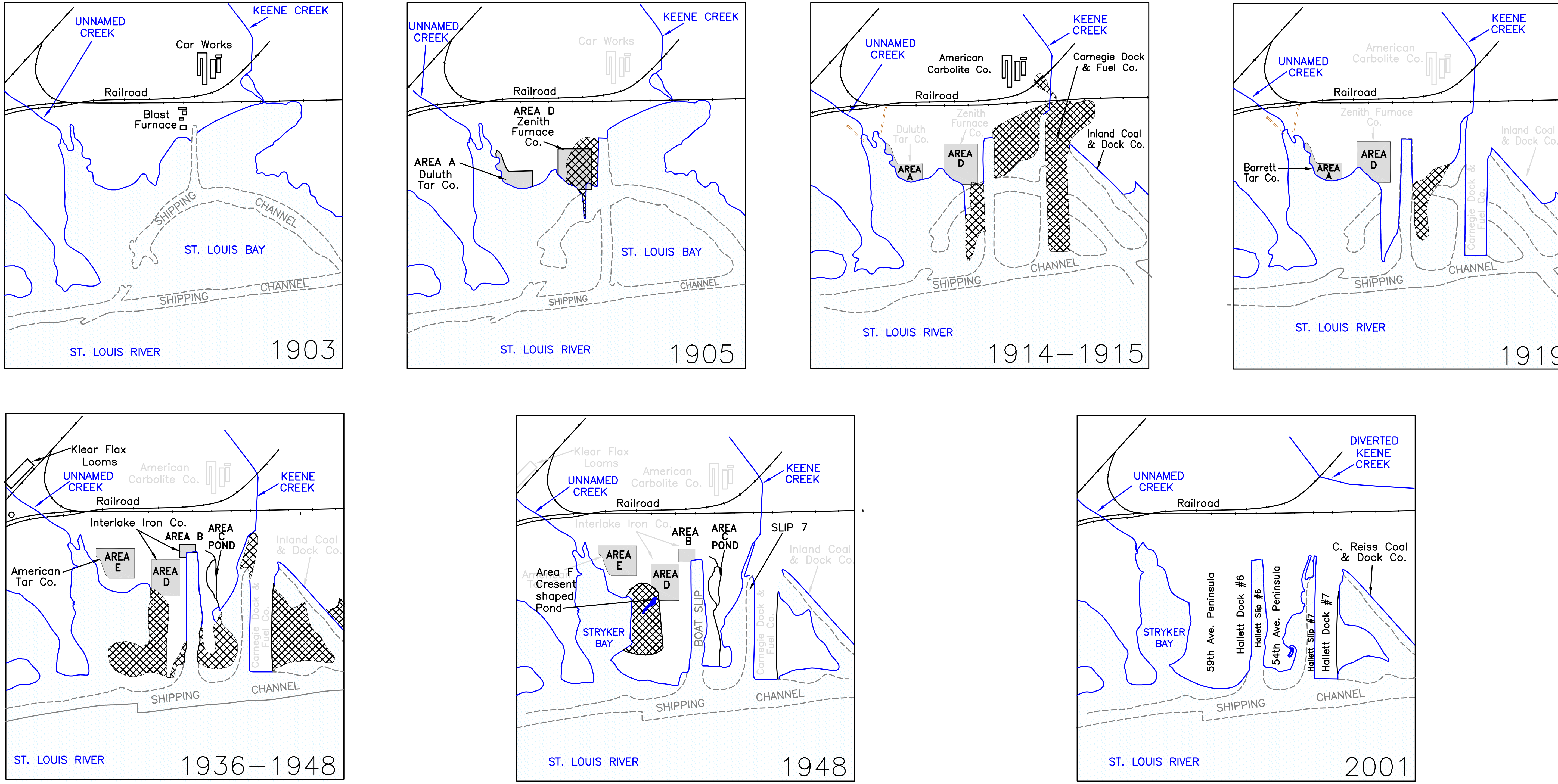
	In-Situ Cap	Dredge/Cap Hybrid	Dredge/Off-Site Disposal
MISCELLANEOUS	$1,117,894	$1,316,444	$2,381,318
DREDGING	$83,275	$4,510,604	$12,085,079
CONTAINMENT	$509,200	$1,917,037	$636,600
DISPOSAL	$0	$0	$17,559,997
TREATMENT	$17,190	$2,234,690	$18,031,720
CAPPING	$7,771,808	$7,453,678	$6,333,577
WETLAND CONSTRUCTION	$437,457	$403,842	$925,307
CONTINGENCY (30%)	$2,981,047	$5,350,889	$17,386,079
TOTAL CONTRACTOR COST	$12,917,872	$23,187,184	$75,339,678
PROPERTY ACQUISITION	$2,495,000	$2,428,619	$1,400,000
PERMITTING and EAW	$250,000	$250,000	$250,000
DESIGN & OVERSIGHT (22%)	$2,841,932	$5,101,180	$16,574,729
TOTAL CAPITAL COST	$18,504,804	$30,966,983	$93,564,407
LONG TERM MONITORING & MAINTENACE (Present Value)	$755,436	$936,871	$328,992
TOTAL REMEDIATION COST (In Millions)	**$19.3**	**$31.9**	**$93.9**
PUBLIC WATERS MITIGATION RANGE	$2,964,690-$13,287,600	$39,690-$1,587,600	$0
TOTAL PROJECT COST (Millions)	**$22.2-32.5**	**$31.9-33.5**	**$93.9**

Table 5-1
Evaluation Criteria by Alternative
SLRIDT Site

	1. No Action	2. *In Situ* Cap	3. Dredge/Cap Hybrid	4. Dredge/Off-Site Disposal
Threshold Criteria				
Property Use[i]	The uses of the aquatic areas of the site are recreation, shipping and aquatic habitat. The preliminary remedial goals were set for protection of aquatic organisms as the most sensitive of those uses.			
Permanence[ii]	None of the alternatives are permanent as defined in the Request for Response Action. Like those that are permanent, alternatives failing to meet the definition of permanent may continue to be evaluated if they meet the threshold criteria.			
Protect Human Health and the Environment by achieving Preliminary Remedial Goal (PRGs)	Not protective of human health or aquatic environment	Protective of human health and aquatic environment because it reduces or eliminates exposure pathways of concern.	Protective of human health and aquatic environment because it reduces or eliminates exposure pathways of concern.	Protective of human health and aquatic environment because it reduces or eliminates exposure pathways of concern. Human health would be protected from potential health effects from air emissions by temporary relocations.
Comply with Permits and ARARs		May have difficulty meeting DNR permit requirements largely because it will result in shallower post-remediation aquatic areas.	Complies with ARARs. May need a variance or exemption for mercury.	Complies with ARARs. May need a variance or exemption for mercury.
Balancing Criteria				
Long-term Effectiveness		Effective with maintenance. Isolated contaminants remain. Residual risk meets RAOs and cleanup levels with cap.	Effective with maintenance. Isolated contaminants and/or residue remain. Residual risk meets RAOs and cleanup levels with caps and post-dredging cover.	Effective with maintenance. Isolated residue remains. Residual risk meets RAOs and cleanup levels with post-dredging cover.
Reduction of toxicity, mobility, or volume, through treatment.		Does not reduce the toxicity, mobility through treatment because it does not treat impacted media. Passive dewatering reduces volume.	Does not reduce the toxicity, mobility through treatment because it does not treat impacted media. Passive dewatering reduces volume. Dredged material in disposal cell has less area exposed.	Does not reduce the toxicity, mobility through treatment. Active dewatering reduces volume. Dredged material in disposal cell has less area exposed.
Implementability		Technically Implementable. May not be administratively implementable if not permittable.	Implementable.	Dredging and dewatering is technically implementable. There are no demonstrated means of controlling dredging emissions. Control of those emissions could be required. Relocation is administratively implementable, but without precedent in Minnesota.
Short-term Risks		Short term risks include adverse effects to the benthic and aquatic community. Short-term risks to humans would be minimal. Potential ambient air impacts to residents and employees of businesses are unlikely. Air monitoring would help protect human health. Temporary surface water quality impacts would not likely exceed chronic levels.	Short term risks include adverse effects to the benthic and aquatic community. Short-term risks to humans would be minimal. Potential ambient air impacts to residents and employees of businesses are unlikely, but possible. Air monitoring would help to protect human health and temporary relocations may be necessary. Temporary surface water quality impacts may exceed chronic but not acute levels. Mercury variance or exemption may be required for dredge water discharge.	Short term risks include adverse effects to the benthic and aquatic community. Potential ambient air impacts to residents and employees of businesses are uncertain, but potentially large. Air monitoring is necessary to protect human health and temporary relocations may be required. If used for sediment transportation truck traffic would be increased to haul to landfill. Surface water quality impacts may exceed chronic but not acute levels. Mercury variance or exemption may be required for dredge water discharge.
Total Cost		$22.2-32.5 Million	$31.9-33.5 Million. Costs could increase due to delays, changes to operations, or temporary relocations associated with possible air impacts. These potential costs area not included in the estimate because they are unlikely.	$93.9 Million. Costs could increase substantially due to delays, changes to operations, or temporary relocations associated with potential air impacts. These potential costs area not included in the estimate because they are unquantifiable.
Other Considerations				
Property (Land and Water) Uses		Modifies current and planned riparian/ property use of Slip 6 and Slip 7 and Stryker Bay.	Modifies current and planned riparian/ property use of Slip 7. Temporarily modifies current and planned riparian/ property use of Stryker Bay.	Does not permanently modify planned riparian/property use. Would temporarily modify current use during remedy implementation.

i MERLA (Minn. Stat. 115B.17, Subd. 2a) requires that in determining the appropriate cleanup standards to be achieved by a response action, the MPCA must consider the planned use of the property.

ii The RFRA for this Site indicates that to be permanent a remedy must provide absolute long-term effectiveness. The MPCA considers a remedy permanent when it allows for unrestricted use of all land and natural resources impacted by the contaminants and, except for the purpose of treatment, does not involve removal of the contaminants to another site and minimizes exchange of the contaminants to other environmental media.



N

0 1200
APPROXIMATE SCALE IN FEET

EXPLANATION

SANITARY SEWER DISCHARGE LINES

SHORELINE

SHIPPING CHANNELS

NEW LAND SINCE PREVIOUS MAP

REFERENCE:

US ARMY CORPS OF ENGINEERS HARBOR MAPS 1903, 1905, 1914–15, 1919, 1936, 1948.
AERIAL PHOTO 1948.
TELECON WITH CITY OF DULUTH SEWER DEPARTMENT.

REFERENCES IT CORP 'FIGURE 1–3 HISTORICAL DEVELOPMENT OF 59TH AND 54TH AVENUE PENINSULAS' FILE NAME RFI_2–1.

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FIGURE 1–1
HISTORICAL DEVELOPMENT OF 59TH AND 54TH AVENUE PENINSULAS
SLRIDT SITE
DULUTH, MINNESOTA

FILE 99006/PHIII/HYA	DATE	REVISION DATE	DRAWN BY
FIGBHIST	4/28/97	11/19/03	KU

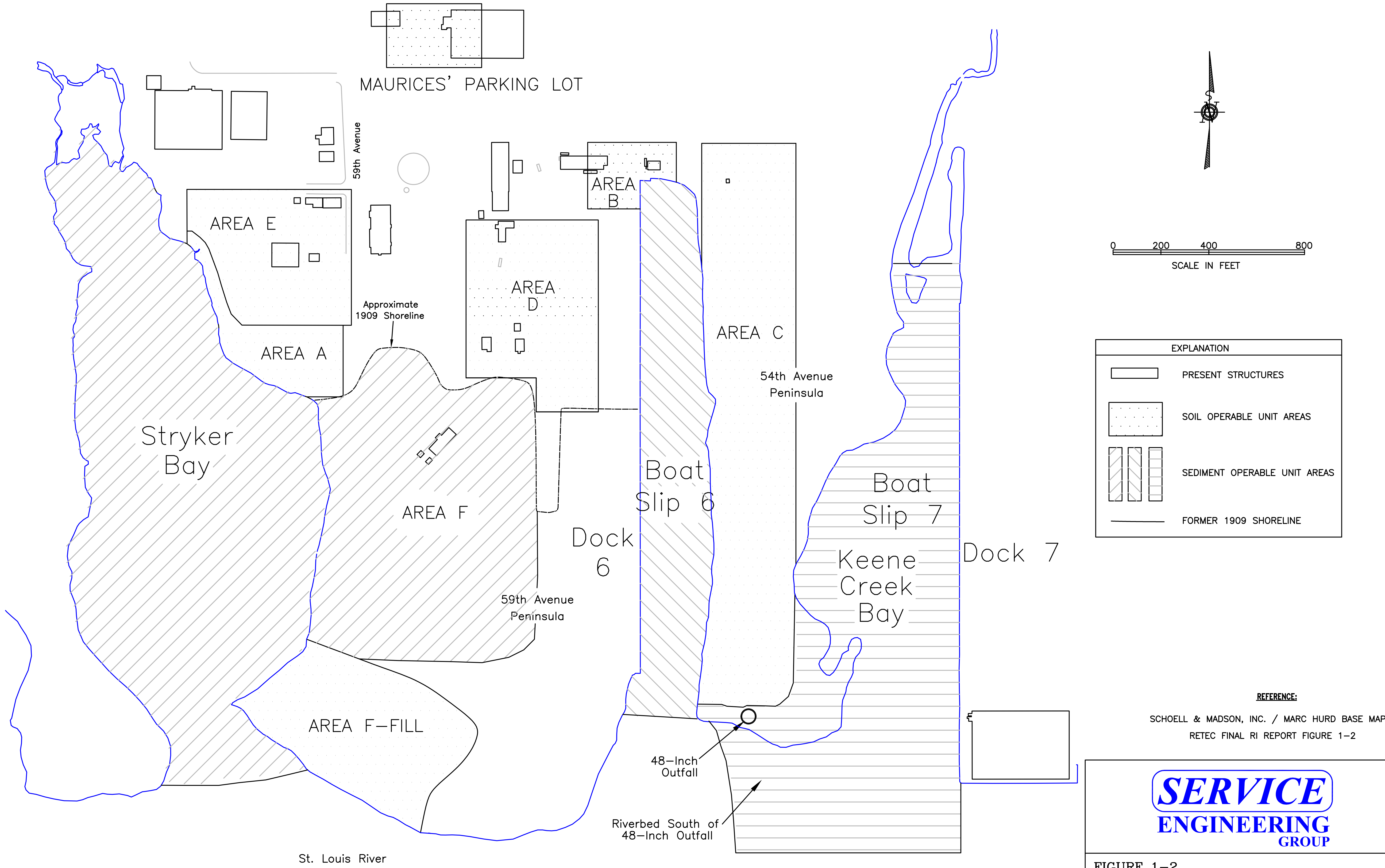

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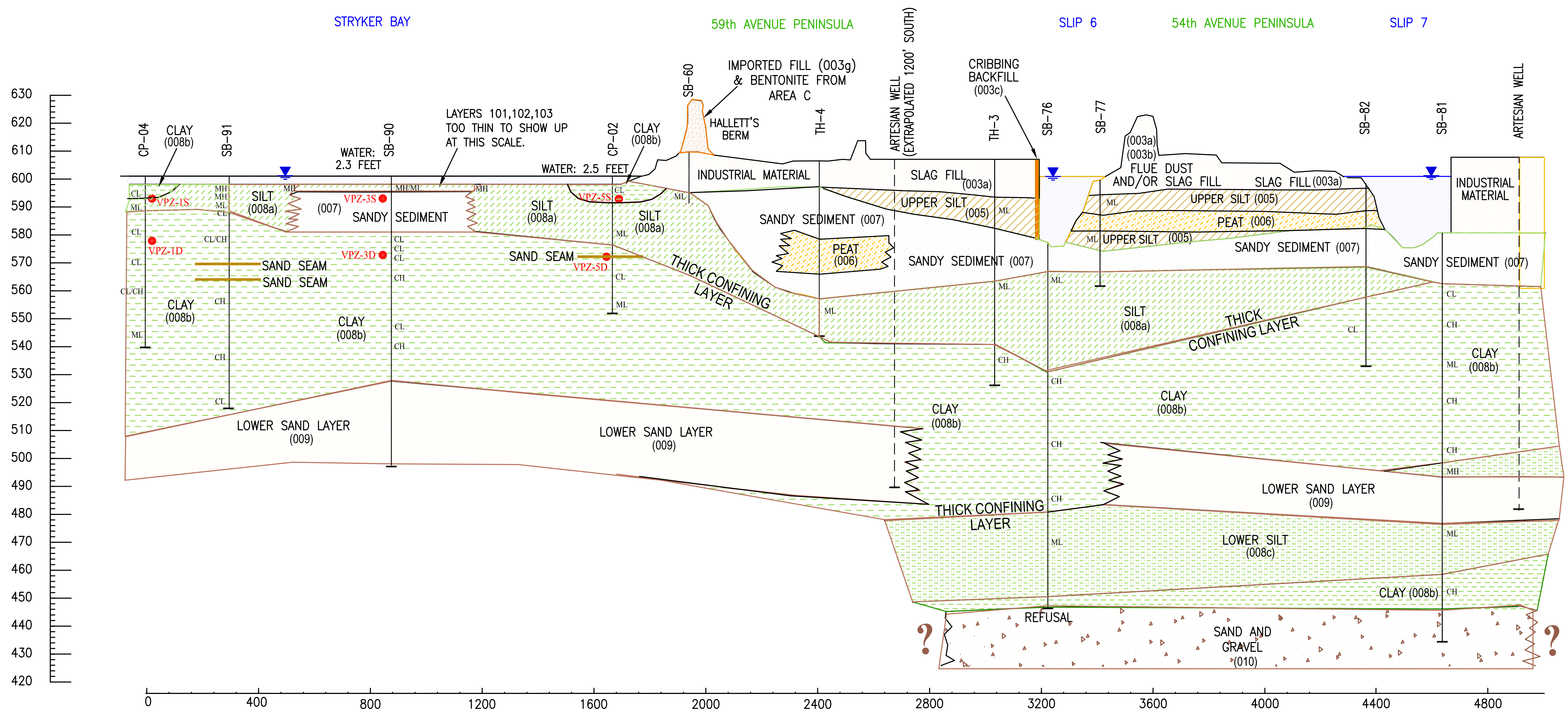
FIGURE 1–2
SITE MAP WITH AREA DESIGNATIONS
SLRIDT SITE
DULUTH, MINNESOTA

FILE NAME	DATE	REV. DATE	DRAWN BY	REVIEWED BY
Alt Exp-NEW3	10/09/02	11/03/03	KU	HH/MC

P:\1999\99006 Interlake\1-Draft\Draft FS\figures-original\Figure 1-2.DWG 11-18-03 11:57:26 AM kevinu



* APPROXIMATE LOCATION OF SITE-WIDE CROSS SECTION

LEGEND:

- INDUSTRIAL MATERIAL
- UPPER SILT (005)
- PEAT (006)
- SANDY SEDIMENT (007)
- VPZ-3D VIBRATING WIRE PIEZOMETER LOCATION
- THICK CONFINING LAYER: SILT (008a); CLAY (008b); LOWER SILT (008c)
- LOWER SAND LAYER (009)
- IMPORTED FILL LAYER (003g)
- CP-02 BORING LOCATION
- TOP OF WATER
- WATER
- SAND & GRAVEL (010)

40 FEET / 400 FEET — 10x VERTICAL EXAGGERATION

FIGURE TITLE	FIGURE 1-3 SITE-WIDE GEOLOGIC CROSS SECTION SLRIDT SITE DULUTH, MINNESOTA				SERVICE ENGINEERING GROUP
FILE NAME 99006/draft1/Draft FS FIGURE 1-3.dwg	DATE 11/21/00	REVISION DATE 11/06/03	DRAWN BY KU	REVIEWED BY MC	

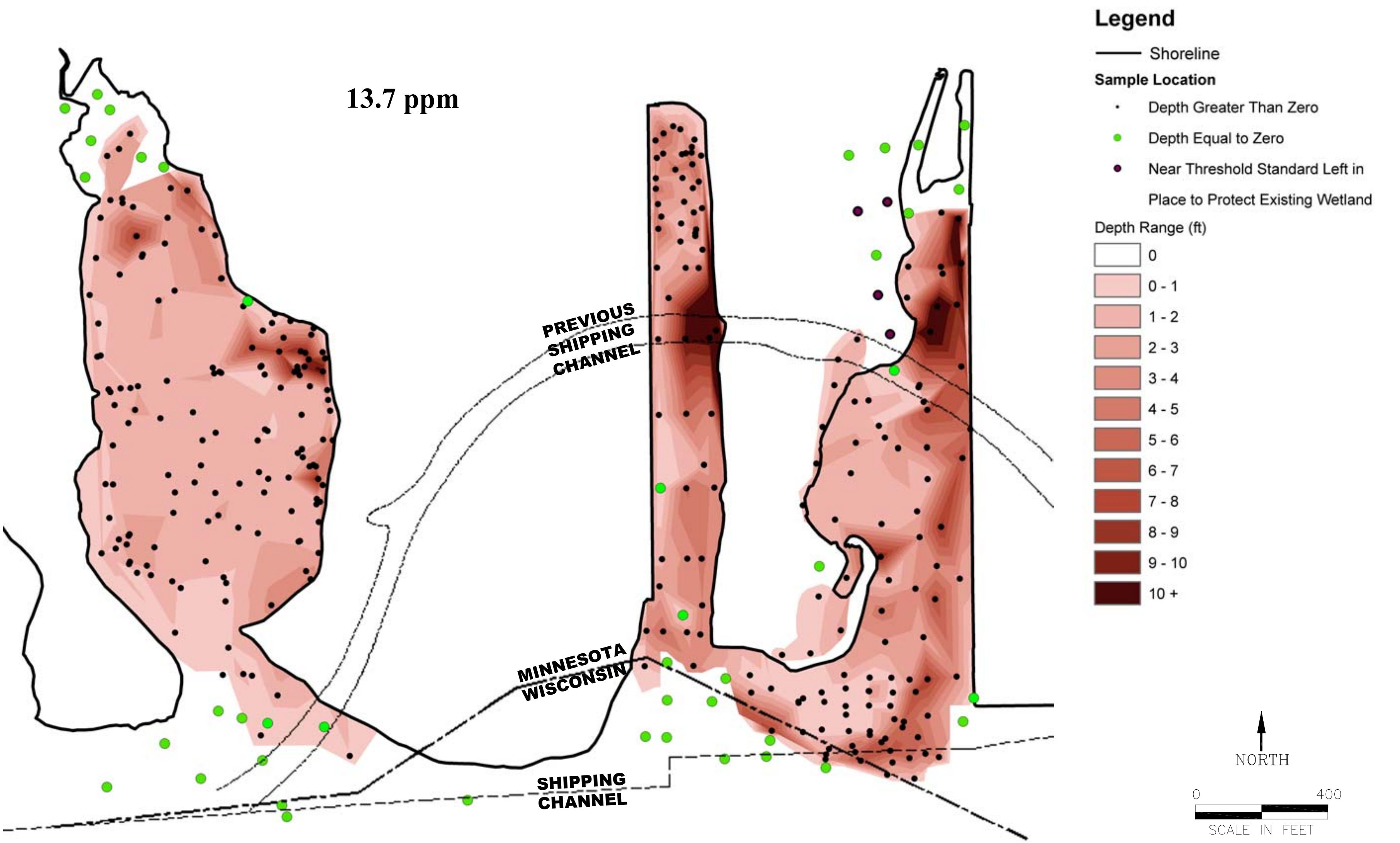


FIGURE TITLE	FIGURE 1-4 EXTENT OF PAH CONTAMINATION USING THRESHOLD CONCENTRATION 13.7 ppm SLRIDT SITE DULUTH, MINNESOTA			
FILE NAME Figure 1-4_pah-13.7ppm.ppt	DATE 12/11/01	REVISION DATE 11/21/03	DRAWN BY K. UTECHT	REVIEWED BY H. HULS

SERVICE ENGINEERING GROUP

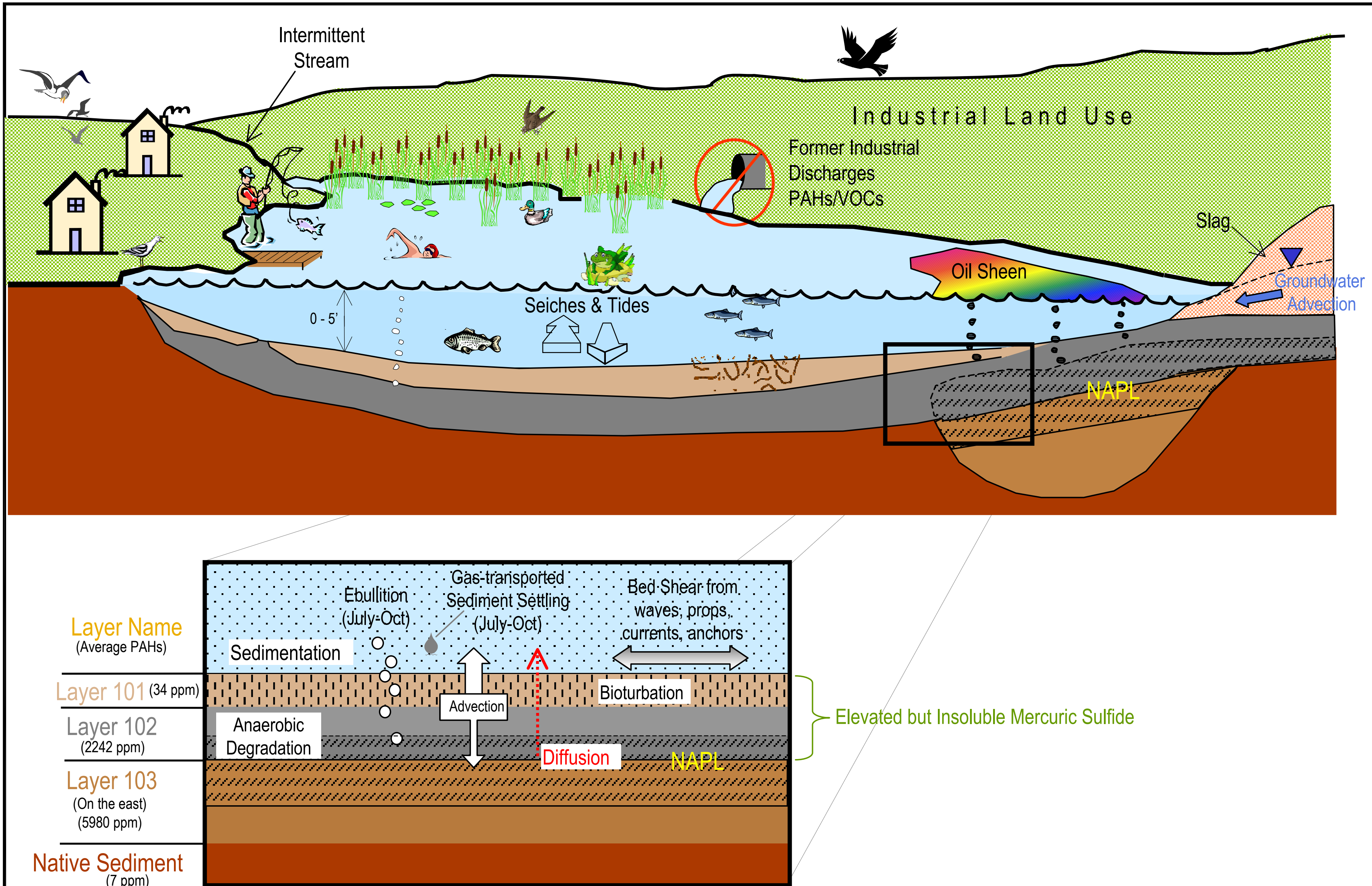


FIGURE TITLE
Figure 1-5
Conceptual Site Model
Stryker Bay
SLRIDT Site

FILE NAME	Figures 1-5 through 1-7.ppt
DATE	11/06/03
DRAWN BY	LS/MC
REVIEWED BY	MC

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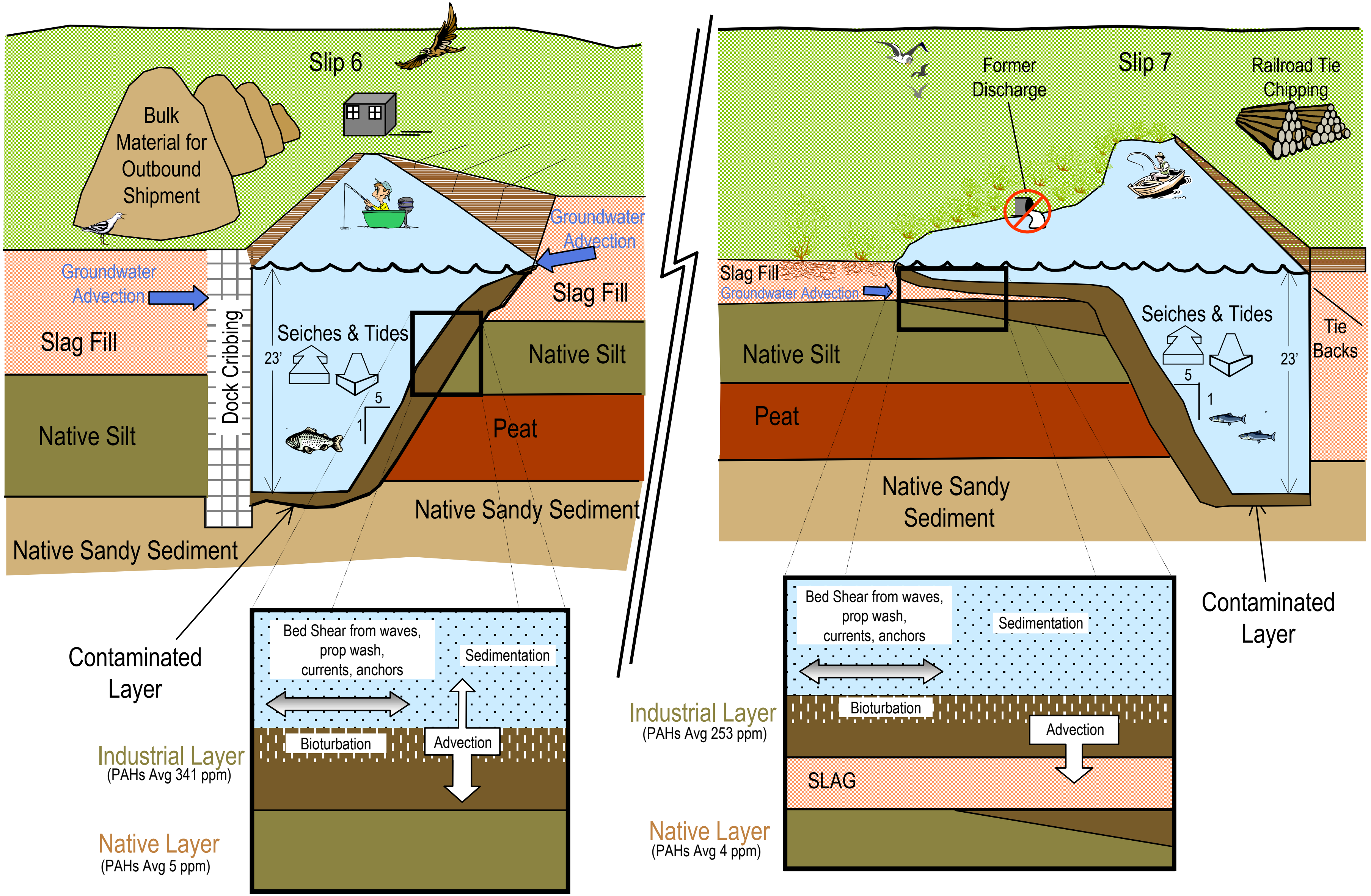

FIGURE TITLE
Figure 1-6
Conceptual Site Model
Slips 6 and 7
SLRIDT Site

FILE NAME	Figures 1-5 through 1-7.ppt
DATE	11/06/03
DRAWN BY	LS/MC
REVIEWED BY	MC

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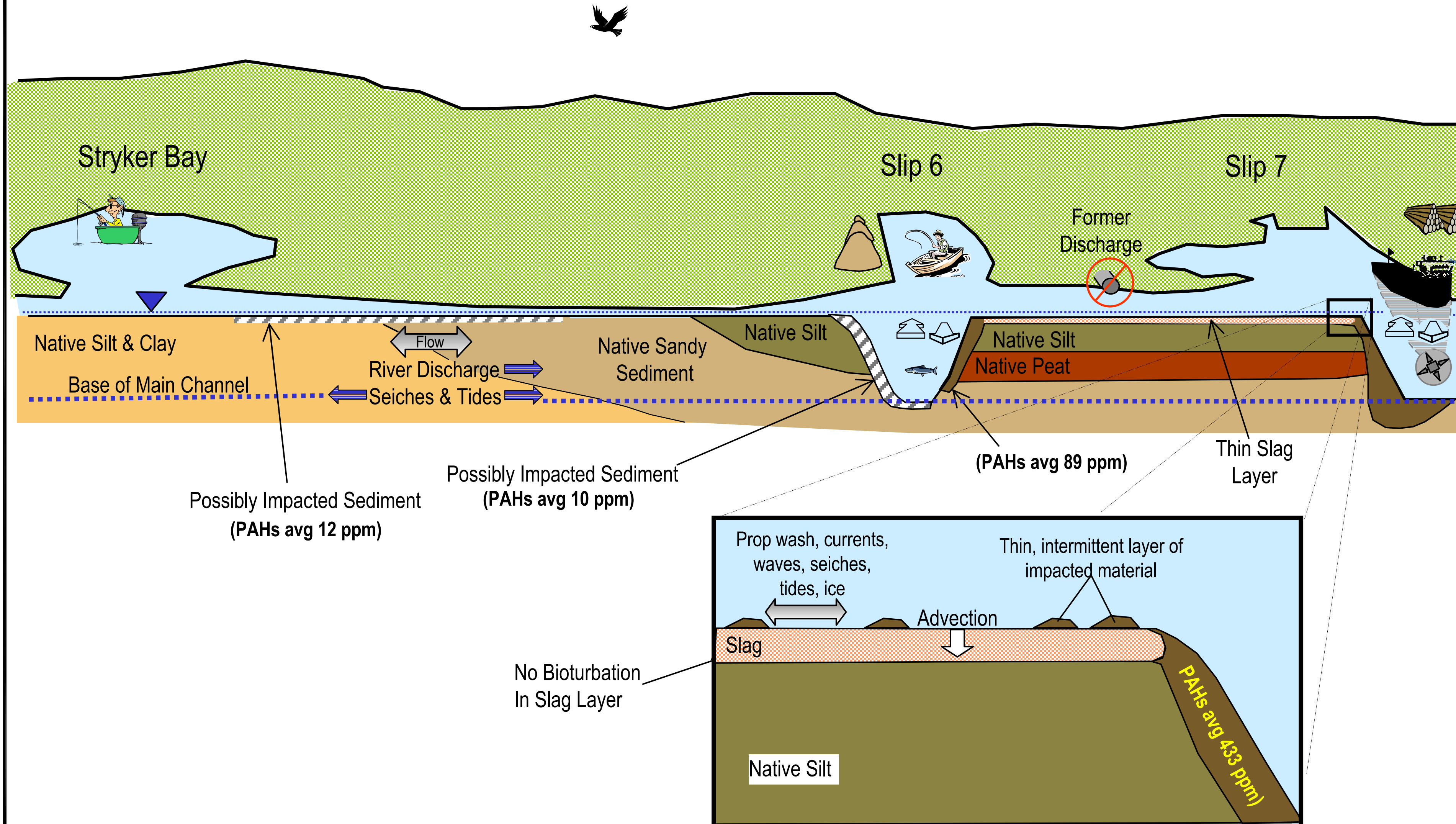

FIGURE TITLE

Figure 1-7
Conceptual Site Model
Main Channel Area
SLRIDT Site

FILE NAME	Figures 1-5 through 1-7.ppt
DATE	11/06/03
DRAWN BY	LS/MC
REVIEWED BY	MC

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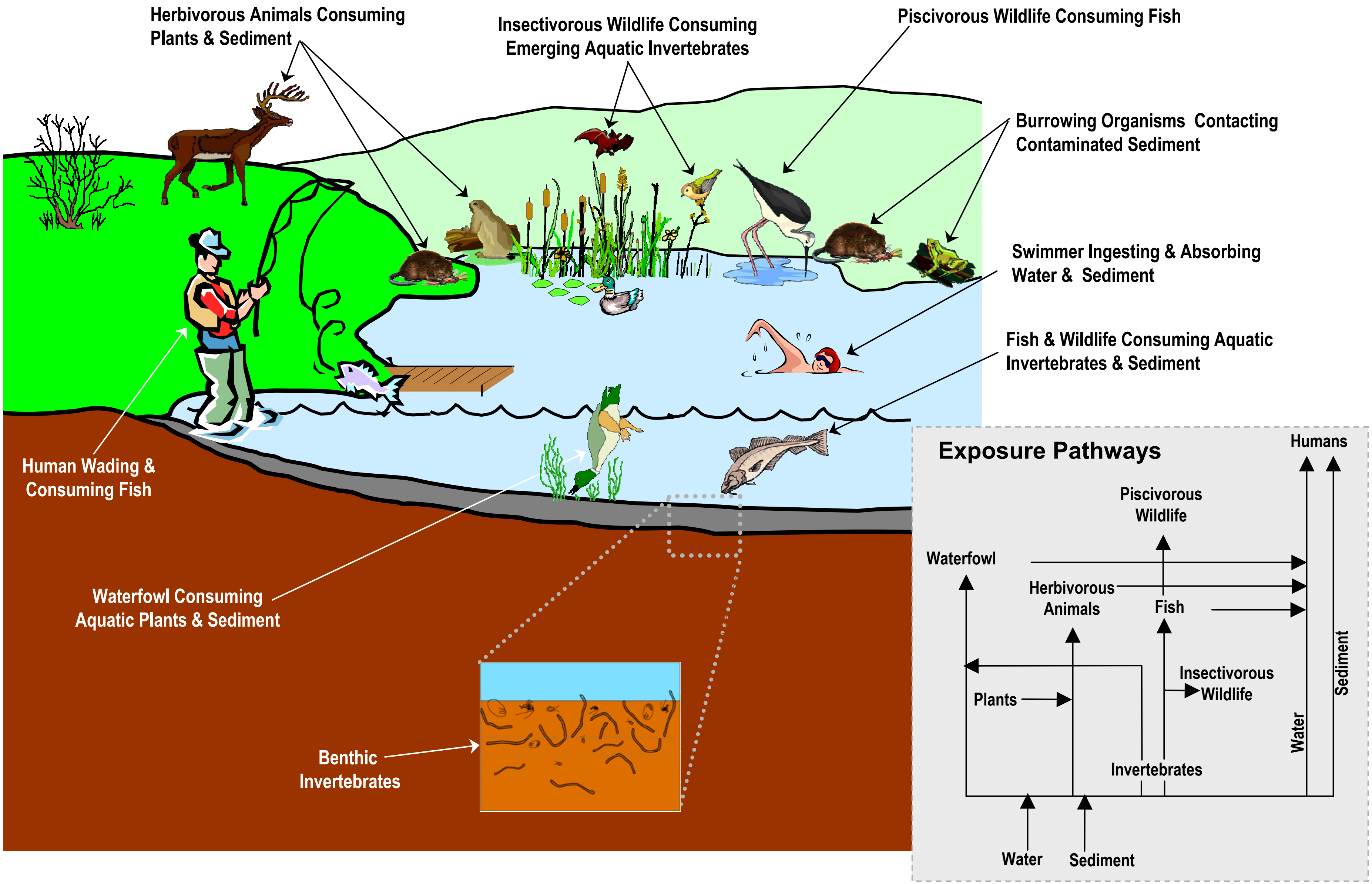

FIGURE TITLE

Figure 1-8
Exposure Pathways of Interest
SLRIDT Site
Duluth, Minnesota

FILE NAME	Fig 1-8 Risk Pathways.ppt
DATE	11/19/03
DRAWN BY	KU
REVIEWED BY	MC

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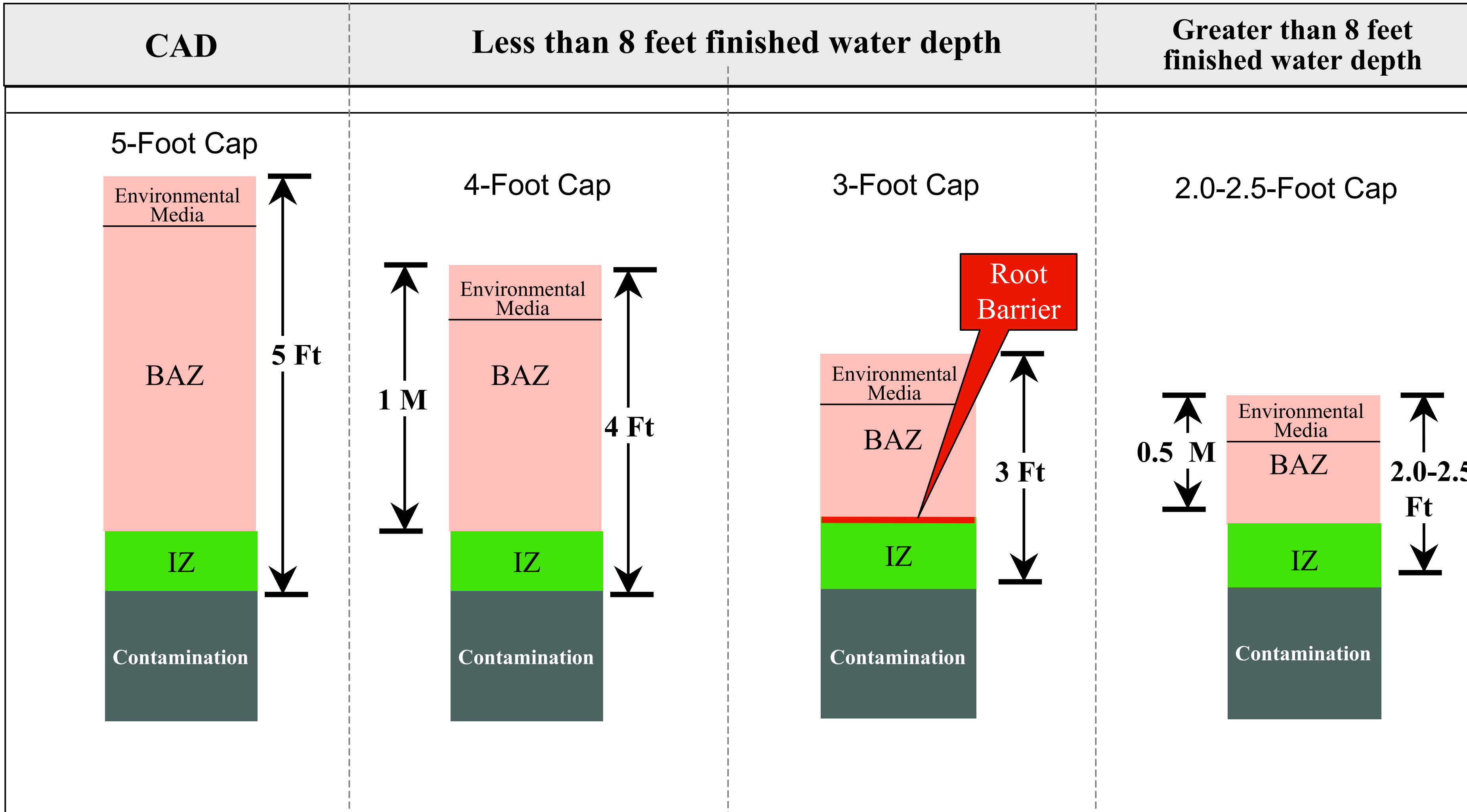
FIGURE 3–1
NAPHTHALENE CONCENTRATIONS IN SEDIMENT
SLRIDT SITE
DULUTH, MINNESOTA

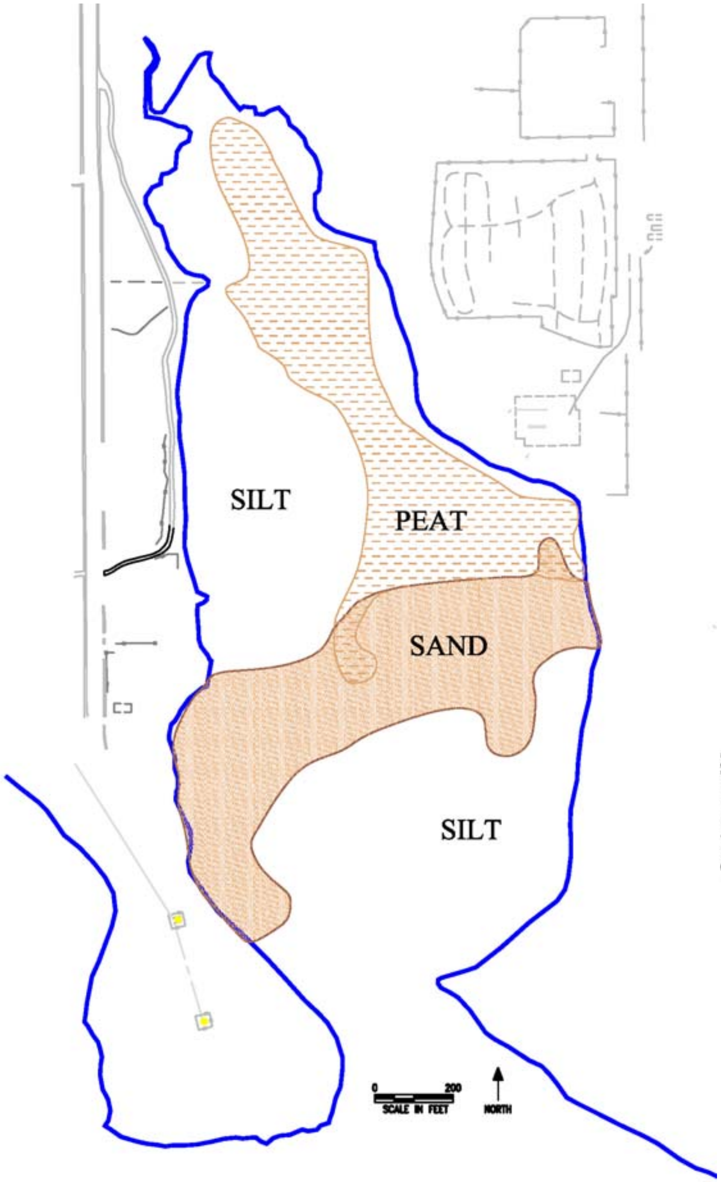
FILE NAME	DATE	REV. DATE	DRAWN BY	REVIEWED BY
figure 3–2_NAPH–con	11/06/03	12/29/03	AM/KU	HH/MC

Figure 3-2
Cap Thicknesses



BAZ = Bioactive Zone
IZ = Isolation Zone
If areas are demonstrated to have downward gradients, the IZ may be excluded.

Figure 3-3
Cap Settlement in Stryker Bay



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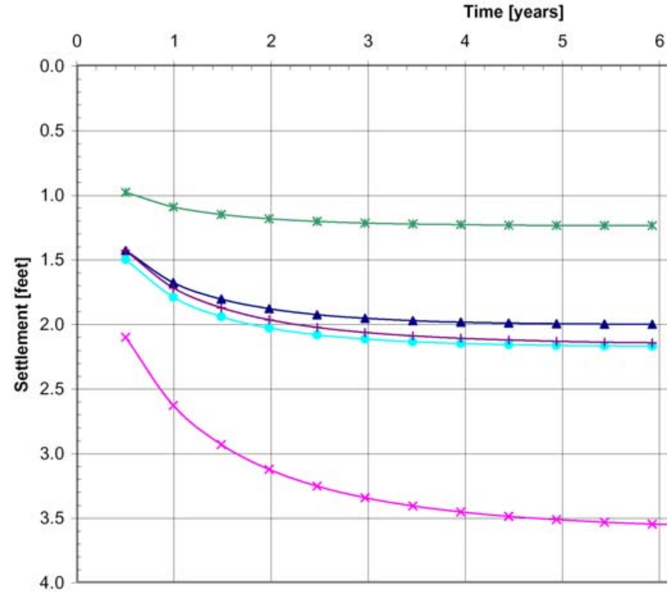
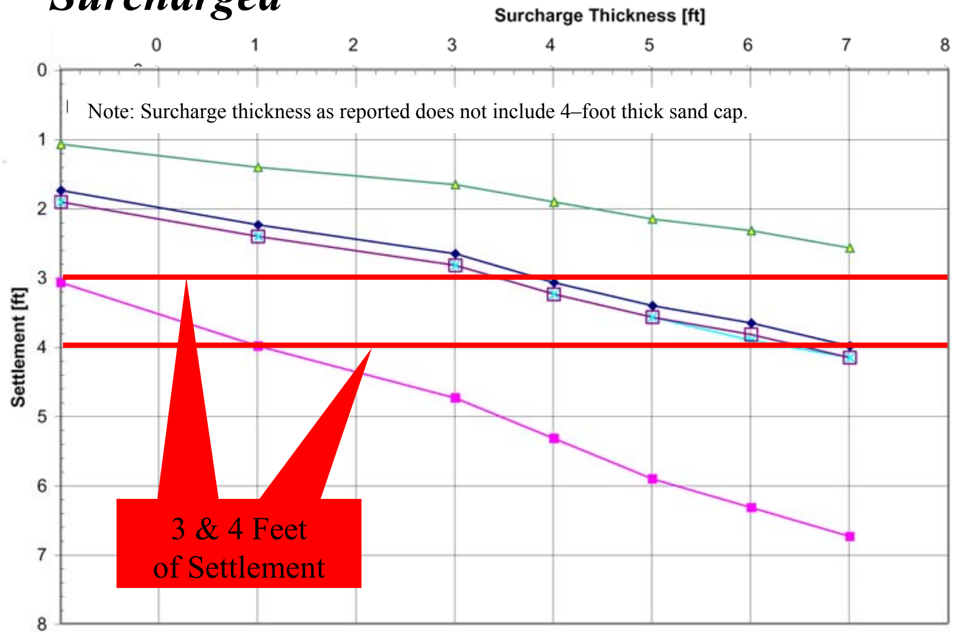
4-Foot Cap



Anchor Memorandum #1 April 18, 2003

Surcharged



Based on Anchor Memorandum #2 dated May 1, 2003

Figure 3-4
Shallow Sheltered Bays Ranked by Median Depth (feet)
Including Existing and Capped Stryker Bay

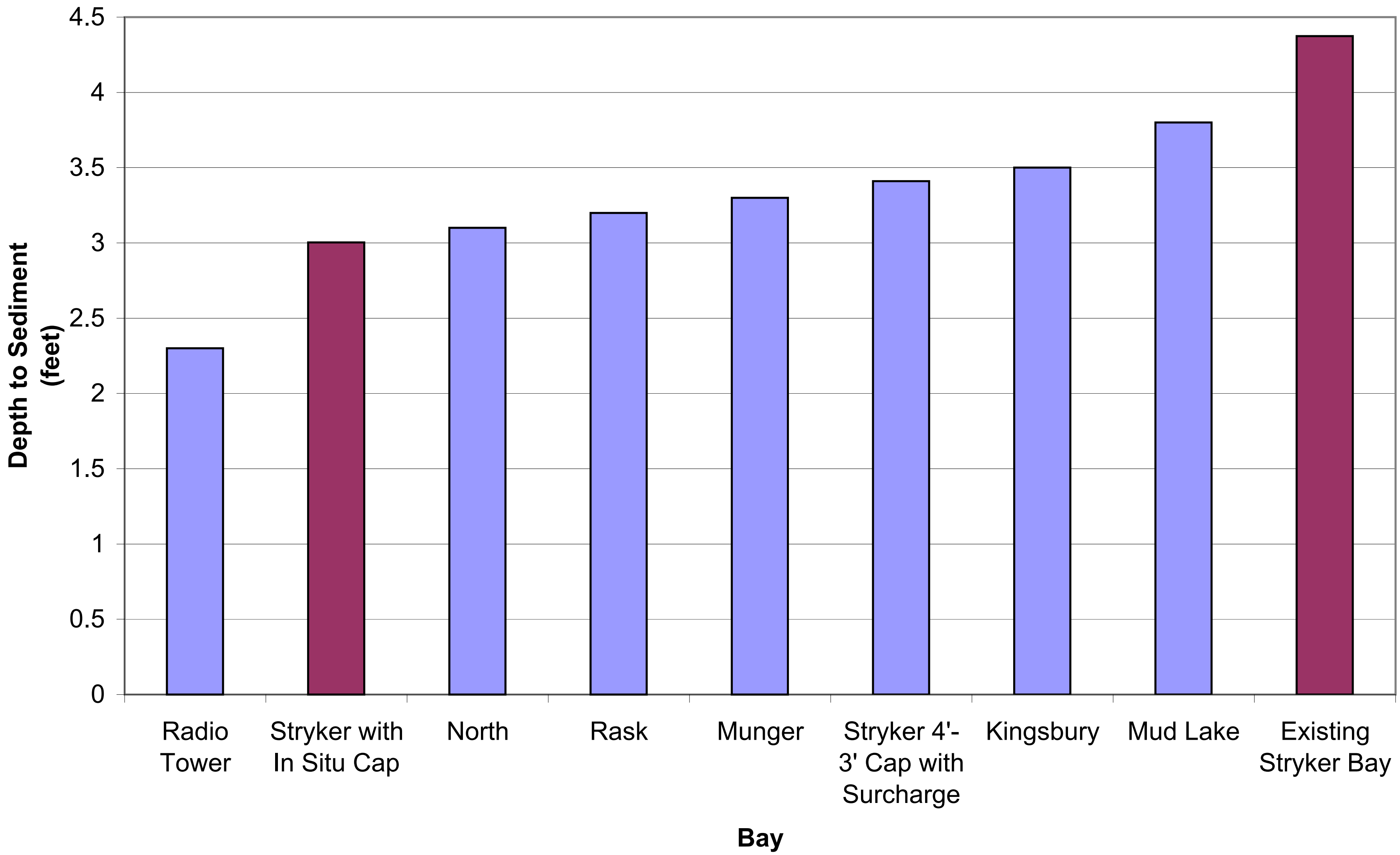


Figure 3-4 Median Depths of SSBs-122903.xls

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Figure 3-5
Summary of Alternatives Previously Evaluated

1997
Alternatives Screening Report

1. No Action
2. Capping In Place
3. Limited Dredging/CAD in Slip 7
4. Dredging/Stryker Bay CDF
5. Dredging/Slip 6 CAD
6. Dredging/Slip 7 CAD
7. Dredging/Stryker Bay and Slip 7 CADs
8. Biotreat In Place
9. Dredging/Thermal Treatment

1998
Feasibility Study

1. No Action
2. Capping In Place (six inches)
3. Dredging/Thin cap/CAD in Slip 7
4. Dredging/Thin cap/Stryker Bay CDF
5. Dredging/Slip 6 CDF
6. Dredging/Slip 7 CAD
7. Dredge/Off-Site Disposal

1999
FFS and Supplemental DAR

1. Wetland (Thick) Cap In Place

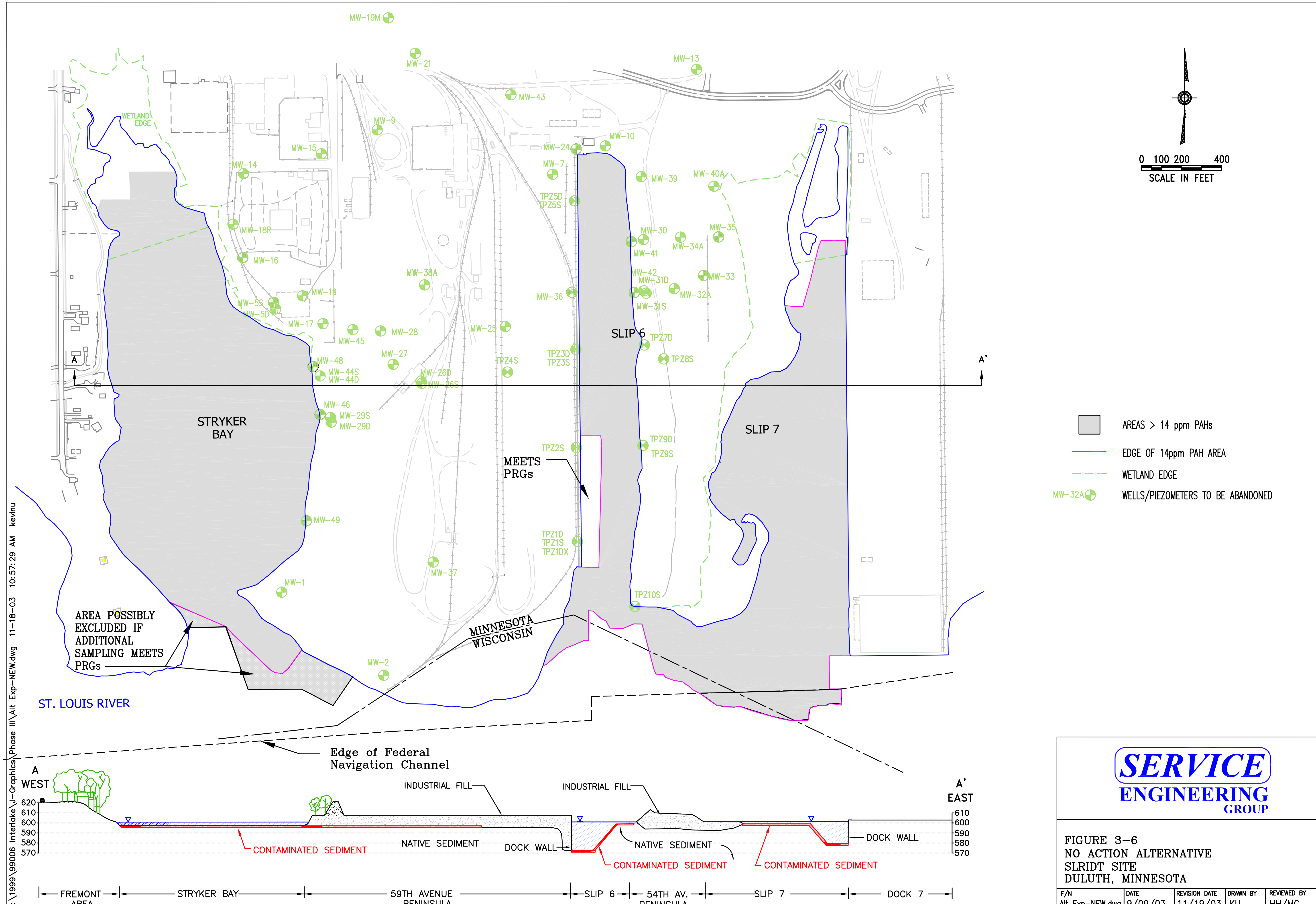
2000
Agreement and DGR

1. No Action
2. In Situ Cap
3. Dredge/On-Site Disposal (Slips 6&7)
4. Dredge/Off-Site Disposal

2003
Focused Feasibility Study

1. No Action
2. In Situ Cap
3. Dredge/Cap Hybrid
4. Dredge/Off-Site Disposal

Note: Red Alternatives carried forward to next step
FFS = Focused Feasibility Study
DAR = Detailed Analysis Re;port
DGR = Data Gap Report



SERVICE ENGINEERING GROUP

FIGURE 3-6
NO ACTION ALTERNATIVE
SLRIDT SITE
DULUTH, MINNESOTA

F/N	DATE	REVISION DATE	DRAWN BY	REVIEWED BY
Alt Exp-NEW.dwg	9/09/03	11/19/03	KU	HH/MC

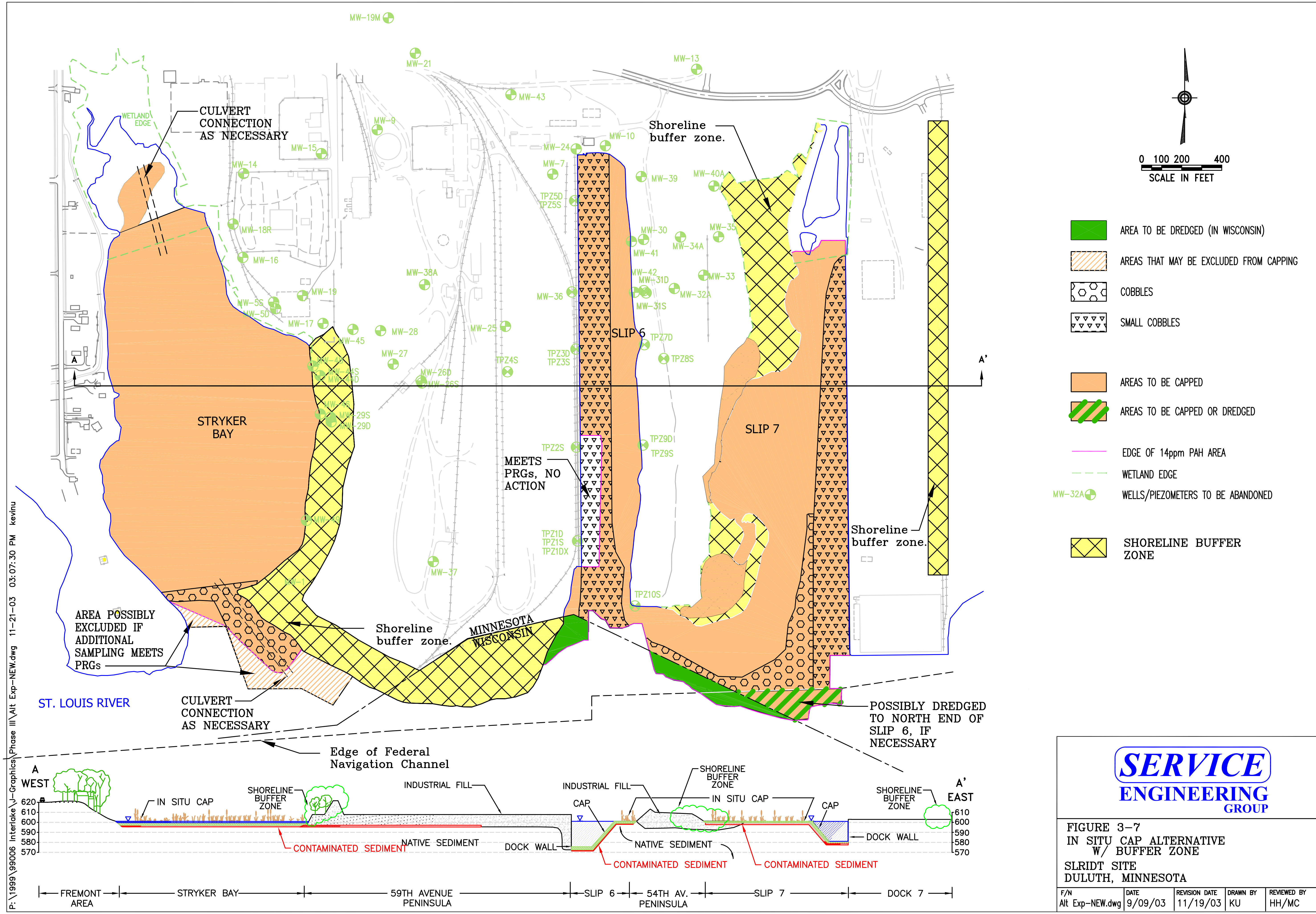


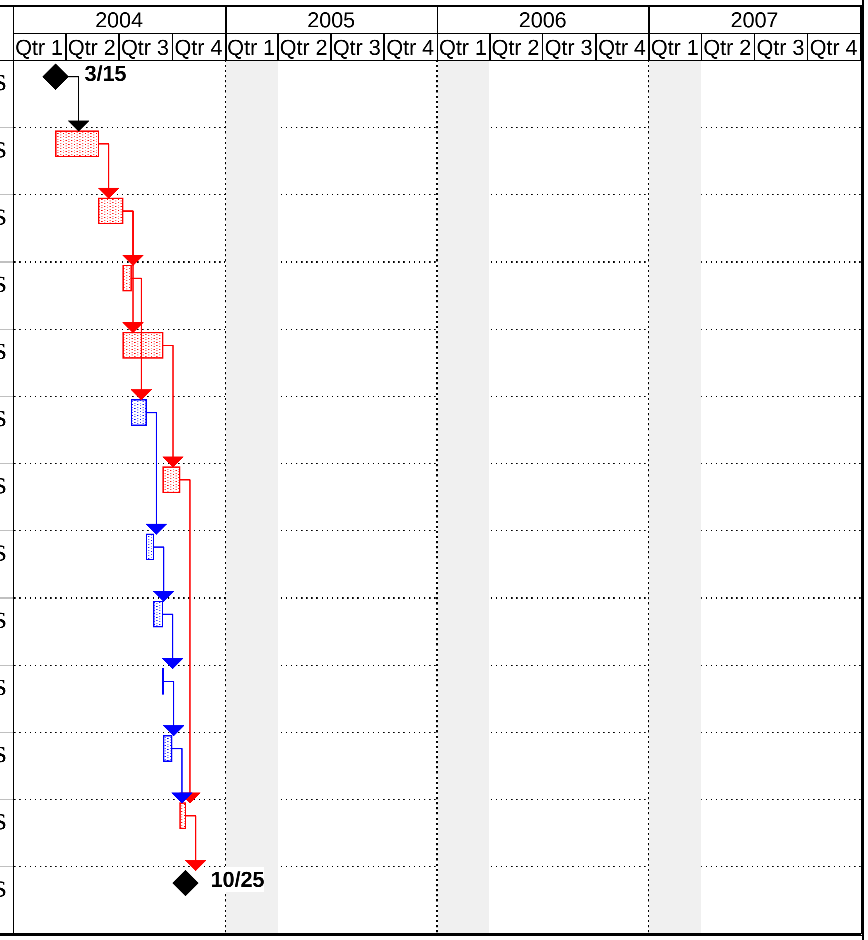
FIGURE 3-7
IN SITU CAP ALTERNATIVE W/ BUFFER ZONE
SLRIDT SITE
DULUTH, MINNESOTA

F/N	DATE	REVISION DATE	DRAWN BY	REVIEWED BY
Alt Exp-NEW.dwg	9/09/03	11/19/03	KU	HH/MC

Figure 3-8
In Situ Cap Schedule

SERVICE ENGINEERING GROUP

ID	Task Name	Duration
1	Complete Design & Permitting	0 days
2	Bidding and Contractor Selection	54 days
3	Mobilization	30 days
4	Dredge WI Area	10 days
5	Stryker Bay Cap - Hydraulic placement (154,494 cy)	49 days
6	Slip 6 Cap- Mechanical placement (54,864 cy)	18 days
7	Slip 7 Cap - Hydraulic Placement - Shallows (65,405 cy)	21 days
8	Slip 7 Cap - Mechanical placement (28,633 cy)	9 days
9	Armor Slips 6 and 7 (32,478 cy)	11 days
10	Armor Mouth of Stryker Bay (3,793 cy)	2 days
11	Place Environmental Media in Stryker Bay (30,460 cy)	10 days
12	Place Environmental Media in Slip 6 and 7 (17,822 cy)	6 days
13	Demobilization	0 days



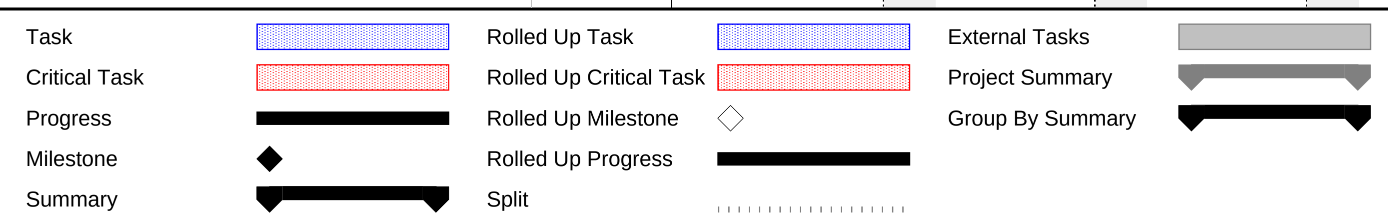


Figure 3-8 In Situ Cap Schedule

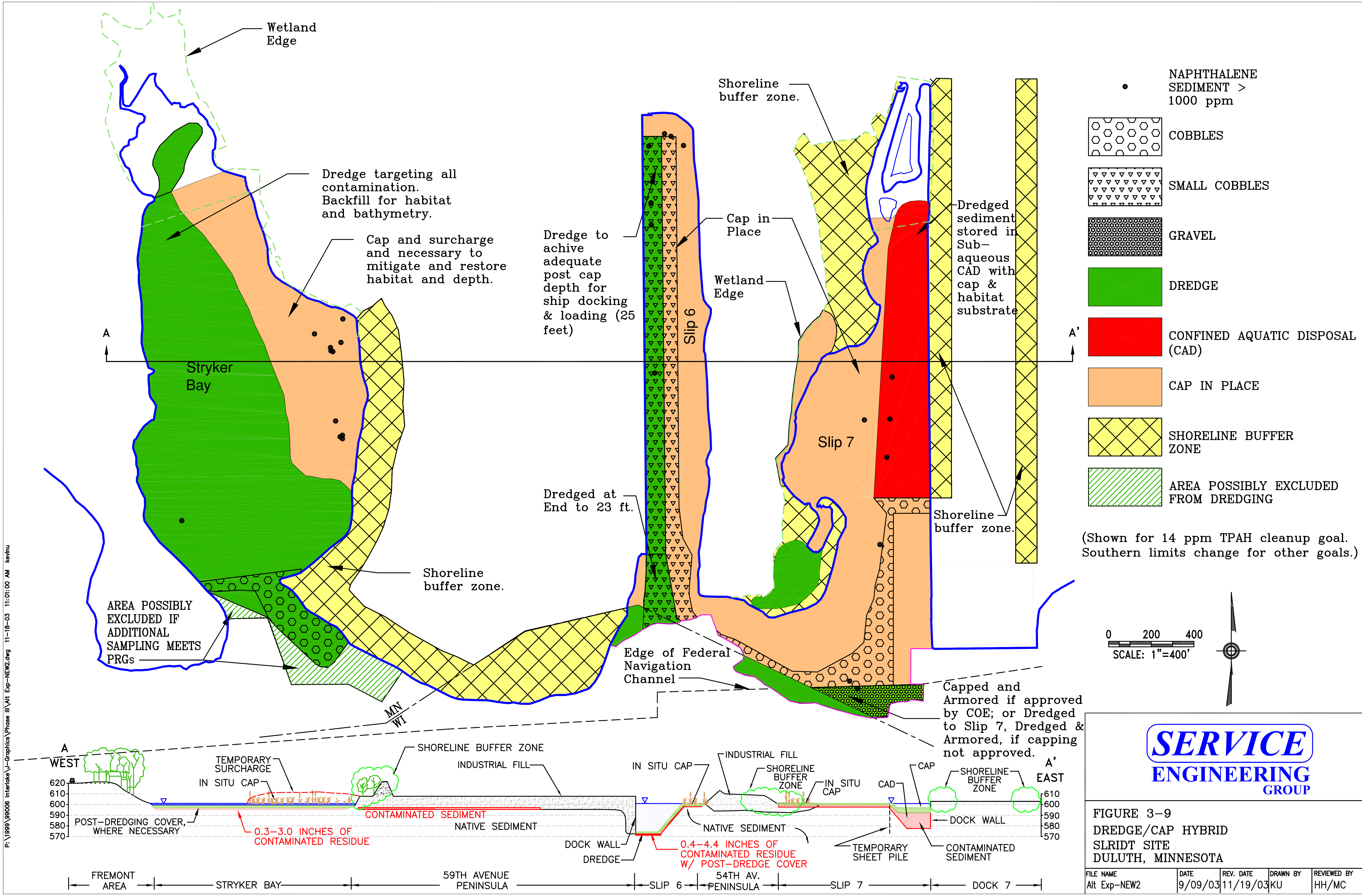
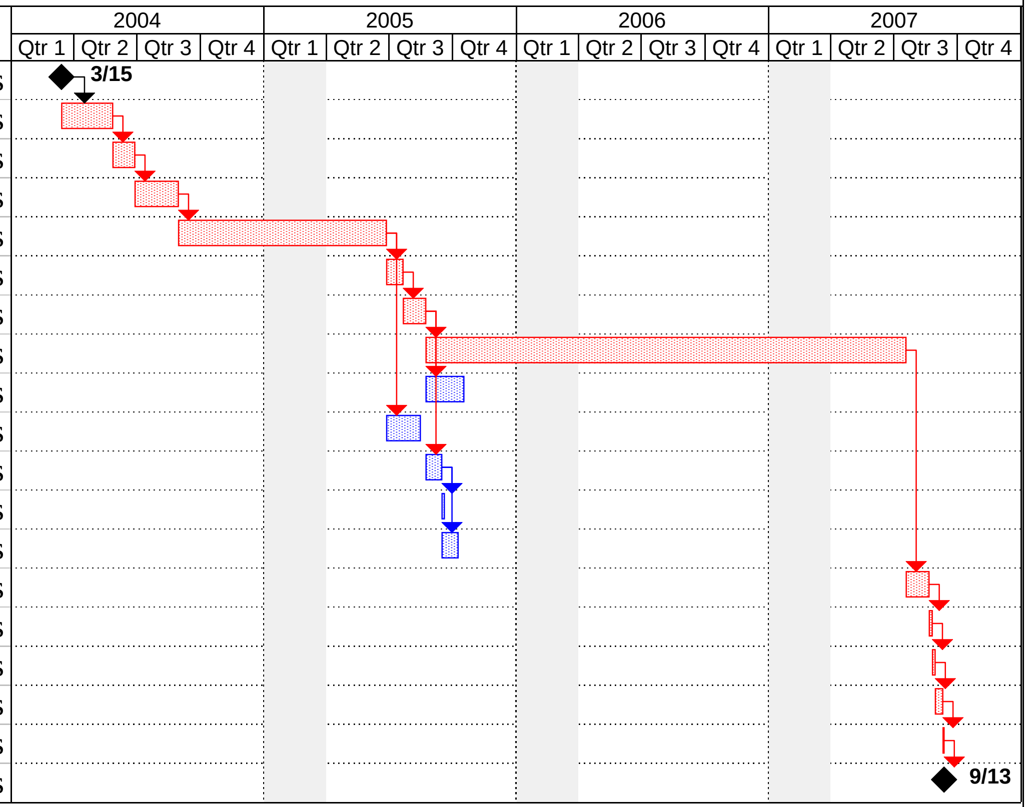


FIGURE 3-9
DREDGE/CAP HYBRID
SLRIDT SITE
DULUTH, MINNESOTA

Figure 3-10
Dredge/Cap Hybrid Schedule

SERVICE ENGINEERING GROUP

ID	Task Name	Duration
1	Complete Design & Permitting	0 days
2	Bidding and Contractor Selection	54 days
3	Mobilization and Site Preparation	22 days
4	Slip 7 CAD Construction	45 days
5	Stryker Bay Dredge (126,566 cy)	106 days
6	Stryker Bay Covering and Capping (58,238 cy)	18 days
7	Place Surcharge (74,447 cy)	23 days
8	Await Surcharge Settlement	280 days
9	Place Env. Media in Stryker Bay (125,707 cy)	39 days
10	Slip 6 Dredging (42,053 cy)	35 days
11	Slip 6 Capping (53,918 cy)	17 days
12	Slip 6 Env. Media (5,029 cy)	2 days
13	Slip 7 CAD Closure (51,418)	16 days
14	Slip 7 Capping (74,447 cy - surcharge material)	23 days
15	Slip 7 Capping (8,184 cy - non surcharge material)	3 days
16	Slip 7 Env. Medial (11,097 cy)	4 days
17	Armor Slip 6 and 7 (22,840 cy)	7 days
18	Armor Mouth of Stryker Bay (3,793)	2 days
19	Demobilization	0 days



Task
Critical Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Critical Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary

Figure 3-10 Hybrid Schedule

SERVICE ENGINEERING GROUP

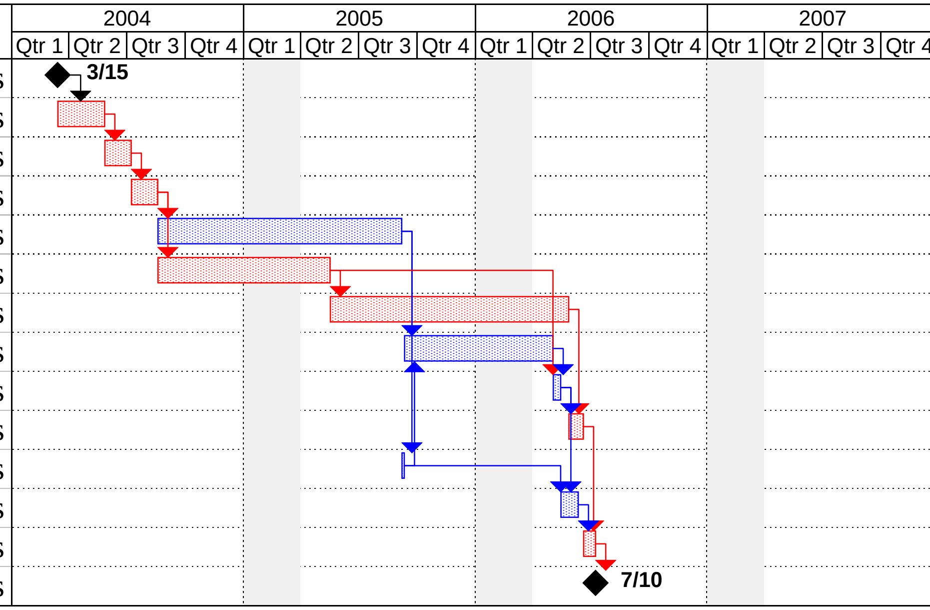
FIGURE 3-11
DREDGE/OFF-SITE DISPOSAL W/ BUFFER ZONE
SLRIDT SITE
DULUTH, MINNESOTA

F/N	DATE	REVISION DATE	DRAWN BY	REVIEWED BY
Alt Exp-NEW.dwg	9/09/03	11/19/03	KU	HH/MC

Figure 3-12
Dredge/Off-Site Disposal Schedule

SERVICE ENGINEERING GROUP

ID	Task Name	Duration
1	Complete Design & Permitting	0 days
2	Bidding and Contractor Selection	54 days
3	Mobilization	30 days
4	Construct Dewatering and Shipping Plant	30 days
5	Dredge Stryker Bay - (197,390 cy)	165 days
6	Dredge Slip 6 - (100,000 cy)	84 days
7	Dredge Slip 7 - (190,500 cy)	159 days
8	Environmental Media in Stryker Bay (188,905 cy)	59 days
9	Environmental Media in Slip 6 (23,706 cy)	8 days
10	Environmental Media in Slip 7 (52,324 cy)	17 days
11	Armor Mouth of Stryker Bay (3,793 cy)	2 days
12	Armor Slip 6 (24,800 cy)	20 days
13	Armor Slip 7 (39,000 cy)	13 days
14	Demobilization	0 days



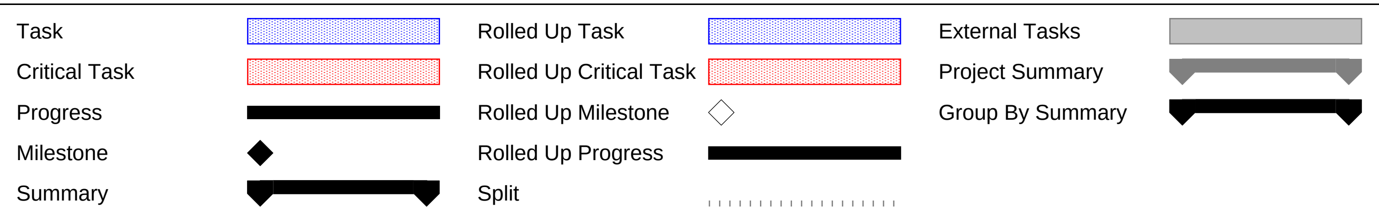


Figure 3-12 Off-Site Schedule

APPENDIX A

ALTERNATIVES COST ANALYSIS

1.0 INTRODUCTION

This appendix provides the cost detail for the remedial alternatives. The limits of the alternatives are based on the sediment PRG of 13.7 mg/Kg TPAHs.

The alternatives included in this cost estimate are as follows:

- *In-Situ* Capping - Includes capping of all targeted sediments
- Mechanical Dredging and Cap Hybrid using CAD in Slip 7
- Dual Mechanical Dredging with Off-Site Disposal to a Landfill

This report will describe the cost elements in Section 2.0 and provide the cost estimate tables for each alternative.

2.0 COST CATEGORY INFORMATION

The cost estimates are shown in Tables A-1 through A-3. Each of the line items are discussed in this section and organized by the major categories shown in these tables to describe the contents of each line. The Slip 7 wetland area remediation costs for each alternative were estimated as separate items and are shown in Table A-4. The total costs from Table A-4 were entered as line items into the summary Tables A-1 through A-3 for each appropriate alternative.

2.1 Miscellaneous Costs

Costs involved with this category are:

Mob/Demob Capping *Anchor Estimates* (PRT Meeting 10/03/02)

Mob/DeMob for capping operations estimated by Anchor include loading crane (2 cy), 12 inch pump, tug (200 hp), piping and diffuser barge all delivered assembled and one month supervision and then breakdown and return of all equipment with two weeks supervision for the shallow capping. For deeper water and slopes this includes delivery and set-up of a clam shell dredge and tug with two weeks set-up and take down for each.

For all mechanical dredging options Anchor estimated delivery and assembly of a small clamshell dredge, upland crane, tug and material barges. This includes supervisor time for set-up and take down.

Bathymetric Survey *COE Price*

For all Options - Bathymetric surveys are required for before and after capping or dredging to measure the control of the construction. Unit costs are COE unit price estimates.

Air Monitoring *EQM Estimate*

Weekly costs based on 5 stations using OSHA Method 35/ Chromasorb 106 tubes with tube change out required each 8 hrs with 3 change outs per day, and 2 man sample technician team. Sorbent tubes would be analyzed at laboratory for Naphthalene.

Surface Water Monitoring *SERVICE Experience and Lab book Price*

For all dredging and capping options - Surface water monitoring will be conducted as often as daily during remediation. For costing purposes, it is assumed that surface water will be monitored daily for turbidity, TSS, and PAH/Hg will be conduced weekly from a boat during operations. Sampling will occur outside the outermost engineering control structure.

H&S Personnel Monitoring *Legend Lab Estimate*

For all Dredging Options - H&S Personnel monitoring will occur during periods of dredging. Air Monitoring for exposure to naphthalene of crewmembers on a rotating weekly basis will be conducted during the dredging operations. Costs include equipment, analysis and reporting.

H&S Level C Personnel Protection *OSHA Requirements, Industrial Supply Catalog*

For all Dredging Options – This cost estimate assumes personnel working within the dredge and containment areas or where they may be exposed to harmful substances and naphthalene will wear level C personal protection including cartridge respirator and protective clothing.

Insurance and Performance Bond

The Insurance and Performance Bond is in alignment with the current rates at 1.5 % of contractor bid costs.

2.2 Dredging

Dredging One Pass

For all Dredging Options - Costs calculated based on an agreed-to-average dredge rate of 50 CY/Hr for each dredge. Dredge volumes are based on a single pass of a 3.5 ft cut with a 0.5 ft overdredge. Areas where the contaminants are deeper, additional passes in 3 ft lifts are added. All dredging is estimated on 24 hrs/day and 5 days/week basis.

Debris Removal *Anchor Estimate*

For all Dredging Options - Debris removal is assumed to be conducted prior to the actual dredging operation. Obstacles removed by way of a mechanical bucket rake system and will be disposed of off site as solid waste.

Silt Curtain/Screen *Means Manual*

For all Dredging Options - Silt curtains will be deployed around each 2.5-acre dredge area for fugitive sediment containment. Curtains will also be placed at the mouth of Stryker Bay and outside the 48" outfall area. Curtains will drape to the mud line plus an additional 6 ft for overlay.

HC Boom *IT Corp FS Estimate*

For all Dredging Options – Hydrocarbon adsorbing booms will be placed on all the shoreline of each body of water dredged, and along the silt curtains.

Off-Site HC Boom Disposal *Local contractor removal, Area solid waste landfill disposal rates*

For all Dredging Options –based on quantity of booms above.

2.3 Containment

Containment costs are for the Slip 7 CAD in the Dredging/ Capping Hybrid Alternative and the engineering control structures at the edge of the treatment/work zones.

Silt Curtains/Screen *Means Manual*

These costs were estimated as discussed above except the locations will be to segregate the treatment/work zones from the river at Stryker Bay, Slip 6, the 48-inch outfall, and Slip 7 for dredging and capping alternatives. Curtains for each area were estimated based on the bathymetry to contain suspended solids.

HC Boom *IT Corp FS Estimate*

When dredging oily sediments, hydrocarbon adsorbing booms will be placed around the CAD during dredging and along the containment silt curtains. It is assumed that no such material will be dredged in the *In Situ* Cap Alternative.

Off-Site HC Boom Disposal *Local contractor removal, Area solid waste landfill disposal rates*

Based on booms estimated above.

Over excavation *Anchor Estimates*

For the CAD - Overexcavation of five feet vertically within the dike footprint and 15 feet laterally beyond the dike toe is required in the construction of the CAD due to structural soil conditions and filled with dike material. This contaminated material would be placed within the CAD footprint.

Perimeter Sheet Piling and Temporary Splitter Piles *Vendor Estimate*

For on-Site storage in Slip 7, splitter dikes would be made with sheet piling to create primary settlement and treatment areas within the CAD. Temporary sheet piles will be placed at the crest of the existing slope to segregate CAD water from the shallow water and wetland area to the west from the dockwall on the northeast corner westerly and southerly. The sheet piling would extend to the western edge of the dike.

Main Dike (in water)

Corps recommends $20/cy cost. (Average of previous bids @19.72/cy). Main dike will be placed at 800 ft from the south end of Slip 7 to five feet above water.

Dike Liners

For the CAD – A 60 mil welded HDPE liner would installed on the top and containment side of the dike in Slip 7. Costs based on COE Dredge Material Management Plan.

Riprap *COE DMMP Estimate*

For the CAD – RipRap will be placed on the outer face of the dike to protect against erosion.

Storm Water Run-on Diversion

Previously estimated for a series of low-level interceptor dikes and culverts to divert water from Dock 7 from running into the CAD.

Weirs *Anchor*

Weir structures are located in the splitter sheet pilling for control of flow and addition of settling chemicals between the primary and secondary cells of the CAD.

2.4 Disposal

This category is only used for the Dredge/Off-Site Disposal Alternative.

Haul and Place for Treatment

An estimate by Anchor was used to off-load mechanically dredged sediments into a dewatering pond for treatment and is estimated at $4/cubic yard.

Off-Site Disposal

This cost is estimated for trucking dewatered sediment to a regional landfill. The estimate is based on cost experience at the Site from previous work during the Soil Operable Unit and is estimated to be $45/cy. The volume is based on dewatered filtercake.

2.5 Treatment

This category applies to dredge water treatment for all dredging options.

Capital and Property Costs

This includes an estimate for $500,000 from the WLSSD to install on-site a lift station and a force main to the Polk St. Lift Station so that sufficient capacity is available to discharge pretreated dredge water to the sanitary sewer. The estimate includes portable pumps from the CAD to the on-site lift station, drilling under the Waseca road and railroad tracks north of the Site and cutting a sewer trench through neighborhood streets to the Polk St. Lift Station. This also includes an easement under the railroad. For the Dredged/Off-Site Disposal Alternative, in addition to the new lift station and force main, capital costs include: the cost of construction of a three-acre lined dredge sediment pond for storage and passive dewatering on the 59th Avenue Peninsula and a dewatered material staging pad. The pond construction would consist of berms constructed from on-site soils by overexcavating about one foot of sand base, a 60 ml HDPE liner, and one foot of soil. The one-acre stockpile pad would be constructed for dewatered sediment similar to the pond except for (1) the addition of a runoff collection system, (2) a 60 ml HDPE cover over the treated sediment while actively loading and (3) berms that would be one foot high.

De-Watering Sediment

This cost only applies to the Dredged/Off-Site Disposal Alternative. Estimated is a plate and frame filter press cost of $30/cy. This was obtained from bids for dewatering sediment dredged from Slip 6 during the IRA of 1996.

HC/Water Collection, Sand Filter & Carbon Adsorption

Average bids were $0.60/gal for treatment. Amount of water that would be collected using a skimmer was estimated based on experience from 1996 IRA.

HC Skimming (includes HC disposal)

This is estimated to be 10% of the water collected and includes costs for separation and disposal of hydrocarbons.

CAD Water Alum/Polymer Treatment *Previous Estimate*

This is based on treatability studies using 8% solids slurry that treatment would include; flocculation in CAD using Alum @ 300 mg/L and Anionic polymer of 10 mg/L; neutralization to pH 7.0 after flocculation. Quantities were adjusted for 16% solids for mechanical dredging.

Sand Filter Capital Cost *Previous Estimate*

Quotes from vendors for Dual/Media Sand Filters with design flow @250 gpm. Automatic backwash and operating controls are included for filter system and will be needed to meet expected WLSSD standards.

Sand Filter Operating Costs

Reference: Treatment Study 1999. This includes labor and maintenance of system on daily basis during active dredging and generator costs for portable pumps since three phase power is not available near Slip 7 or on 59th Avenue peninsula.

Electrical Pumping to WLSSD lift station

The energy cost of $0.07/Kwhr was used to pump from the lift station to the force main.

Air Emissions Control *SERVICE and Vendors*

Covers over the dewatering facilities are included for the Dredge/Off-Site Disposal Alternative. A cover for the CAD in Slip 7 has not been included because it is likely not necessary. Potential controls at the dredge were not included because they were not found to be effective in PRT meeting 10/03/02.

WLSSD Fee

WLSSD quote based on volume for discharge to WLSSD sewer system. No city fees would be required for this configuration.

2.6 Capping

All capping operations are assumed to be 24 hours/day, placing 3,200 yds /day, and 5 days/week.

Post-dredge Cover *SERVICE Average Estimate*

Post-dredge cover averages approximately 2.5 feet thick to restore bathymetry, but will vary depending on the depth of dredging. This estimate is based on upland borrow ($17.24/yd) material with labor to place accounting for $8.25/yd of that $17.24 /yd..

***In-Situ* Capping**

The estimates of dredging and capping volumes used for costs are shown in **Table 1-1** of the Feasibility Study Report. This only applies to the *In Situ* Capping and Dredge/Cap Hybrid Alternatives. A 4-foot thick cap in the shallows and 2-foot cap in areas deeper than eight feet finished water depth have been generally for this item. A 3-foot cap would be used in some shallow areas with a geotextile root barrier. The shallows of Slips 6 and 7 are assumed to use the 3-foot cap because of the expected downward gradients in these areas. Unit rates are the same as for Post-Dredge Cover. Replacing surcharged material from Stryker Bay to be used as capping material has been estimated to be $10.00/cy based on hydraulic dredging and placement. As part of the cap the top 0.5 feet of the cap, in areas without armoring, would include an environmental media that is richer in fines and organic content than sand. This material is assumed to have the same unit cost as the sand cap and post-dredge cover material.

Slip 7 CAD Sand Cap

Same unit rates and conditions apply as above except for a five-foot thick cap.

Riprap Armoring *Local Contractors*

Armoring requirements are for two size types; 2-4 inch small cobbles to be placed at the south end of Slip 6, and for cobbles 4-6 inch in size to be placed in Stryker Bay, Slip 6, Slip 7, and the Channel area. Cost is based on a quote by a local contractor delivered to the dock plus the cost of labor and equipment to place material ($5.50/cy) developed in the capping plan by Anchor in Appendix D-4 of the DGR.

2.7 Wetlands Construction *EPA Guidance on Wetland Construction*

Seeding

Cost estimates are to place seed in areas shallower than 8 feet.

Slip 7 Wetland Remediation

Costs are detailed in Table A-4 and are based on unit costs for the treatment, disposal and capping costs described in this document. The wetlands will be excavated and hauled to the disposal or treatment area based on estimates by SERVICE. Clearing trees and shrubs estimates are from the Means Manual.

2.8 Property Acquisition

Costs are based on an appraiser estimate of the market value of the Hallott's Docks and EPA's relocation policy. Also included is a rough estimate of $1.4 million to aquire easements for shoreline buffer zones for all alternatives.

2.9 Permitting and EAW

This cost is estimated for obtaining 4 permits and preparing an Environmental Assessment Worksheet for the State of Minnesota. If permits or EAW were contested, these costs would be exceeded.

2.10 Design

COE recommends 12%.

2.11 Oversight and Admin

For this COE recommended 10%. Costs for project management and oversight.

2.12 Long Term Monitoring and Maintenance (Present Value) *Local Contractors, Means Manual, Previous Estimates*

The present worth cost analysis factor was 7% (as recommended by the EPA), and applied annually for 30 years. Costs for equipment, time, and materials are from local contractor estimates for services, the Means Manual for Construction, or based on staff experience.

Costs for long-term monitoring and maintenance consists of the following:
Capped Areas – Monitoring for Capped Areas consists of bathymetry monitoring for erosion of the cap; core analysis of the cap to monitor PAHs, metals, and mercury; and fish sampling for cPAHs and possibly mercury. The existing wells (48) would have been abandoned. Components of each cost element include project management, labor, equipment, materials, analytical testing and reports every 5 years.

Wetland Monitoring: to evaluate the recovery of restored or converted wetlands.

Maintenance Activities. Consist of inspection and maintenance, erosion repair, and major repair of cap or dike in year 15. Options involving some form of capping will have inspection and maintenance during years one through 5, then every fives years thereafter. Options involving containment will have inspection and maintenance of the dike, and armoring materials at the same intervals.

2.13 Public Water Mitigation *DNR*

Off-Site mitigation costs were provided for the three alternatives in a memo from John Linc Stine, DNR Waters to Dan Talsma, XIK, dated November 19, 2003 and were given as a cost range for *In-Situ* Capping and Dredge/Cap Hybrid Alternatives due to uncertainties in their estimates of this unscoped work.

Table A-1
Cost Estimate - *In-Situ* Cap

13.7 ppm goal
SLRIDT Site, Duluth, MN

Activity	Unit	Unit Cost	Quantity Total	Cost Total Upland borrow
MISCELLANEOUS				
Mob/Demob Shallow	year	$213,000	1	$213,000
Mob/Demob Shallow Winter Restart	year	$94,000	1	$94,000
Mob/Demob Deep & Slope	year	$105,000	1	$105,000
Mob/Demob Small Dredge	year	$50,000	1	$50,000
Bathymetric Survey (Initial and final)	lump	$37,500	2	$75,000
Well Abandonment	lump	$15,000	1	$15,000
Surface Water Monitoring	Weekly	$3,253	155	$503,612
Insurance and Performance Bond	1.5%			$62,282
SUBTOTAL				$1,117,894
CONTAINMENT				
Silt Curtain/Screen	sq. ft	$7.60	67,000	$509,200
SUBTOTAL				$509,200
CAPPING				
Cover Environmental Media	cy	$17.24	50,084	$863,440
Capping Sand	cy	$17.24	311,782	$5,375,123
Surcharge replacement	cy	$17.24	0	$0
Geofrabic shallows	sf	$0.18	2,272,493	$409,049
Armoring	cy	$29.12	38,063	$1,108,392
Slip 6 CAD Sand Cap (5 ft)	cy	$17.24	917	$15,803
SUBTOTAL				$7,771,808
DREDGING (WI)				
Dredging	cy	$23.00	3,621	$83,275
SUBTOTAL				$83,275
TREATMENT				
CAD Water Alum/Polymer Treatment	gal	$0.0018	3,255,730	$5,795
WLSSD fees	gal	$ 0.0035	3,255,730	$11,395
				$17,190
WETLANDS CONSTRUCTION				
Seeding	acre	$2,000	62.21	$124,411
Slip 7 Wetland Remediation	Lump	$313,046	1.00	$313,046
SUBTOTAL				$437,457
Subtotal Construction				$9,936,825
Contingency	30%			$2,981,047
TOTAL CONTRACTOR COST				**$12,917,872**
PROPERTY ACQUISITION				
Purchase Slips and relocate	lump	$1,095,000	1	$1,095,000
Shoreline Buffer Zone Easement	lump	$1,400,000	1	$1,400,000
PERMITTING and EAW				$250,000
Design	12%			$1,550,145
Oversight and Admin	10%			$1,291,787
TOTAL CAPITAL COST				**$18,504,804**
Long Term Monitoring & Maint. (present value)	lump	$755,436	1	$755,436
TOTAL REMEDIATION COST				**$19,260,239**
PUBLIC WATERS MITIGATION RANGE				$2,964,690-$13,287,600
TOTAL PROJECT COST (Millions)				**$22.2-32.5**

Table A-2
Cost Estimate-Dredge/Cap Hybrid
(13.7 ppm, Mechanical dredging, 16% solids)
SLRIDT Site, Duluth, MN

SERVICE ENGINEERING GROUP

Activity	Unit	Unit Cost	Quantity Total	Cost Total Upland borrow
MISCELLANEOUS				
Mob/Demob dredging	lump	$193,000	1	$193,000
Mob/Demob capping	year	$213,000	1	$213,000
Bathymetric Survey	ea	$37,500	3	$112,500
Air Monitoring	Weekly	$8,726	30	$259,409
Surface Water Monitoring	Weekly	$3,650	30	$108,503
H&S Personnel Monitoring	Days	$1,050	149	$156,066
H&S Level C Personnel Protection	Days	$272	149	$40,428
Well abandonment	lump	$15,000	1.0	$15,000
Insurance and Performance Bond	1.5%			$218,538
SUBTOTAL				$1,316,444
DREDGING				
Dredging	cy	$23.00	178,361	$4,102,301
Debris Removal	acre	$4,092	34.5	$141,063
Silt Curtain/Screen	sq ft	$7.60	13,200	$100,320
HC Boom	ft	$4.00	25,680	$102,720
Off-Site HC Boom Disposal	ft	$2.50	25,680	$64,200
SUBTOTAL				$4,510,604
CONTAINMENT				
Silt Curtain/Screen	sq. ft	$7.60	52,000	$395,200
HC Boom	ft	$4.00	19,600	$78,400
Off-Site HC Boom Disposal	ft	$2.50	19,600	$49,000
Overexcavation	cy	$39.00	8,260	$322,154
Perimeter Sheet Piling	cy	$10.00	38,431	$384,310
Main Dike Slip 7 (in water)	cy	$20.00	14,944	$298,882
Dike Liner (60 mil)	sy	$5.75	4,511	$25,936
Air Emissions Control	sq.ft	$2.60	-	??
Sheet Piling (plastic temporary splitter)	sq.ft	$10.00	9,844	$98,440
Riprap	ton	$45.00	1,915	$86,189
Storm water run-on diversion	lump	$150,000	1	$150,000
Weirs	lump	$28,525	1	$28,525
SUBTOTAL				$1,917,037
TREATMENT				
Capital and property Cost of Lift Station, Force Main	lump	$1,000,000	1	$1,000,000
HC/Water Collection Sand Filter & Carbon Adsorption	gal	$0.60	10,970	$6,582
HC Skimming (includes HC disposal)	gal	$5.67	1,097	$6,220
CAD Water Alum/Polymer Treatment	gal	$0.0018	140,074,844	$249,333
Sand Filter Capital Cost	lump	$ 384,776	1	$384,776
Sand Filter Operating Costs	day	$ 571	149	$84,870
Electrical Pumping to WLSSD lift station	gal	$0.000090	140,085,815	$12,608
WLSSD	gal	$ 0.0035	140,085,815	$490,300
SUBTOTAL				$2,234,690

Table A-2
Cost Estimate-Dredge/Cap Hybrid
(13.7 ppm, Mechanical dredging, 16% solids)
SLRIDT Site, Duluth, MN

Activity	Unit	Unit Cost	Quantity Total	Cost Total Upland borrow
CAPPING				
Cover Environmental Media	cy	$17.24	147,540	$2,543,590
Capping Sand	cy	$17.24	169,852	$2,928,244
Surcharge Replacement	cy	$10.00	23,030	$230,297
Slip 7 CAD Sand Cap (5 ft)	cy	$17.24	51,418	$886,439
Geofrabic shallows	sf	$0.18	877,107	$157,879
Armoring	cy	$29.12	24,287	$707,228
SUBTOTAL				$7,453,678
WETLAND CONSTRUCTION				
Seeding	acre	$2,000	57.79	$115,574
Slip 7 Wetland Remediation	Lump	$288,268	1.00	$288,268
SUBTOTAL				$403,842
Subtotal Construction				$17,836,295
Contingency	30%			$5,350,889
TOTAL CONTRACTOR COST				**$23,187,184**
PROPERTY ACQUISITION				
Purchase Slip 7 & new conveyors for Slip 6 & relocate	lump	$1,028,619	1.00	$1,028,619
Shoreline Buffer Zone Easement	lump	$1,400,000	1	$1,400,000
PERMITTING and EAW	lump	$250,000	1.00	$250,000
Design	12%			$2,782,462
Oversight and Admin	10%			$2,318,718
TOTAL CAPITAL COST				**$30,966,983**
Long term Monitoring & Maintenance (Present Value)	lump	936,871	1	$936,871
TOTAL REMEDIATION COST				**$31,903,855**
PUBLIC WATERS MITIGATION RANGE				$39,690-$1,587,600
TOTAL PROJECT COST				**$31.9-33.5**

Table A-3
Cost Estimate-Dredge/Off-Site Disposal
(13.7ppm, 2 Mechanical dredges)
SLRIDT Site, Duluth, MN

SERVICE ENGINEERING GROUP

Activity	Unit	Unit Cost	Quantity Total	Cost Total Upland borrow
MISCELLANEOUS				
Mob/Demob Dredging	lump	$193,000	1	$193,000
Mob/Demob Dredging Winter Restart	lump	$94,000	2	$188,000
Mob/Demob capping	year	$213,000	1	$213,000
Bathymetric Survey	ea	$37,500	3	$112,500
Air Monitoring	Weekly	$8,726	41	$359,643
Surface Water Monitoring	Weekly	$3,650	41	$150,428
H&S Personnel Monitoring	Days	$1,050	206	$216,369
H&S Level C Personnel Protection	Days	$272	206	$56,050
Well Abandonment	lump	$15,000	1	$15,000
Insurance and Performance Bond	1.5%			$877,328
SUBTOTAL				$2,381,318
DREDGING				
Dredging	cy	$23.00	494,558	$11,374,823
Debris Removal	acre	$4,092	84	$342,697
Silt Curtain/Screen	sq ft	$7.60	26,400	$200,640
HC Boom	ft	$4.00	25,680	$102,720
Off-Site HC Boom Disposal	ft	$2.50	25,680	$64,200
SUBTOTAL				$12,085,079
CONTAINMENT				
Silt Curtain/Screen	sq. ft	$7.60	67,000	$509,200
HC Boom	ft	$4.00	19,600	$78,400
Off-Site HC Boom Disposal	ft	$2.50	19,600	$49,000
SUBTOTAL				$636,600
DISPOSAL				
Haul and Place for Treatment	cy	$4.00	494,558	$1,978,230
Off-site Transportation and Disposal	cy	$45.00	346,261	$15,581,767
SUBTOTAL				$17,559,997
TREATMENT				
Capital and Property Cost (Lift Station, Force Main, Storage Pond & Pad)	lump	$1,691,998	1	$1,691,998
De-watering sediment	cy	$30.00	494,558	$14,836,725
HC/Water Collection Sand Filter & Carbon Adsorption	gal	$0.60	21,941	$13,164
HC Skimming (includes HC disposal)	gal	$5.67	2,188	$12,406
Sand Filter Capital Cost	lump	$765,022	1	$765,022
Sand Filter Operating Costs	day	$932	206	$192,053
Electrical Pumping to WLSSD lift station	gal	$0.00009	62,923,000	$5,663
Air Emissions Cover	sq. ft	$2.60	174,240	$453,024
WLSSD Fee	gal	$0.00098	62,923,000	$61,665
SUBTOTAL				$18,031,720
CAPPING				
Cover Environmental Media	cy	$17.24	266,811	$4,599,821
Capping Sand	cy	$17.24	42,431	$731,510
Armoring	cy	$29.12	34,418	$1,002,246
SUBTOTAL				$6,333,577

Table A-3
Cost Estimate-Dredge/Off-Site Disposal
(13.7ppm, 2 Mechanical dredges)
SLRIDT Site, Duluth, MN

Activity	Unit	Unit Cost	Quantity Total	Cost Total Upland borrow
WETLAND CONSTRUCTION				
Seeding	acre	$2,000	62.24	$124,483
Slip 7 Wetland Remediation	Lump	$800,824	1.00	$800,824
SUBTOTAL				$925,307
Subtotal Construction				$57,953,598
CONTINGENCY	30%			$17,386,079
TOTAL CONTRACTOR COST				**$75,339,678**
PROPERTY ACQUISITION				
Purchase Slip 6 & 7 and relocate	lump	$1,095,000	0	$0
Shoreline Buffer Zone Easement	lump	$1,400,000	1	$1,400,000
PERMITTING and EAW	lump	$250,000	1	$250,000
DESIGN	12%			$9,040,761
OVERSIGHT and ADMIN	10%			$7,533,968
TOTAL CAPITAL COST				**$93,564,407**
Long term Monitoring & Maintenance (Present Value)	lump	$328,992	1	$328,992
TOTAL REMEDIATION COST				**$93,893,399**
PUBLIC WATERS MITIGATION RANGE				$0
TOTAL PROJECT COST (Millions)				**$93.9**

Table A-4
Cost Estimate - Slip 7 Wetland Remediation

In-Situ Cap					
Activity		**Unit**	**Unit Cost**	**Quantity**	**Cost**
				Total	**Total**
Capping cost per acre	Cap material (3.5 feet)	CY	$17.24	15,205	$ 262,135
	Clear trees and shrub	AC	$ 3,000.00	2.69	$ 8,078
	Cover Environmental Media (0.5 ft)	CY	$17.24	2,172	$ 37,448
Hydroseed		AC	$ 2,000.00	2.69	$ 5,385
Construction Subtotal					**$ 313,046**

Dredge/Cap Hybrid					
Activity		**Unit**	**Unit Cost**	**Quantity**	**Cost**
				Total	**Total**
Excavating cost per acre					
	Excavte 2 ft of Topsoil/Sediment	AC-FT	$ 24,200.00	2.86	$ 69,198
	Clear trees and shrub	AC	$ 3,000.00	1.43	$ 4,289
	Cover Environmental Media (1 ft)	CY	$17.24	2,307	$ 39,766
	Disposal of soil into CAD	CY	$ 3.78	4,613	$ 17,438
Capping cost per acre					
	Clear trees and shrub	AC	$ 3,000.00	1.26	$ 3,789
	Cap material (3.5 feet)	CY	$17.24	7,132	$ 122,955
	Cover Environmental Media (6 inches)	CY	$17.24	1,019	$ 17,565
Hydraulic Connection		CY	$ 15.00	267	$ 4,000
Channel Rip Rap		CY	$ 29.12	133	$ 3,883
Hydroseed		AC	$ 2,000.00	2.69	$ 5,385
Construction Subtotal					**$ 288,268**

Dredge Off-Site Disposal					
Activity		**Unit**	**Unit Cost**	**Quantity**	**Cost**
				Total	**Total**
Excavating cost per acre					
	Excavte 2 ft of Topsoil/Sediment	AC-FT	$ 24,200.00	5.39	$ 130,329
	Clear trees and shrub	AC	$ 3,000.00	2.69	$ 8,078
	Cover Environmental Media (1 ft)	CY	$17.24	4,344	$ 74,896
	Treatment and Disposal Off-Site	CY	$ 67.00	8,689	$ 582,136
Hydroseed		AC	$ 2,000.00	2.69	$ 5,385
Construction Subtotal					**$ 800,824**

Table A-5
Monitoring/Maintenance
Post-Remediation
In Situ Cap Alternative
Present Value Estimate

Discount Rate per EPA **7.00%**

Year of Expenditure			**1**			**2**			**3**			**4**		
Activity	**# Sites**	**Unit Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	1	$37,500	$37,500	1	$37,500	$37,500	1	$37,500	$37,500	1	$37,500	$37,500	1	$37,500
Cores	12	$931	$11,172	1	$11,172	$11,172	1	$11,172	$11,172	1	$11,172	$11,172	1	$11,172
Mercury Analysis (Stryker Bay)	5	$30	$150	1	$150	$150	1	$150	$150	1	$150	$150	1	$150
Annual Report/5 Year report	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000
Sum of Annual Cost					**$60,822**			**$60,822**			**$60,822**			**$60,822**
Present Value Discount Factor	**7.00%**				0.93			0.87			0.82			0.76
Present Value			$0		$56,843			$53,124			$49,649			$46,401
Net Present Value, rolling sum					$56,843			$109,967			$159,616			$206,017
Habitat Recovery (Years 2,5,10)														
Biota Survey	1	$10,000				$10,000	1	$10,000						
Wetland Monitoring	1	$30,000				$30,000	1	$30,000						
QA/QC plan and Report	1	$70,000				$70,000	1	$70,000						
Sum of Annual Cost					**$0**			**$110,000**			**$0**			**$0**
Present Value Discount Factor								0.87						
Present Value								$96,078						
Net Present Value, rolling sum								$96,078			$96,078			$96,078
Total Present Value Monitoring					$56,843			$206,046			$255,694			$302,095
Post Remediation Maintenance														
Inspection & Maintenance			$18,480	1	$18,480	$18,480	1	$18,480	$18,480	1	$18,480	$18,480	1	$18,480
Erosion Repair			$7,467	1	$7,467	$7,467	1	$7,467	$7,467	1	$7,467	$7,467	1	$7,467
Major Repair Cap only														
Sum of Annual Cost					**$25,947**			**$25,947**			**$25,947**			**$25,947**
Present Value Discount Factor					0.93			0.87			0.82			0.76
Present Value Maintenance					$24,250			$22,663			$21,181			$19,795
Net Present Value, rolling sum					$24,250			$46,913			$68,094			$87,889
Total Present Value Maintenance														
Total Present Value - Monitoring & Maintenance					$81,093			$252,959			$323,788			$389,984

Table A-5

Monitoring/Maintenance

Post-Remediation

***In Situ* Cap Alternative**

Present Value Estimate

Discount Rate per EPA

Year of Expenditure		**5**			**6**			**7**			**8**			**9**	
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$12,000	1	$12,000												
Sum of Annual Cost			**$60,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71			0.67			0.62			0.58			0.54
Present Value			$43,365			$0			$0			$0			$0
Net Present Value, rolling sum			$249,382			$249,382			$249,382			$249,382			$249,382
Habitat Recovery (Years 2,5,10)															
Biota Survey	$10,000	1	$10,000												
Wetland Monitoring	$30,000	1	$30,000												
QA/QC plan and Report	$70,000	1	$70,000												
Sum of Annual Cost			**$110,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71												
Present Value			$78,428												
Net Present Value, rolling sum			$174,507			$174,507			$174,507			$174,507			$174,507
Total Present Value Monitoring			$423,889			$423,889			$423,889			$423,889			$423,889
Post Remediation Maintenance															
Inspection & Maintenance	$18,480	1	$18,480	$0	1	$0	$0	1	$0	$0	1	$0	$0	1	$0
Erosion Repair	$7,467	1	$7,467												
Major Repair Cap only															
Sum of Annual Cost			**$25,947**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71			0.67			0.62			0.58			0.54
Present Value Maintenance			$18,500			$0			$0			$0			$0
Net Present Value, rolling sum			$106,389												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$530,278			$423,889									

Table A-5
Monitoring/Maintenance
Post-Remediation
***In Situ* Cap Alternative**

Present Value Estimate
Discount Rate per EPA

Year of Expenditure	10			11			12			13			14		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$68,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51			0.48			0.44			0.41			0.39
Present Value			$34,986			$0			$0			$0			$0
Net Present Value, rolling sum			$284,368			$284,368			$284,368			$284,368			$284,368
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring	$30,000	1	$30,000												
QA/QC plan and Report	$70,000	1	$70,000												
Sum of Annual Cost			**$100,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51												
Present Value			$50,835												
Net Present Value, rolling sum			$225,342			$225,342			$225,342			$225,342			$225,342
Total Present Value Monitoring			$509,709			$509,709			$509,709			$509,709			$509,709
Post Remediation Maintenance															
Inspection & Maintenance	$18,480	1	$18,480	$0	1	$0	$0	1	$0	$0	1	$0	$0	1	$0
Erosion Repair	$7,467	1	$7,467												
Major Repair Cap only															
Sum of Annual Cost			**$25,947**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51			0.48			0.44			0.41			0.39
Present Value Maintenance			$13,190			$0			$0			$0			$0
Net Present Value, rolling sum			$119,579												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$629,289												

Table A-5
Monitoring/Maintenance
Post-Remediation
In Situ Cap Alternative
Present Value Estimate
Discount Rate per EPA

SERVICE ENGINEERING GROUP

Year of Expenditure	15			16			17			18			19		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$68,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.36			0.34			0.32			0.30			0.28
Present Value			$24,944			$0			$0			$0			$0
Net Present Value, rolling sum			$309,312			$309,312			$309,312			$309,312			$309,312
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$225,342			$225,342			$225,342			$225,342			$225,342
Total Present Value Monitoring			$534,654			$534,654			$534,654			$534,654			$534,654
Post Remediation Maintenance															
Inspection & Maintenance	$18,480	1	$18,480												
Erosion Repair	$7,467	1	$7,467												
Major Repair Cap only	$85,290	1	$85,290												
Sum of Annual Cost			**$111,237**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.36			0.34			0.32			0.30			0.28
Present Value Maintenance			$40,318			$0			$0			$0			$0
Net Present Value, rolling sum			$159,897												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$694,550												

Table A-5

Monitoring/Maintenance

Post-Remediation

***In Situ* Cap Alternative**

Present Value Estimate

Discount Rate per EPA

Year of Expenditure	20			21			22			23			24		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$68,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.26			0.24			0.23			0.21			0.20
Present Value			$17,785			$0			$0			$0			$0
Net Present Value, rolling sum			$327,097			$327,097			$327,097			$327,097			$327,097
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$225,342			$225,342			$225,342			$225,342			$225,342
Total Present Value Monitoring			$552,439			$552,439			$552,439			$552,439			$552,439
Post Remediation Maintenance															
Inspection & Maintenance	$18,480	1	$18,480												
Erosion Repair	$7,467	1	$7,467												
Major Repair Cap only															
Sum of Annual Cost			**$25,947**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.26			0.24			0.23			0.21			0.20
Present Value Maintenance			$6,705			$0			$0			$0			$0
Net Present Value, rolling sum			$166,602												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$719,041												

Table A-5

Monitoring/Maintenance

Post-Remediation

***In Situ* Cap Alternative**

Present Value Estimate

Discount Rate per EPA

SERVICE ENGINEERING GROUP

Year of Expenditure	25			26			27			28			29		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$68,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.18			0.17			0.16			0.15			0.14
Present Value			$12,680			$0			$0			$0			$0
Net Present Value, rolling sum			$339,777			$339,777			$339,777			$339,777			$339,777
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$225,342			$225,342			$225,342			$225,342			$225,342
Total Present Value Monitoring			$565,119			$565,119			$565,119			$565,119			$565,119
Post Remediation Maintenance															
Inspection & Maintenance	$18,480	1	$18,480												
Erosion Repair	$7,467	5	$37,336												
Major Repair Cap only															
Sum of Annual Cost			**$55,816**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.18			0.17			0.16			0.15			0.14
Present Value Maintenance			$10,284			$0			$0			$0			$0
Net Present Value, rolling sum			$176,886												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$742,005												

Table A-5
Monitoring/Maintenance
Post-Remediation
***In Situ* Cap Alternative**

Present Value Estimate
Discount Rate per EPA

Year of Expenditure		**30**		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**TOTAL COST**
Bathymetry	$37,500	1	$37,500	$375,000
Cores	$11,172	1	$11,172	$111,720
Mercury Analysis (Stryker Bay)	$150	1	$150	$1,500
Annual Report/5 Year report	$20,000	1	$20,000	$160,000
Sum of Annual Cost			**$68,822**	**$648,220**
Present Value Discount Factor			0.13	
Present Value			$9,041	$348,818
Net Present Value, rolling sum			$348,818	
Habitat Recovery (Years 2,5,10)				
Biota Survey				$20,000
Wetland Monitoring				$90,000
QA/QC plan and Report				$210,000
Sum of Annual Cost			**$0**	**$320,000**
Present Value Discount Factor				
Present Value				$225,342
Net Present Value, rolling sum			$225,342	
Total Present Value Monitoring			$574,160	
Post Remediation Maintenance				
Inspection & Maintenance	$18,480	1	$18,480	$184,800
Erosion Repair	$7,467	2	$14,935	$112,009
Major Repair Cap only				$85,290
Sum of Annual Cost			**$33,415**	**$382,099**
Present Value Discount Factor			0.13	
Present Value Maintenance			$4,390	$181,276
Net Present Value, rolling sum			$181,276	
Total Present Value Maintenance				
Total Present Value - Monitoring & Maintenance			$755,436	

Table A-6
Monitoring/Maintenance
Post-Remediation
Dredge Cap Hybrid
Present Value Estimate

Discount Rate per EPA **7.00%**

Year of Expenditure			**1**			**2**			**3**			**4**		
Activity	**# Sites**	**Unit Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	1	$37,500	$37,500	1	$37,500	$37,500	1	$37,500	$37,500	1	$37,500	$37,500	1	$37,500
Cores	12	$931	$11,172	1	$11,172	$11,172	1	$11,172	$11,172	1	$11,172	$11,172	1	$11,172
Mercury Analysis (Stryker Bay)	5	$30	$150	1	$150	$150	1	$150	$150	1	$150	$150	1	$150
Annual Report/5 Year report	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000
Sum of Annual Cost					**$60,822**			**$60,822**			**$60,822**			**$60,822**
Present Value Discount Factor	**7.00%**				0.93			0.87			0.82			0.76
Present Value			$0		$56,843			$53,124			$49,649			$46,401
Net Present Value, rolling sum					$56,843			$109,967			$159,616			$206,017
Habitat Recovery (Years 2,5,10)														
Biota Survey	1	$10,000				$10,000	1	$10,000						
Wetland Monitoring	1	$30,000				$30,000	1	$30,000						
QA/QC plan and Report	1	$70,000				$70,000	1	$70,000						
Sum of Annual Cost					**$0**			**$110,000**			**$0**			**$0**
Present Value Discount Factor								0.87						
Present Value								$96,078						
Net Present Value, rolling sum								$96,078			$96,078			$96,078
Total Present Value Monitoring					$56,843			$206,046			$255,694			$302,095
Post Remediation Maintenance														
Inspection & Maintenance			$33,760	1	$33,760	$33,760	1	$33,760	$33,760	1	$33,760	$33,760	1	$33,760
Erosion Repair			$22,546	1	$22,546	$22,546	1	$22,546	$22,546	1	$22,546	$22,546	1	$22,546
Major Repair Cap only														
Sum of Annual Cost					**$56,306**			**$56,306**			**$56,306**			**$56,306**
Present Value Discount Factor					0.93			0.87			0.82			0.76
Present Value Maintenance					$52,623			$49,180			$45,963			$42,956
Net Present Value, rolling sum					$52,623			$101,803			$147,765			$190,721
Total Present Value Maintenance														
Total Present Value - Monitoring & Maintenance					$109,466			$307,848			$403,460			$492,816

Table A-6
Monitoring/Maintenance
Post-Remediation
Dredge Cap Hybrid
Present Value Estimate
Discount Rate per EPA

SERVICE ENGINEERING GROUP

Year of Expenditure	**5**			**6**			**7**			**8**			**9**		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$12,000	1	$12,000												
Sum of Annual Cost			**$60,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71			0.67			0.62			0.58			0.54
Present Value			$43,365			$0			$0			$0			$0
Net Present Value, rolling sum			$249,382			$249,382			$249,382			$249,382			$249,382
Habitat Recovery (Years 2,5,10)															
Biota Survey	$10,000	1	$10,000												
Wetland Monitoring	$30,000	1	$30,000												
QA/QC plan and Report	$70,000	1	$70,000												
Sum of Annual Cost			**$110,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71												
Present Value			$78,428												
Net Present Value, rolling sum			$174,507			$174,507			$174,507			$174,507			$174,507
Total Present Value Monitoring			$423,889			$423,889			$423,889			$423,889			$423,889
Post Remediation Maintenance															
Inspection & Maintenance	$33,760	1	$33,760												
Erosion Repair	$22,546	1	$22,546												
Major Repair Cap only															
Sum of Annual Cost			**$56,306**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71			0.67			0.62			0.58			0.54
Present Value Maintenance			$40,146			$0			$0			$0			$0
Net Present Value, rolling sum			$230,867			$230,867			$230,867			$230,867			$230,867
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$654,756			$654,756			$654,756			$654,756			$654,756

Table A-6
Monitoring/Maintenance
Post-Remediation
Dredge Cap Hybrid
Present Value Estimate
Discount Rate per EPA

Year of Expenditure	10			11			12			13			14		
Activity	Cost Event	Events Year	Annual Cost	Cost Event	Events Year	Annual Cost	Cost Event	Events Year	Annual Cost	Cost Event	Events Year	Annual Cost	Cost Event	Events Year	Annual Cost
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$68,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51			0.48			0.44			0.41			0.39
Present Value			$34,986			$0			$0			$0			$0
Net Present Value, rolling sum			$284,368			$284,368			$284,368			$284,368			$284,368
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring	$30,000	1	$30,000												
QA/QC plan and Report	$70,000	1	$70,000												
Sum of Annual Cost			**$100,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51												
Present Value			$50,835												
Net Present Value, rolling sum			$225,342			$225,342			$225,342			$225,342			$225,342
Total Present Value Monitoring			$509,709			$509,709			$509,709			$509,709			$509,709
Post Remediation Maintenance															
Inspection & Maintenance	$33,760	1	$33,760												
Erosion Repair	$22,546	1	$22,546												
Major Repair Cap only															
Sum of Annual Cost			**$56,306**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51			0.48			0.44			0.41			0.39
Present Value Maintenance			$28,623			$0			$0			$0			$0
Net Present Value, rolling sum			$259,490			$259,490			$259,490			$259,490			$259,490
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$769,200			$769,200			$769,200			$769,200			$769,200

Table A-6
Monitoring/Maintenance
Post-Remediation
Dredge Cap Hybrid
Present Value Estimate
Discount Rate per EPA

Year of Expenditure	15			16			17			18			19		
Activity	Cost Event	Events Year	Annual Cost	Cost Event	Events Year	Annual Cost	Cost Event	Events Year	Annual Cost	Cost Event	Events Year	Annual Cost	Cost Event	Events Year	Annual Cost
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$68,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.36			0.34			0.32			0.30			0.28
Present Value			$24,944			$0			$0			$0			$0
Net Present Value, rolling sum			$309,312			$309,312			$309,312			$309,312			$309,312
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$225,342			$225,342			$225,342			$225,342			$225,342
Total Present Value Monitoring			$534,654			$534,654			$534,654			$534,654			$534,654
Post Remediation Maintenance															
Inspection & Maintenance	$33,760	1	$33,760												
Erosion Repair	$22,546	1	$22,546												
Major Repair Cap only	$85,290	1	$85,290												
Sum of Annual Cost			**$141,596**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.36			0.34			0.32			0.30			0.28
Present Value Maintenance			$51,321			$0			$0			$0			$0
Net Present Value, rolling sum			$310,811			$310,811			$310,811			$310,811			$310,811
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$845,465			$845,465			$845,465			$845,465			$845,465

Table A-6
Monitoring/Maintenance
Post-Remediation
Dredge Cap Hybrid
Present Value Estimate
Discount Rate per EPA

Year of Expenditure	**20**			**21**			**22**			**23**			**24**		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$68,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.26			0.24			0.23			0.21			0.20
Present Value			$17,785			$0			$0			$0			$0
Net Present Value, rolling sum			$327,097			$327,097			$327,097			$327,097			$327,097
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$225,342			$225,342			$225,342			$225,342			$225,342
Total Present Value Monitoring			$552,439			$552,439			$552,439			$552,439			$552,439
Post Remediation Maintenance															
Inspection & Maintenance	$33,760	1	$33,760												
Erosion Repair	$22,546	1	$22,546												
Major Repair Cap only															
Sum of Annual Cost			**$56,306**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.26			0.24			0.23			0.21			0.20
Present Value Maintenance			$14,551			$0			$0			$0			$0
Net Present Value, rolling sum			$325,362			$325,362			$325,362			$325,362			$325,362
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$877,800			$877,800			$877,800			$877,800			$877,800

Table A-6
Monitoring/Maintenance
Post-Remediation
Dredge Cap Hybrid
Present Value Estimate
Discount Rate per EPA

SERVICE ENGINEERING GROUP

Year of Expenditure	**25**			**26**			**27**			**28**			**29**		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$37,500	1	$37,500												
Cores	$11,172	1	$11,172												
Mercury Analysis (Stryker Bay)	$150	1	$150												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$68,822**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.18			0.17			0.16			0.15			0.14
Present Value			$12,680			$0			$0			$0			$0
Net Present Value, rolling sum			$339,777			$339,777			$339,777			$339,777			$339,777
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$225,342			$225,342			$225,342			$225,342			$225,342
Total Present Value Monitoring			$565,119			$565,119			$565,119			$565,119			$565,119
Post Remediation Maintenance															
Inspection & Maintenance	$33,760	1	$33,760												
Erosion Repair	$22,546	5	$112,731												
Major Repair Cap only															
Sum of Annual Cost			**$146,491**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.18			0.17			0.16			0.15			0.14
Present Value Maintenance			$26,991			$0			$0			$0			$0
Net Present Value, rolling sum			$352,353			$352,353			$352,353			$352,353			$352,353
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$917,472			$917,472			$917,472			$917,472			$917,472

Table A-6
Monitoring/Maintenance
Post-Remediation
Dredge Cap Hybrid
Present Value Estimate
Discount Rate per EPA

Year of Expenditure	30			
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**TOTAL COST**
Bathymetry	$37,500	1	$37,500	$375,000
Cores	$11,172	1	$11,172	$111,720
Mercury Analysis (Stryker Bay)	$150	1	$150	$1,500
Annual Report/5 Year report	$20,000	1	$20,000	$160,000
Sum of Annual Cost			**$68,822**	**$648,220**
Present Value Discount Factor			0.13	
Present Value			$9,041	$348,818
Net Present Value, rolling sum			$348,818	
Habitat Recovery (Years 2,5,10)				
Biota Survey				$20,000
Wetland Monitoring				$90,000
QA/QC plan and Report				$210,000
Sum of Annual Cost			**$0**	**$320,000**
Present Value Discount Factor				
Present Value				$225,342
Net Present Value, rolling sum			$225,342	
Total Present Value Monitoring			$574,160	
Post Remediation Maintenance				
Inspection & Maintenance	$33,760	1	$33,760	$337,600
Erosion Repair	$22,546	2	$45,093	$338,194
Major Repair Cap only				$85,290
Sum of Annual Cost			**$78,853**	**$761,084**
Present Value Discount Factor			0.13	
Present Value Maintenance			$10,359	$362,711
Net Present Value, rolling sum			$362,711	
Total Present Value Maintenance				
Total Present Value - Monitoring & Maintenance			$936,871	

Table A-7

Monitoring/Maintenance

Post-Remediation

Dredge/Off-Site Disposal

Present Value Estimate

Discount Rate per EPA **7.00%**

Year of Expenditure			1			2			3			4		
Activity	**# Sites**	**Unit Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	1		$0	1	$0	$0	1	$0	$0	1	$0	$0	1	$0
Cores	12		$0	1	$0	$0	1	$0	$0	1	$0	$0	1	$0
Mercury Analysis (Stryker Bay)	5		$0	1	$0	$0	1	$0	$0	1	$0	$0	1	$0
Annual Report/5 Year report	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000	$12,000	1	$12,000
Sum of Annual Cost					**$12,000**			**$12,000**			**$12,000**			**$12,000**
Present Value Discount Factor	**7.00%**				0.93			0.87			0.82			0.76
Present Value					$11,215			$10,481			$9,796			$9,155
Net Present Value, rolling sum					$11,215			$21,696			$31,492			$40,647
Habitat Recovery (Years 2,5,10)														
Biota Survey	0	$10,000												
Wetland Monitoring	1	$30,000				$30,000	1	$30,000						
QA/QC plan and Report	1	$70,000				$70,000	1	$70,000						
Sum of Annual Cost					**$0**			**$100,000**			**$0**			**$0**
Present Value Discount Factor								0.87						
Present Value								$87,344						
Net Present Value, rolling sum								$87,344			$87,344			$87,344
Total Present Value Monitoring					$11,215			$109,040			$118,836			$127,990
Post Remediation Maintenance														
Inspection & Maintenance		$7,469	$7,469	1	$7,469	$7,469	1	$7,469	$7,469	1	$7,469	$7,469	1	$7,469
Erosion Repair														
Major Repair None in this option														
Sum of Annual Cost					**$7,469**			**$7,469**			**$7,469**			**$7,469**
Present Value Discount Factor					0.93			0.87			0.82			0.76
Present Value Maintenance					$6,980			$6,524			$6,097			$5,698
Net Present Value, rolling sum					$6,980			$13,504			$19,601			$25,299
Total Present Value Maintenance														
Total Present Value - Monitoring & Maintenance					$18,195			$122,544			$138,437			$153,289

Table A-7
Monitoring/Maintenance
Post-Remediation
Dredge/Off-Site Disposal
Present Value Estimate
Discount Rate per EPA

SERVICE ENGINEERING GROUP

Year of Expenditure		**5**			**6**			**7**			**8**			**9**	
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$0	1	$0												
Cores	$0	1	$0												
Mercury Analysis (Stryker Bay)	$0	1	$0												
Annual Report/5 Year report	$12,000	1	$12,000												
Sum of Annual Cost			**$12,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71			0.67			0.62			0.58			0.54
Present Value			$8,556			$0			$0			$0			$0
Net Present Value, rolling sum			$49,202			$49,202			$49,202			$49,202			$49,202
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring	$30,000	1	$30,000												
QA/QC plan and Report	$70,000	1	$70,000												
Sum of Annual Cost			**$100,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71												
Present Value			$71,299												
Net Present Value, rolling sum			$158,642			$158,642			$158,642			$158,642			$158,642
Total Present Value Monitoring			$207,845			$207,845			$207,845			$207,845			$207,845
Post Remediation Maintenance															
Inspection & Maintenance	$7,469	1	$7,469												
Erosion Repair															
Major Repair None in this option															
Sum of Annual Cost			**$7,469**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.71			0.67			0.62			0.58			0.54
Present Value Maintenance			$5,325			$0			$0			$0			$0
Net Present Value, rolling sum			$30,624												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$238,469			$207,845			$207,845			$207,845			$207,845

Table A-7
Monitoring/Maintenance
Post-Remediation
Dredge/Off-Site Disposal
Present Value Estimate
Discount Rate per EPA

Year of Expenditure	10			11			12			13			14		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$0	1	$0												
Cores	$0	1	$0												
Mercury Analysis (Stryker Bay)	$0	1	$0												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$20,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51			0.48			0.44			0.41			0.39
Present Value			$10,167			$0			$0			$0			$0
Net Present Value, rolling sum			$59,369			$59,369			$59,369			$59,369			$59,369
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring	$30,000	1	$30,000												
QA/QC plan and Report	$70,000	1	$70,000												
Sum of Annual Cost			**$100,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51												
Present Value			$50,835												
Net Present Value, rolling sum			$209,477			$209,477			$209,477			$209,477			$209,477
Total Present Value Monitoring			$268,847			$268,847			$268,847			$268,847			$268,847
Post Remediation Maintenance															
Inspection & Maintenance	$7,469	1	$7,469												
Erosion Repair															
Major Repair None in this option															
Sum of Annual Cost			**$7,469**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.51			0.48			0.44			0.41			0.39
Present Value Maintenance			$3,797			$0			$0			$0			$0
Net Present Value, rolling sum			$34,421												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$303,268			$268,847			$268,847			$268,847			$268,847

Table A-7
Monitoring/Maintenance
Post-Remediation
Dredge/Off-Site Disposal
Present Value Estimate
Discount Rate per EPA

SERVICE ENGINEERING GROUP

Year of Expenditure	**15**			**16**			**17**			**18**			**19**		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$0	1	$0												
Cores	$0	1	$0												
Mercury Analysis (Stryker Bay)	$0	1	$0												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$20,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.36			0.34			0.32			0.30			0.28
Present Value			$7,249			$0			$0			$0			$0
Net Present Value, rolling sum			$66,618			$66,618			$66,618			$66,618			$66,618
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$209,477			$209,477			$209,477			$209,477			$209,477
Total Present Value Monitoring			$276,096			$276,096			$276,096			$276,096			$276,096
Post Remediation Maintenance															
Inspection & Maintenance	$7,469	1	$7,469												
Erosion Repair															
Major Repair None in this option															
Sum of Annual Cost			**$7,469**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.36			0.34			0.32			0.30			0.28
Present Value Maintenance			$2,707			$0			$0			$0			$0
Net Present Value, rolling sum			$37,128												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$313,224			$276,096			$276,096			$276,096			$276,096

Table A-7
Monitoring/Maintenance
Post-Remediation
Dredge/Off-Site Disposal
Present Value Estimate
Discount Rate per EPA

Year of Expenditure	20			21			22			23			24		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$0	1	$0												
Cores	$0	1	$0												
Mercury Analysis (Stryker Bay)	$0	1	$0												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$20,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.26			0.24			0.23			0.21			0.20
Present Value			$5,168			$0			$0			$0			$0
Net Present Value, rolling sum			$71,787			$71,787			$71,787			$71,787			$71,787
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$209,477			$209,477			$209,477			$209,477			$209,477
Total Present Value Monitoring			$281,264			$281,264			$281,264			$281,264			$281,264
Post Remediation Maintenance															
Inspection & Maintenance	$7,469	1	$7,469												
Erosion Repair															
Major Repair None in this option															
Sum of Annual Cost			**$7,469**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.26			0.24			0.23			0.21			0.20
Present Value Maintenance			$1,930			$0			$0			$0			$0
Net Present Value, rolling sum			$39,058												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$320,323			$281,264			$281,264			$281,264			$281,264

Table A-7
Monitoring/Maintenance
Post-Remediation
Dredge/Off-Site Disposal
Present Value Estimate
Discount Rate per EPA

Year of Expenditure	25			26			27			28			29		
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**	**Cost Event**	**Events Year**	**Annual Cost**
Bathymetry	$0	1	$0												
Cores	$0	1	$0												
Mercury Analysis (Stryker Bay)	$0	1	$0												
Annual Report/5 Year report	$20,000	1	$20,000												
Sum of Annual Cost			**$20,000**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.18			0.17			0.16			0.15			0.14
Present Value			$3,685			$0			$0			$0			$0
Net Present Value, rolling sum			$75,472			$75,472			$75,472			$75,472			$75,472
Habitat Recovery (Years 2,5,10)															
Biota Survey															
Wetland Monitoring															
QA/QC plan and Report															
Sum of Annual Cost			**$0**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor															
Present Value															
Net Present Value, rolling sum			$209,477			$209,477			$209,477			$209,477			$209,477
Total Present Value Monitoring			$284,949			$284,949			$284,949			$284,949			$284,949
Post Remediation Maintenance															
Inspection & Maintenance	$7,469	1	$7,469												
Erosion Repair															
Major Repair None in this option															
Sum of Annual Cost			**$7,469**			**$0**			**$0**			**$0**			**$0**
Present Value Discount Factor			0.18			0.17			0.16			0.15			0.14
Present Value Maintenance			$1,376			$0			$0			$0			$0
Net Present Value, rolling sum			$40,435												
Total Present Value Maintenance															
Total Present Value - Monitoring & Maintenance			$325,384			$284,949			$284,949			$284,949			$284,949

Table A-7
Monitoring/Maintenance
Post-Remediation
Dredge/Off-Site Disposal
Present Value Estimate
Discount Rate per EPA

SERVICE ENGINEERING GROUP

Year of Expenditure	30			
Activity	**Cost Event**	**Events Year**	**Annual Cost**	**TOTAL COST**
Bathymetry	$0	1	$0	$0
Cores	$0	1	$0	$0
Mercury Analysis (Stryker Bay)	$0	1	$0	$0
Annual Report/5 Year report	$20,000	1	$20,000	$160,000
Sum of Annual Cost			**$20,000**	**$160,000**
Present Value Discount Factor			0.13	
Present Value			$2,627	$78,099
Net Present Value, rolling sum			$78,099	
Habitat Recovery (Years 2,5,10)				
Biota Survey				$0
Wetland Monitoring				$90,000
QA/QC plan and Report				$210,000
Sum of Annual Cost			**$0**	**$300,000**
Present Value Discount Factor				
Present Value				$209,477
Net Present Value, rolling sum			$209,477	
Total Present Value Monitoring			$287,576	
Post Remediation Maintenance				
Inspection & Maintenance	$7,469	1	$7,469	$74,690
Erosion Repair				$0
Major Repair None in this option				$0
Sum of Annual Cost			**$7,469**	**$74,690**
Present Value Discount Factor			0.13	
Present Value Maintenance			$981	$41,416
Net Present Value, rolling sum			$41,416	
Total Present Value Maintenance				
Total Present Value - Monitoring & Maintenance			$328,992	

APPENDIX B
ARAR- AND PRG- RELATED TABLES PROVIDED BY THE MPCA

Table B-1
Ground Water and Surface Water ARAR Standards
St Louis River/Interlake/Duluth Tar Superfund Site

CHEMICAL or POLLUTANT	CAS No.	Units	SURFACE WATER STANDARDS (See Notes #1 and #2)		SURFACE WATER CRITERIA AND GUIDELINE VALUES (See Note #3)			GROUND WATER STANDARDS				Detected Above Standards (yes/total # of tests)	
						TIER II							
			7052 GLI, 2B Chronic Standard (See Note #1)	7050 2B, 2C & 2D, Chronic Standards (See Note #2)	MN SITE SPECIFIC CHRONIC CRITERIA	SECONDARY CHRONIC VALUE (See Note #4)	EPA CHRONIC LOEL (See Note #5)	MCLs (See Note 6) 4720	MCLGs (See Note 6) 4720	HRLs (See Note 7) 4717	7065	Surface Water	Ground Water
INORGANICS -- TRACE METALS													
Arsenic	7440382	ug/l	53	53				50	0			0/2	0/58
Cadmium	7440439	ug/l	1.86	0.86				5	5	4		0/2	0/30
Chromium, total	7440473	ug/l						100	100				0/32
Chromium, +3	16065831	ug/l	64.3	155						20000			
Chromium, +6	18540299	ug/l	11	11						100			0/32
Copper	7440508	ug/l	6.88	7.88				1,300 (See Note #6)	1,300 (See Note #6)			0/2	0/58
Iron	7439896	ug/l			See Note #3				See Note #15				
Lead	7439921	ug/l	4.08	2.02				15 (See Note #6)				0/2	1/57
Manganese	7439965	ug/l			See Note #3					100			
Mercury (total)	7469976	ug/l	0.0013*	0.0069				2	2				1/101
Mercury (total) (continued)	7469976	ug/l		See Note #8									
Methyl Mercury													
Nickel	7440020	ug/l	38.6	117				100		100		0/2	0/30
Zinc	7440666	ug/l	88.6	78.4					See Note #15	2000		0/2	4/59
INORGANICS -- MAJOR IONS													
Ammonia, unionized as N, (See Note #9)	7664417	ug/l	See Note #9	40 (See Note #9 and WS #3)									
Cyanide, free	57125	ug/l	5.2	5.2				200		100			10/60
Cyanide, dissociable													
Sulfate	14808798	mg/l			See Note #3				See Note #15				
VOLATILE ORGANICS													
Acetone	67641	ug/l				1500				700			0/45
Benzene	71432	ug/l	114	114				5	zero	10			58/111
Bromoform (C)	75252	ug/l		466					zero	40			
Bromobenzene													
Bromochloromethane													
Bromodichloromethane	75274									6			
Bromomethane	74839									10			
Carbon tetrachloride (C)	56235	ug/l		5.9				5	zero	3			
Carbon tetrachloride (C)(continued)	56235	ug/l		See Note #8									
Chlorobenzene (Monochlorobenzene)	108907	ug/l	10	20				100	100	100			
Chloroethane													
Chloromethane (methyl chloride)	74873												
Chloroform	67663	ug/l		155					zero	60			
1,2- Dibromo-3-chloropropane (C)	96128	ug/l							zero				
Dibromomethane													
1,2- Dibromoethane	106934	ug/l							zero	0.004			
Dibromochloromethane	124481	ug/l							zero	10			
1,2- Dichlorobenzene (ortho)	95501	ug/l				14		600	600	600			
1,3- Dichlorobenzene	541731	ug/l				71			600				
1,4- Dichlorobenzene (para) (C)	106467	ug/l				15		175	75	10			
Dichloroflouromethane													
Dichlorodiflouromethane (Freon 12)	75718	ug/l								1000			
1,1- Dichloroethane	75343	ug/l				47				70			
1,2- Dichloroethane (C)	107062	ug/l		190				5	zero	4			2/39
1,2- Dichloroethane (C)(continued)	107062	ug/l		See Note #8									
1,1- Dichloroethylene	75354	ug/l				25		7	7	6			
1,2- Dichloroethylene (cis)	156592	ug/l						70	70	70			
1,2- Dichloroethylene (trans)	156605	ug/l						100	100	100			
Dichloromethane (Methylene chloride) (C)	75092	ug/l	1516	1940				5	zero	50			1/33
1,2- Dichloropropane (C)	78875	ug/l						5	zero	5			
1,3- Dichloropropane	542756									2			0/36
2,2- Dichloropropane													

Table B-1
Ground Water and Surface Water ARAR Standards
St Louis River/Interlake/Duluth Tar Superfund Site

CHEMICAL or POLLUTANT	CAS No.	Units	SURFACE WATER STANDARDS (See Notes #1 and #2)		SURFACE WATER CRITERIA AND GUIDELINE VALUES (See Note #3)			GROUND WATER STANDARDS				Detected Above Standards (yes/total # of tests)	
						TIER II							
			7052 GLI, 2B Chronic Standard (See Note #1)	7050 2B, 2C & 2D, Chronic Standards (See Note #2)	MN SITE SPECIFIC CHRONIC CRITERIA	SECONDARY CHRONIC VALUE (See Note #4)	EPA CHRONIC LOEL (See Note #5)	MCLs (See Note 6) 4720	MCLGs (See Note 6) 4720	HRLs (See Note 7) 4717	7065	Surface Water	Ground Water
1,3- Dichloropropene (cis, trans)	542756	ug/l				0.055				2			1/37
1,1- Dichloropropylene													
Ethyl benzene	100414	ug/l		68				700	700	700			3/115
Ethyl ether	60297	ug/l								1000			
Hexachlorobutadiene	87683	ug/l					9.3			1			
Isoproplybenzene (cumene)	98828	ug/l								300			0/45
Methyl ethyl ketone (2-Butanone)	78933	ug/l				14000				4000			
4- Methyl-2-pentanone (Methyl isobutyl ketone)	108101	ug/l				170				300			0/45
Methyl-tert-butyl eyther (MTBE)													
Napthalene	91203	ug/l								300			20/85
N-butylbenzene													
N-propylbenzene													
P-isopropyltoluene													
sec-butylbenzene													
Styrene (C)	100425	ug/l			See Note #3			100	100				7/67
tert-butylbenzene													
1,1,1,2- Tetrachloroethane	630206									70			
1,1,2,2- Tetrachloroethane (C)	79345	ug/l		13						2			
1,1,2,2- Tetrachloroethylene (PCE) (C)	127184	ug/l		8.9				5	zero	7			
Tetrahydrofurane													
Toluene	108883	ug/l	253	253				1000	1000	1000			1/115
1,2,3- Trichlorobenzene													
1,2,4- Trichlorobenzene	120821	ug/l				110		70	70				
1,1,1- Trichloroethane	71556	ug/l		329				200	200	600			
1,1,2- Trichloroethane	79005	ug/l			See Note #3			5	3	3			
1,1,2- Trichloroethylene (TCE) (C)	79016	ug/l	330	120				5	zero	30			
Trichlorofluoromethane (Freon 11)	75694	ug/l								2000			
1,1,2- Trichlorotrifluouroethane	76161?	ug/l											
1,2,3- Trichloropropane	96184	ug/l								40			
1,2,4- Trimethylbenzene													
1,3,5- Trimethylbenzene													
Vinyl chloride (C) (Cloroethene)	75014	ug/l		9.2				2	zero	0.2			
Vinyl chloride (C) (continued)	75014	ug/l		See Note #8									
M&P - Xylene													
O - Xylene (1,2-=Dimethylbenzene)													
Xylenes, total	1330207	ug/l		166				10000	10000	10000			0/115
NON- (AND SEMI-) VOLATILE ORGANICS													
Hexachlorobenzene (C)	118741	ug/l	0.000419*	0.00024				1	zero	0.2			
Hexachlorobenzene (C)	118741	ug/l		See Note #8									
Octachlorosytrene													
			*										
POLYNUCLEAR AROMATIC HYDROCARBONS													
Total PAHs													
Acenaphthene	83329	ug/l		20						400		0/2	0/85
Acenaphthylene													
Anthracene	120127	ug/l		0.035						2000		0/2	0/85
Benzo(a)anthracene	56553	ug/l				0.027						0/2	
Benzo(a)pyrene	50328	ug/l			See Note #3			0.2					1/85
Benzo(g,h,i)perylene													
Carbozole													
Fluoranthene	206440	ug/l		1.9						300		0/2	0/85
Fluorene	86737	ug/l				3.9				300		0/2	0/85
1- Methylnaphthalene	90120	ug/l				2.1						0/2	
2- Methylnaphthalene													
Naphthalene	91203	ug/l		81						300		0/2	16/45
Phenanthrene	85018	ug/l		3.6								0/2	

Table B-1
Ground Water and Surface Water ARAR Standards
St Louis River/Interlake/Duluth Tar Superfund Site

CHEMICAL or POLLUTANT	CAS No.	Units	SURFACE WATER STANDARDS (See Notes #1 and #2): 7052 GLI, 2B Chronic Standard (See Note #1)	SURFACE WATER STANDARDS (See Notes #1 and #2): 7050 2B, 2C & 2D, Chronic Standards (See Note #2)	SURFACE WATER CRITERIA AND GUIDELINE VALUES (See Note #3): MN SITE SPECIFIC CHRONIC CRITERIA	TIER II: SECONDARY CHRONIC VALUE (See Note #4)	TIER II: EPA CHRONIC LOEL (See Note #5)	GROUND WATER STANDARDS: MCLs (See Note 6) 4720	GROUND WATER STANDARDS: MCLGs (See Note 6) 4720	GROUND WATER STANDARDS: HRLs (See Note 7) 4717	GROUND WATER STANDARDS: 7065	Detected Above Standards (yes/total # of tests): Surface Water	Detected Above Standards (yes/total # of tests): Ground Water
Pyrene	129000	ug/l								200			0/85
POLYCHLORINATED BIPHENYLS													
Polychlorinated biphenyls (PCBs, total) (C)	1336363	ug/l	0.0000252*	0.000000029				0.5	zero	0.04			
PCBs, total (C)(continued)	1336363	ug/l		See Note #8									
DIOXINS AND DIBENZOFURANS	See Note #16												
Total Dioxin-like equavalence as 2,3,7,8-TCDD													
PCDDs													
2,3,7,8-TCDD	1746016	ug/l	3.1E-09		See Note #3			0.00003	zero				
Other TCDD													
1,2,3,7,8-PeCDD													
Other PeCDD													
1,2,3,4,7,8-HxCDD													
1,2,3,6,7,8-HxCDD													
1,2,3,7,8,9-HxCDD													
Other HxCDD													
1,2,3,4,6,7,8-HpCDD													
Other HpCDD													
1,2,3,4,6,7,8,9-OCDD													
PCDFs													
2,3,7,8-TCDF													
Other TCDF													
1,2,3,7,8-PeCDF													
2,3,4,7,8-PeCDF													
Other PeCDF													
1,2,3,4,7,8-HxCDF													
1,2,3,6,7,8-HxCDF													
2,3,4,6,7,8-HxCDF													
1,2,3,7,8,9-HxCDF													
Other HxCDF													
1,2,3,4,6,7,8-HpCDF													
1,2,3,4,7,8,9-HpCDF													
Other HpCDF													
1,2,3,4,6,7,8,9-OCDF													
Co Planar PCBs													
Structure (IUPAC#)													
3,3',4,4'-TCB (77)													
3,4,4',5-TCB (81)													
2,3,3',4,4'-PeCB (105)													
2,3,4,4',5-PeCB (114)													
2,3',4,4',5-PeCB (118)													
2',3,4,4',5-PeCB (123)													
3,3',4,4',5-PeCB (126)													
2,3,3',4,4',5-HxCB (156)													
2,3,3',4,4',5'-HxCB (157)													
2,3',4,4',5,5'-HxCB (167)													
3,3',4,4',5,5'-HxCB (169)													
2,3,3',4,4',5,5'-HpCB (189)													
INDICATOR PARAMETERS													
Dissolved oxygen	W02	mg/l		5 as a daily min.									
Dissolved oxygen (continued)	W02	mg/l		See Note #11									

Table B-1
Ground Water and Surface Water ARAR Standards
St Louis River/Interlake/Duluth Tar Superfund Site

CHEMICAL or POLLUTANT	CAS No.	Units	SURFACE WATER STANDARDS (See Notes #1 and #2): 7052 GLI, 2B Chronic Standard (See Note #1)	SURFACE WATER STANDARDS (See Notes #1 and #2): 7050 2B, 2C & 2D, Chronic Standards (See Note #2)	SURFACE WATER CRITERIA AND GUIDELINE VALUES (See Note #3): MN SITE SPECIFIC CHRONIC CRITERIA	SURFACE WATER CRITERIA AND GUIDELINE VALUES (See Note #3): TIER II SECONDARY CHRONIC VALUE (See Note #4)	SURFACE WATER CRITERIA AND GUIDELINE VALUES (See Note #3): TIER II EPA CHRONIC LOEL (See Note #5)	GROUND WATER STANDARDS: MCLs (See Note 6) 4720	GROUND WATER STANDARDS: MCLGs (See Note 6) 4720	GROUND WATER STANDARDS: HRLs (See Note 7) 4717	GROUND WATER STANDARDS: 7065	Detected Above Standards (yes/total # of tests): Surface Water	Detected Above Standards (yes/total # of tests): Ground Water
Oil											no free visible oil		
pH	W08	low		6.5, See Note #12							6.5-9.5		
pH (continued)	W08	high		9.0, See Note #12									
Specific conductance	W11	umhos/cm											
Temperature	W12	F		See Note #13									
Total dissolved solids	W14	mg/l											
Turbidity	W15	NTUs		25				TT			25		
Total Organic Carbon													
Unspecified toxic or corrosive substances											See Note #14		
Particle Size analysis													

C= Carcinogenic
WS= Worksheet
TT= Treatment Techniques

NOTES:

Note #1 GLI = Great Lakes Initiative. Minn. Rules ch. 7052, Class 2B chronic standards are applicable to the surface water at the SLRIDT Site. In addition, the surface waters are identified as outstanding international resource waters (OIRW). The objectives for OIRW is to maintain water quality at existing conditions where the water quality is better than existing standards. When Minn. Rule ch. 7052 standards exist, they will be used as the applicable standard for the SLRIDT site. Cadmium, chromium +3, copper, nickel, and zinc are hardness dependent. A hardness of 70 mg/l for the St. Louis River was used. See Worksheets #1.

Highlighted in red box = Bioaccumulative Chemical of Concern (BCC). Highlighted in red box with * = Bioaccumulative substances of immediate concern (BSICs)

Note #2 Minn. Rules pt. 7050.0470 subp. 1 pertains to waters of Lake Superior Basin. The portion of the St.Louis River in which the Interlake site is located is an unlisted water. In Minn. Rule pt. 7050.0430, an unlisted water is classified as a class 2B, 3B, 4A, 4B, 5, and 6 water. Chronic standards for 2B are listed here. If the water quality standards for the various classes are different, the more restrictive of the standards apply. Because a water body has more than one use classification, all the water quality standards in each class apply to that body of water.

In addition, Class 3D, 4C and 5 standards are applicable to wetlands. For pH, if Class 3, 4, or 5 standards are exceeded, background conditions shall be maintained. See Minn. R. 7050.0223, subp. 5; 7050.0224, subp. 4; and 7050.0225, subp. 2. Cadmium, chromium +3, copper, lead, nickel, and zinc are hardness dependent. A hardness of 70 mg/l for the St. Louis River was used. See Worksheets #2.

Note #3 If standards have not been determined in either 7052 or 7050 a site-specific criterion will be developed in accordance with Minn. Rules pt 7050.0218. The MPCA staff have developed site-specific criteria or site-specific guideline values for some chemicals. Site-specific criteria are more thoroughly investigated, but neither criteria nor guideline values have been promulgated to standards. Iron and manganese have special application. Please consult MPCA staff and obtain their approval prior to use of the criteria or guideline values.

Note #4 Criteria values developed by Suter and Tsao (1996) using Tier II method described in EPA's Water Quality Guidance for the Great Lakes System. Suter, G.W. and C.L. Tsao, 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. Oak Ridge National Laboratory, Health Sciences Research Division. ES/ER/TM-96/R2. Source for biphenyl (92524), tetrachloromethane (56235), and tribromomethane (75252) Tier 2 Secondary Chronic Values: EPA 1996. Ecotox thresholds. ECO Update 3(2). EPA 540/F-95/038. OSWER.

Note #5 Lowest Observed Effect Level values reported by EPA when insufficient data exists to calculate a National Ambient Water Quality Criterion. Effects were observed at this level and, therefore, the water concentration stated is not protective.

Note #6 HRLs = Health Risk Limits. Cleanup levels for groundwater contamination plumes will be based on managing risk by applying promulgated health risk groundwater standards for human receptors and promulgated aquatic life standards for environmental receptors. Minn. Rules 7060, Underground Waters of the State establishes state policy and imposes regulations on pollution of all ground waters in the state. The policy of Minn. Rules ch. 7060 is to preserve these waters for their highest resource value defined as a source of drinking, culinary, or food processing water. Minn. Rules ch. 7060 also includes a nondegradation goal, prohibition of discharge to saturated zone, limitation on discharge to unsaturated zone, and remediation requirements

The HRLs, adopted under Minn. Stat. § Section 103H.201 are appropriate cleanup levels for managing ground water contamination and risk to human receptors in compliance with Minn. Rules ch. 7060. The individual HRL values have been derived to correspond to the target risk levels. When multiple contaminants exist as a site, a mixtures evaluation is required to determine whether the target risk limit for the mixture is exceeded. The MCL "action level" for Lead and Copper is listed. If the "action level" listed for Lead and Copper is exceeded in more than 10 percent of the samples collected from household taps corrective action must be taken.

Note #7 The National Primary and Secondary Drinking Water Standards (40 CFR Parts 141-143), better known as maximum contaminant levels and maximum contaminant level goals (MCLs and MCLGs), are relevant and appropriate standards, because the groundwater in the area is a potential source of drinking water. Groundwater from the deep aquifer artesian wells has, in the past, been used as a drinking water source. In addition, groundwater use through private wells may occur off-site within the vicinity of the site.

Note #8 For a pollutant with an asterisk next to the FAV and the maximum standard (MS), the following applies. For carcinogenic or highly bioaccumulative chemicals with BCF's greater than 5000 or log Kow values greater than 5.19, the human health chronic standard may be two or more orders smaller than the acute toxicity-based MS. For the MS: if the ratio of CS to the MS is greater than 100, the CS times 100 should be substituted for the applicable MS. For the FAV: if the ratio of CS to FAV is greater than 200, the CS times 200 should be substituted for the applicable FAV. From Minn R. 7050.0222, subp. 7.

Table B-1
Ground Water and Surface Water ARAR Standards
St Louis River/Interlake/Duluth Tar Superfund Site

CHEMICAL or POLLUTANT	CAS No.	Units	SURFACE WATER STANDARDS (See Notes #1 and #2)		SURFACE WATER CRITERIA AND GUIDELINE VALUES (See Note #3)			GROUND WATER STANDARDS				Detected Above Standards (yes/total # of tests)	
						TIER II							
			7052 GLI, 2B Chronic Standard (See Note #1)	7050 2B, 2C & 2D, Chronic Standards (See Note #2)	MN SITE SPECIFIC CHRONIC CRITERIA	SECONDARY CHRONIC VALUE (See Note #4)	EPA CHRONIC LOEL (See Note #5)	MCLs (See Note 6) 4720	MCLGs (See Note 6) 4720	HRLs (See Note 7) 4717	7065	Surface Water	Ground Water

Note #9

AMMONIA, un-ionized as N - Standards that vary with pH and Temperatures. See attached Worksheet #3 (7050) for performing calculations. The ammonia leaching toward a surface water from a contaminated ground water site should be measured by collecting water samples from the temporary and permanent wells that are located within the site plume upgradient to and within a two year travel time of discharge to the surface water body in question. The ammonia needs to be analyzed as TOTAL ammonia. The pH and temperature of the receiving body of water also need to be measured at the time the ammonia sample is taken. This information is used in the equation listed below, to determine the percent un-ionized ammonia, which, is then utilized to convert the total ammonia concentration in the wells to an un-ionized concentration.

The percent unionized ammonia can be calculated for any temperature and pH by using the following formula taken from Emerson, K., R.C. Russo, R.E. Lund, and R.V. Thurston. 1975. Aqueous ammonia equilibrium calculations; effect of pH and temperature. Journal of the Fisheries Board of Canada 32: 2379-2383.

$f = [\,1 / (10^{(pka - pH)} + 1]\times 100$

where:

f = the percent of the total ammonia in the un-ionized state

pka = 0.09 + [2730/T], the dissociation constant for ammonia

T = temperature in degrees Kelvin (273.16 degrees Kelvin = 0 degrees Celsius).

Note #10 Worksheet #5 contains potency slope factors and a weighting scheme for cPAHs for groundwater.

Note #11 Dissolved Oxygen. This standard applies to all Class 2 waters. The dissolved oxygen standard requires compliance with the standard 50 percent of the days at which the flow of the receiving water is equal to the lowest weekly flow with a once in ten year recurrence interval (7Q10). (From Minn. R. 7050.0222, subps. 4 and 5). Class 2D: If background is less than 5.0 mg/l. as a daily minimum, maintain background.

Note #12 pH. Class 2D standard: Maintain background.

Note #13 Temperature. **Class 2B standard:** Five degrees F above natural in streams and three degrees F above natural in lakes, based on monthly average of maximum daily temperature, except in no case shall it exceed the daily average temperature of 86 degrees F. **Class 2D standard**: Maintain background.

Note #14 None at levels acutely toxic to humans or other animals or plant life, or directly damaging to real property.

Note #15

SECONDARY DRINKING WATER REGULATIONS (SDWR)

Chemical	Status	SDWR (ug/l)
Aluminum	Final	50 to 200
Chloride	Final	250,000
Color	Final	15 color units
Copper	Final	1000
Corrosivity	Final	non-corrosive
Fluoride	Final	2000
Foaming Agents	Final	500
Iron	Final	300
Manganese	Final	50
Odor	Final	3 threshold odor numbers
pH	Final	6.5-8.5
Silver	Final	100
Sulfate	Final	250,000
Total Dissolved Solids (TDS)	Final	500,000
Zinc	Final	5000

Summer 2000 Drinking Water Regulations and Health Advisories (Office of Water, EPA). (http://www.epa.gov/ostwater/drinking/standards/)

SDWR - Secondary Drinking Water Regulations. Non-enforceable Federal guidelines.

Note #16 Dioxin and Furan equivalence are found in 7052.0380.

Yellow highlighting shows the standard used for surface water for the "Detected Above Standards" Column.

Purple highlighting shows the standard used for groundwater for the "Detected Above Standards" Column.

Green highlighting of the compoounds indicates that the MPCA found the compounds to not be significant of concern based on standards.

Table B - 2

DRAFT (will be final in ROD) Contaminant	**Site Specific PRGs**					
	Sediment		**Pore Water**	**Biota**	**Surface Water**	
	Definition of the areal extent to be remediated (Dredge or cap)	Bulk sediment at the base of the BAZ in cap	Pore water by ESG from bulk sediment at the base of the BAZ in cap	Biota tissue residue in capped areas (species to be determined)	Surface water FAVs outside the remedial treatment zone	Discharge of treated CAD water
INORGANICS -- TRACE METALS					**(ug/l)**	**(ug/l)**
Arsenic		0.6 of the Mean PEC-Q			680	BT/PT Values (to be determined)
Cadmium					6.04**	
Chromium, total						
Chromium, +3					2692**	
Chromium, +6					32	
Copper					20	
Iron					2726	
Lead					155**	
Manganese						
Nickel					694**	
Zinc					177**	
Mercury (total)		0.3 mg/kg		**TBD**	0.26!	
INORGANICS -- MAJOR IONS					**(ug/l)**	**(ug/l)**
Cyanide, free					44!!	BT/PT Values (to be determined)
Sulfate						
VOLATILE ORGANICS					**(ug/l)**	**(ug/l)**
Benzene					8974	8974
Ethyl benzene					3717	3717
Toluene					2703	2703
Xylenes, total					2814	2814
POLYNUCLEAR AROMATIC HYDROCARBONS					**(ug/l)**	**(ug/l)**
Total PAHs	13.7 mg/kg	**TBD** mg/kg				
Total C-PAHs as BAP Eq. (list to be determined)				**TBD**		
Acenaphthene			USEPA ESB FCV TU > 1.0 (PAH final list to be determined)		112	BT/PT Values (to be Determined)
Acenaphthylene					0.63	
Anthracene						
Benzo(a)anthracene						
Benzo(a)pyrene					0.625*	
Benzo(g,h,i)perylene						
Carbozole						
Fluoranthene					6.9	
Fluorene						
1- Methylnaphthalene						
2- Methylnaphthalene						
Naphthalene					818	
Phenanthrene					64	
Pyrene						
INDICATOR PARAMETERS						
pH					6.0 - 9.0	6.0 - 9.0
Total suspended solids					**TBD**	**TBD**
Turbidity					**TBD**	**TBD**

TBD = To Be Determined

* Benzo-a-pyrene is a carcinogen and the Aquatic Life Site specific criterion FAV was determined to be 0.625 ug/l. See Minn. Rule ch. 7052.0110, subpart 2 for more information.

** Based on the hardness of 70 mg/l as CaCO3 (St. Louis River at WLSSD)

! Mercury is normally applied as the chronic std of 1.3 ng/l, however, given the dredging operation, EO will allow the use of an adjusted FAV. 260 ng/l as an FAV is the result of 200 times the chronic standard (1.3 ng/l). This is done because of the highly bioaccumulative nature of mercury. See Minn. Rule ch. 7050.0222, subpart 7, item E for more information.

!! The metals are applied as total metals as required by EPA, however, the following metals can have an adjusted total FAV taken into account the dissolved fraction relationship shown in Minn. Rule ch. 7052.0360: arsenic, cadmium, chromium III, chromium VI, copper, lead, nickel, silver, and zinc. Mercury is also listed in Minn Rule ch. 7052.0360, however, because of the highly bioaccumulative nature of mercury, EO will not apply the metal conversion factor for mercury found in Minn. Rule ch. 7052.0360.

BT/PT = Best Technology in Process and Treatment

APPENDIX C

AIR EMISSIONS ESTIMATES AND MODELING UPDATES

SLRIDT SITE FEASIBILITY STUDY

1.0 INTRODUCTION

Air emissions from alternatives with dredging and disposal in a CAD or in an off-site disposal facility were measured in the laboratory and modeled for the site in the DGR (SERVICE 2002) Appendices A-1 through A-4. The results predicted that naphthalene may exceed the acute and chronic ambient air standards during dredging in Stryker Bay. The MPCA and Minnesota Department of Health expressed concern about the uncertainty inherent in the study and its results.. Based on those comments and discussions with Dr. Reible of Louisiana State University, and more investigation of the testing and modeling inputs, changes were made and the emissions were remodeled. This appendix describes the key changes and impacts to the modeling results.

2.0 EMISSION Data Changes

The DGR used a naphthalene solubility limit of 7 mg/L and an additional correction factor of 5.2% to predict the actual solubility of naphthalene at the Site. Since the 7 mg/L is proposed as a site-specific solubility there was no need for adding an additional factor of 5.2%. Therefore, using the logic in the DGR Appendix A2, Section A2-3.3.3, the proposed “breakpoint” of 238 $mg_{naphthalene}/kg_{sed}$ should be 4,570 $mg_{naphthalene}/kg_{sed}$. (A breakpoint is a sediment concentration above which greater concentrations do not increase the concentration dissolved in the water or the flux to the air. Below this breakpoint, sediment concentration varies linearly with solubility and flux rate.)

Dr. Danny Rieble from LSU was consulted since he had initially recommended the use of a breakpoint to extrapolate test data to other sediment concentrations. On April 23, 2003, Dr. Rieble affirmed the approach of linear scaling for sediment with concentrations different than the tested sediment. He agreed there is a breakpoint, which the sediment concentration is unimportant and the expected dissolution rate will be constant. Dr. Rieble agreed with the MPCA's conclusion that use of a 5.2% ratio of naphthalene to other organics measured in NAPL was redundant with the use of site-specific solubility and Koc values when calculating a Break Point limit.

Consequently, SERVICE has removed the 5.2% factor from it breakpoint calculations, while using the site specific Koc and solubility. The revised breakpoint is 4,570 mg/kg. The revised sediment breakpoint curves and their method of construction are shown in Figure C-1. Increasing the breakpoint effectively increases the projected emission rates for sediment with the higher concentrations of naphthalene when compared to the original modeling.

To calculate sediment concentration scaling factors, SERVICE used the measured slurry concentration of naphthalene in each of the three slurry emission tests as equal to a scaling factor of 1.0 for emission flux rates. This means that the sediment concentration for each modeled cell would be divided by the sediment concentration from the emission test slurry to determine strength factors for other sediment concentrations. Where the modeling cell sediment concentration exceeds a breakpoint of 4,570 mg/Kg, the calculated emission rate for 4,570 mg/Kg will be substituted, effectively limiting the strength factor maximum to that of the breakpoint.

As a result of the new breakpoint, in combination with the relative positioning of the test result on the sloped portion of the breakpoint function, several Stryker Bay modeling cells had strength factors greater than 1.0. The calculated strength factors for each dredging cell for each emission test are shown in Table C-1. Each of the cell sediment concentrations with the appropriate correction factors is shown graphically in Figure C-1. These strength factors were then used for input to update the dispersion model while dredging each cell.

Dispersion modeling was conducted to estimate the chronic and acute exposures with this new correction. Three runs were prepared using Option 1 Alternative 5 from the base case in the DGR. The first run included only the impact of dredging in the northern half of Stryker Bay over 7 months of construction. This would be equivalent to 100 percent efficient engineering controls for emissions from the CAD or on-site dewatering facilities. The second run included Stryker Bay dredging with a Slip 6 CAD disposal with no engineering controls, and the third run assumed a 75% efficiency in engineering controls for the Slip 6 CAD. Note that since these last runs, the CAD has been moved to Slip 7 to increase its distance from the home and business receptor properties.

In addition to the newly corrected breakpoint adjustments, some changes were made to make the CAD more representative of actual site conditions. They are as follows:

- Reduce the number of cells containing higher-emitting 8% mixed slurry from four to one, assuming the truly turbid area is smaller than previously modeled. The 8% quiescent flux rate was substituted for the other three active primary cells reflecting a less agitated condition since they would be farther from the presumed discharge point.
- The two southern quiescent (settling chamber) cells were reduced from the 0-24 hr quiescent flux rate to the 6-24 hr quiescent flux rate to better reflect flocculated conditions with dissolved naphthalene remaining after flocculation.
- The strength factors were adjusted monthly (replacing annual average) at the CAD, based on the concentration in the active dredge cell to better reflect the sediment being discharged to the CAD.

These adjustments in the model and the resulting emission rates for input are shown in Table C-2 for Case 2 where all sources are uncontrolled. Cases 1 and 3 can be derived from this table by reducing or eliminating some of the sources.

This modeling does not include updates to the Dredge/Off-Site Disposal Alternative.

3.0 Discussion of Results

Although the best available testing and modeling have been applied to conditions at the SLRIDT Site, the State and Companies agree that a large amount of uncertainty cannot be eliminated. So the modeling results will be interpreted only qualitatively.

With these adjustments, the dredge activity is about a third of the emission sources with the CAD representing the other two-thirds. These results match well with US Steel's model and actual monitoring experience when dredging sediment containing naphthalene from the Grand Calumet River. The largest emissions from dredging and placement of dredged material in the CAD are now directly associated with sediments with the highest concentration of naphthalene.

Even with engineering controls at the CAD assumed to be in the 75-100% range, the acute and chronic limits would likely be exceeded, with the acute limits potentially exceeded in the larger area.

Estimated exceedances occurred only when the two high dredging cells with the highest naphthalene concentrations in Stryker Bay were dredged. The model estimates that if those cells were not dredged, the naphthalene limits could likely be met while dredging. The number of days per month (21 working days per month) in compliance would be the same for all three modeled cases and are shown in Figure C-2. The number of receptors affected and maximum concentrations would vary depending on the success of controls on the CAD.

Table C-1 Sediment Correction Factors Using 4570 mg/Kg Break Point and Sediment Emission Test Slurry Naphthalene Concentrations

Air Emission Sediment Slurry Type	Sediment Concentration (mg/Kg)
1%Q	480
8%Q	956
8%M	195

Stryker Bay Emission Model Cell #	Highest Naphthalene Result in cell (mg/Kg)	1%Q 4570 BP Emission Rate Multiplier	8%Q 4570 BP Emission Rate Multiplier	8%M 4570 BP Emission Rate Multiplier
7	0	0.000	0.000	0.000
15	0	0.000	0.000	0.000
14	5	0.010	0.005	0.026
6	10	0.021	0.010	0.051
12	10	0.021	0.010	0.051
1	17	0.035	0.018	0.087
4	18	0.038	0.019	0.092
3	23	0.048	0.024	0.118
9	27	0.056	0.028	0.138
2	132	0.275	0.138	0.677
8	132	0.275	0.138	0.677
13	1100	2.292	1.151	5.641
5	1200	2.500	1.255	6.154
Break Point	4570	9.521	4.780	23.436
11	5600	9.521	4.780	23.436
10	15000	9.521	4.780	23.436

Bold cells are modeled in the northern half of Stryker Bay.

TABLE C-2. NAPHTHALENE EMISSION RATES USED IN CHRONIC ANALYSIS AND EVALUATION OF DAYS PER YEAR OVER ODOR THRESHOLD FOR ALTERNATIVE 5 - CASE 2

Raking / Dredging in Stryker Bay

		Working - 1% Quies. (0-2 Hrs)				Off Hours - 1% Quies. (0-6 Hrs)				Weekend - 1% Quies.(6-24 Hrs)						
Month	Dredge Sequence	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Monthly Active ER, ($g/m^2/s$)	Monthly Background ER ($g/m^2/s$)	Monthly Emissions[a], (kg)
April	Cell 11	9.521	1,209,222	22	15	9.521	600,498	22	9	9.521	66,631	9	24	1.863E-04	1.851E-05	14,482
May	Cell 10	9.521	1,209,222	22	15	9.521	600,498	22	9	9.521	66,631	9	24	1.863E-04	1.851E-05	14,482
June	Cell 9	0.056	7,144	22	15	0.056	3,548	22	9	0.056	394	9	24	1.100E-06	1.094E-07	86
July	Cell 3	0.048	6,086	22	15	0.048	3,022	22	9	0.048	335	9	24	9.374E-07	9.315E-08	73
August	Cell 2	0.275	34,927	22	15	0.275	17,345	22	9	0.275	1,925	9	24	5.380E-06	5.346E-07	418
September	Cell 8	0.275	34,927	22	15	0.275	17,345	22	9	0.275	1,925	9	24	5.380E-06	5.346E-07	418
October	Cell 1	0.035	4,498	22	15	0.035	2,234	22	9	0.035	248	9	24	6.928E-07	6.885E-08	54
															7-Month Total =	30,013

Note: Chronic analysis assumed completion of one 3-acre cell per month and 7 cells per year.

a. Total monthly emissions include the other 14 cells in Stryker Bay at the Weekend - 1% Quiescent (6-24 hour) emission rate. For instance, in April while Cell 11 is dredged, all other 14 cells are at a backround emission rate due to naphthalene escaping the silt curtain.

CDF Agitated Pool in Northmost Cell (AGIT 1)

		Working - 8% Mixed Slurry (0-2 Hs)				Off Hours - 8% Quies. Slurry (0-6 Hrs)				Weekend - 8% Quies. Slurry (6-24 Hrs)					
Month	Dredge Sequence	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Emission Rate, ($g/m^2/s$)	Monthly Emissions[a], (kg)
April	Cell 11	23.436	4,555,938	22	15	4.780	251,943	22	9	4.780	34,694	9	24	5.828E-04	18,949
May	Cell 10	23.436	4,555,938	22	15	4.780	251,943	22	9	4.780	34,694	9	24	5.828E-04	18,949
June	Cell 9	0.138	26,917	22	15	0.028	1,489	22	9	0.028	205	9	24	3.443E-06	112
July	Cell 3	0.118	22,929	22	15	0.024	1,268	22	9	0.024	175	9	24	2.933E-06	95
August	Cell 2	0.677	131,594	22	15	0.138	7,277	22	9	0.138	1,002	9	24	1.683E-05	547
September	Cell 8	0.677	131,594	22	15	0.138	7,277	22	9	0.138	1,002	9	24	1.683E-05	547
October	Cell 1	0.087	16,948	22	15	0.018	937	22	9	0.018	129	9	24	2.168E-06	70
														7-Month Total =	39,271

CDF Agitated Pool in Lower 75% of Cells (AGIT 2, AGIT 3, and AGIT 4)

		Working - 8% Quies Slurry (0-2 Hrs)				Off Hours - 8% Quies. Slurry (0-6 Hrs)				Weekend - 8% Quies. Slurry (6-24 Hrs)					
Month	Dredge Sequence	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Emission Rate, ($g/m^2/s$)	Monthly Emissions[a], (kg)
April	Cell 11	4.780	408,891	22	15	4.780	251,943	22	9	4.780	34,694	9	24	7.180E-05	2,335
May	Cell 10	4.780	408,891	22	15	4.780	251,943	22	9	4.780	34,694	9	24	7.180E-05	2,335
June	Cell 9	0.028	2,416	22	15	0.028	1,489	22	9	0.028	205	9	24	4.242E-07	14
July	Cell 3	0.024	2,058	22	15	0.024	1,268	22	9	0.024	175	9	24	3.614E-07	12
August	Cell 2	0.138	11,810	22	15	0.138	7,277	22	9	0.138	1,002	9	24	2.074E-06	67
September	Cell 8	0.138	11,810	22	15	0.138	7,277	22	9	0.138	1,002	9	24	2.074E-06	67
October	Cell 1	0.018	1,521	22	15	0.018	937	22	9	0.018	129	9	24	2.671E-07	9
														7-Month Total =	4,839

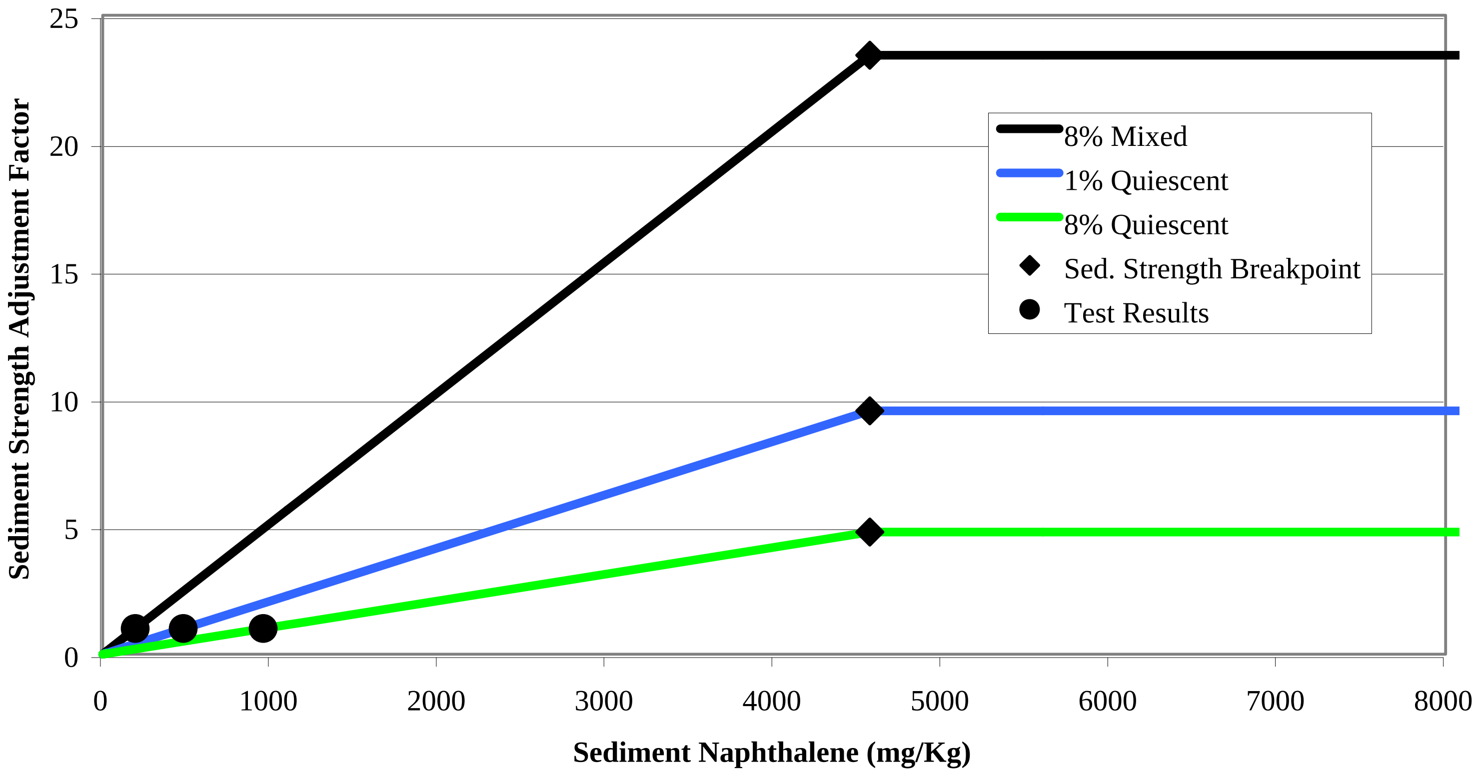
CDF Quiescent Pool (QUE 1 and QUE 2)

		8% Quies. Slurry (6-24 Hrs)					
Month	Dredge Sequence	Discount Factor	Discount ER ($\mu g/m^2/hr$)	Days	Hrs	Monthly ER ($g/m^2/s$)	Monthly Emissions[a] (kg)
April	Cell 11	4.780	34,694	31	24	9.637E-06	313
May	Cell 10	4.780	34,694	31	24	9.637E-06	313
June	Cell 9	0.028	205	31	24	5.694E-08	2
July	Cell 3	0.024	175	31	24	4.850E-08	2
August	Cell 2	0.138	1,002	31	24	2.784E-07	9
September	Cell 8	0.138	1,002	31	24	2.784E-07	9
October	Cell 1	0.018	129	31	24	3.585E-08	1
						7-Month Total =	649

Sample Calculations for Naphthalene for Raking and Dredging for Cell 9 in June:

$[(0.056 * 127008\ \mu g/m^2/hr * 2.5\ acres * 4046.83\ m^2/acre * 22\ days * 15\ hrs / 10^6\ \mu g/g) + (0.056 * 63072\ \mu g/m^2/hr * 0.5\ acre * 4046.83\ m^2/acre * 22\ days * 15\ hrs / 10^6\ \mu g/g) +$
$(0.056 * 63072\ \mu g/m^2/hr * 3\ acre * 4046.83\ m^2/acre * 22\ days * 9\ hr / 10^6\ \mu g/g) + (0.056 * 6998.4\ \mu g/m^2/hr * 3\ acre * 4046.83\ m^2/acre * 9\ days * 24\ hrs / 10^6\ \mu g/g)] /$
$3\ acres / 4046.83\ m^2/acre / 31\ days/month / 24\ hours/day / 3600\ seconds/hr = 1.1E-06\ g/m^2/s$

Figure C-1 Sediment Strength Factors Using 4570 mg/Kg Break Point and Sediment Emission Test Slurry Naphthalene Concentrations



Solution is determined by defining the portion below the breakpoint using the two values (0,0) and (test concentration,1.0) to define slope. Beyond the breakpoint, the strength factor remains constant at the breakpoint value.

Figure C-2
Days of Acute Emissions Exceedence