## Focused Feasibility Study

# Lower Maumee River Wastewater Treatment Plant and Sway Bridge

### Maumee Area of Concern, Toledo Ohio • September 2023

**Prepared For:**

**United States Environmental Protection Agency**
Great Lakes National Program Office
77 West Jackson Boulevard, SR-6J • Chicago, Illinois 60604-3507
Interagency Agreement/Amendment No. DW-096-95980201

**Prepared By:**

**United States Army Corps of Engineers - Buffalo District**
478 Main Street • Buffalo, NY 14202

Great Lakes RESTORATION · EPA United States Environmental Protection Agency · Ohio Environmental Protection Agency · Ohio Lake Erie Commission · U.S. ARMY · US Army Corps of Engineers® Buffalo District

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## TABLE OF CONTENTS

# TABLES, FIGURES, AND APPENDICES

## List of Tables



## List of Figures

**List of Appendices**

## LIST OF ABBREVIATIONS

| | |
|---|---|
| AOC | Area of Concern |
| BSAF | biota-sediment accumulation factors |
| BUI | beneficial use impairment |
| CDF | confined disposal facility |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| COC | constituent of concern |
| CSM | conceptual site model |
| CY | cubic yards |
| ENR | enhanced natural recovery |
| EPA | Environmental Protection Agency |
| FFS | focused feasibility study |
| GLLA | Great Lakes Legacy Act |
| GLNPO | Great Lakes National Program Office |
| IBI | index of biotic integrity |
| ICI | invertebrate community index |
| LF | linear feet |
| L-ICI | lacustrine invertebrate community index |
| LWD | lower water datum |
| LMR | Lower Maumee River |
| mg/kg | milligram/kilogram |
| MNR | monitored natural recovery |
| NCP | National Contingency Plan |
| ORD | Office of Research and Development |
| PAH | polycyclic aromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| PEC | probable effect concentration |

| | |
|---|---|
| ppm | parts per million |
| QHEI | Qualitative Habitat Evaluation Index |
| RAO | remedial action objectives |
| RAP | remedial action plan |
| RG | remedial goal |
| SHPO | State Historic Preservation Office |
| SSP | steel sheet pile |
| SWAC | surface weighted average concentration |
| TCLP | toxicity characteristic leaching procedure |
| TEC | threshold effects concentration |
| TOC | total organic carbon |
| TU | Toxicity Unit |
| TLCPA | Toledo-Lucas County Port Authority |
| USACE | US Army Corps of Engineers |
| USC | US Code |
| EPA | US Environmental Protection Agency |
| WWTP | wastewater treatment plant |

# 1. INTRODUCTION

The United States Environmental Protection Agency (EPA) and Ohio EPA entered into a Great Lakes Legacy Act (GLLA) Project Agreement to conduct Focused Feasibility Studies (FFSs) in the Maumee Area of Concern (AOC), Toledo, Ohio. The US Army Corps of Engineers (USACE) Buffalo District prepared this FFS through an Interagency Agreement with the EPA Great Lakes National Program Office (GLNPO). This FFS has been prepared to evaluate remedial alternatives for contaminated sediment in the Lower Maumee River (LMR) project area and includes two distinct reaches (Sway Bridge and wastewater treatment plant (WWTP)). The scope of this FFS does not consider alternatives for any other matrix such as soil, surface water, or groundwater that may be impacted at the site.

The format of this study follows similar and previously developed FFSs for other sediment remedial actions in the Maumee AOC and other Great Lakes AOCs. It utilizes the organizational format and evaluation criteria established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), although it does not fall under the purview of that regulation. This FFS will assume the formulation of multiple alternatives and a rough order of magnitude cost estimate for the remedy Planning and preliminary design in this FFS includes remedial technologies and processing options such as sediment removal, capping, transport, dewatering, and evaluation of potential placement (disposal) sites, as well as the no action alternative and monitored natural recovery (MNR) alternatives at each of the sites.

This FFS relies primarily on the data compilation and analysis of sediment chemistry and biological conditions presented in the Sediment Characterization Report (USACE 2022) to support the evaluation of potential remedial measures. Additional lines of evidence provided by project partners are described in Section 1.3.1. This FFS report:

- Identifies remedial action objectives (RAOs);
- Considers the range of available remedial technologies;
- Evaluates those technologies considered relevant to the remediation of the LMR sediment of concern; and
- Compares remedial alternatives to help identify a preferred remedy for contaminated sediment in the Lower Maumee River.

The following sections describe the conceptual site model (CSM) for the two reaches of the river being considered for sediment remediation. The CSM provides a description of the study area including land uses and potential sources of contamination, summary of investigations used to support the FFS, and the beneficial use impairments (BUIs) resulting from previous industrial and commercial uses of the river. It also describes impacts to receptors potentially being exposed to the contamination.

## 1.1 Maumee River and AOC Background

The LMR project area is part of the 130-mile-long Maumee River that originates near Fort Wayne, Indiana. The lower 23 miles of the Maumee River are located within the Maumee AOC, in Toledo, Ohio. The Maumee River is the largest waterbody in the Maumee AOC. Land use throughout the greater Maumee AOC is diverse, representing urban and rural developments, agriculture, and pockets of native forests, prairies, and wetlands. This area is designated as an AOC due to human activities (industry, agriculture, shipping, etc.) that have impaired the human use (i.e., drinking water, fish consumption, recreation) and ecological use (i.e., habitat, aquatic population, wildlife diversity) of this area (MAAC 2023).

In 1985, Maumee AOC was designated as one of the 43 international “areas of concern” due to ecosystem impacts and degraded water quality. According to the Great Lakes Water Quality Agreement, an AOC may have up to 14 different BUIs resulting from changes in the chemical, physical, or biological integrity of the Great Lakes system (IJC 1987). The BUIs established for an AOC assist communities in defining the issues that negatively impact the area thereby supporting restoration efforts. The Maumee Remedial Action Plan (RAP) organization was formed in 1987 as a community effort to restore the area’s waterways to “fishable and swimmable” conditions. The Maumee AOC was determined to have 10 BUIs. There are five BUIs for the portion of the Lower Maumee Large River Assessment Unit, which is within the Maumee AOC. These include:

- Degradation of fish populations – BUI 3a
- Degradation of benthos – BUI 6
- Restrictions on dredging activities – BUI 7
- Eutrophication or undesirable algae – BUI 8
- Loss of fish and wildlife habitat – BUI 14

The remediation of contaminated sediments will contribute to the removal of the degradation of benthos BUI.

The last seven miles of the Maumee River includes a portion of the Toledo Harbor federally maintained navigation channel which is designed to accommodate deep-draft commercial navigation. Specifically, the Maumee River includes approximately seven of the 13-mile-long navigation channel which is maintained by the US Army Corps of Engineers, Buffalo District. The channel is maintained to a depth of -27 feet Low Water Datum (LWD) and width of 400 feet within the first three miles.

The Toledo Harbor federal navigation channel supports the Port of Toledo, which offers 35 piers, wharves and docks located in Maumee Bay along the southeast side of the Maumee River mouth, and along both banks of the lower seven miles of the river. Many of the piers, wharves and docks are used for multiple purposes. The port handles over 27 different bulk commodities. Historically, three dry bulk commodities have been dominant – receipt of iron ore, shipment of coal, and shipment of grain. Other bulk commodities handled through the port include gravel, sand, salt, limestone, wheat, oats, soybeans, maize, coke, abrasives, pig iron, fertilizer, cement, molasses, benzene, and scrap metal. In addition, several waterfront facilities are equipped to receive and/or ship petroleum products (e.g., oil, asphalt). The Toledo-Lucas County Port Authority (TLCPA) offers long- and short-term dry storage space, as well as open storage areas, for commodities shipped through the port. The Port of Toledo also holds waterfront plants engaged in making repairs to vessels of wide-ranging sizes. Tug operations for towing, docking and shifting vessels at the harbor, and for towing services at numerous other Great Lakes ports, are also housed at the port (USACE 2022a).

The portions of the river being addressed in this FFS are adjacent to (outside of) the navigation channel and are not maintained by the USACE.

## 1.2 Project Area Descriptions

The lower portion of the Maumee River continues to be a crucial commercial resource to the region, while also providing recreational opportunities to the community and an increasing amount of habitat to aquatic life and wildlife in the Maumee AOC. The following sub-sections describe the two project sites and surrounding land and river uses.

### 1.2.1 Sway Bridge

The bridge referred to as "the Sway Bridge" in this report is the second railroad bridge in the river, located approximately two miles from the mouth of the river (see Figure 1-1). It is owned by Wheeling & Lake Erie Railway and is also called Toledo Pivot Bridge. Sediment contamination was observed upstream and downstream of the Sway Bridge. Historically, the land use adjacent to the Sway Bridge site supported industrial operations including iron, coke, and manufactured gas operations, including former petroleum facilities. The TLCPA owns most of the land adjacent to the Sway Bridge area which supports industrial uses including several active docks, barge access, and refineries. Future uses may include the docking of commercial vessels that may need up to 27 to 28 feet of water depth.

There are several structures in or adjacent to the Sway Bridge project area. The bridge, which is used by Norfolk and Western Railroad, includes an abutment. Downstream of the bridge is the Ironville dock which contains an active railyard and steel sheet pile (SSP) dock with cranes and unloading equipment. A very old, concrete wall reinforced with PZ sheet pile is located upstream of the Sway Bridge. Approximately a half a mile downstream from the Sway Bridge is another railroad bridge owned by CSX (also known as the Jessie St. Bridge or the Lower River Bridge). There is a fuel dock, containing a pipeline for unloading vessels, just upstream of the CSX railroad bridge. Finally, a petroleum pipeline and other utility chases also intersect the Sway Bridge project area (Figures 1-1 and 1-2). Details regarding the Sway Bridge's shoreline structures can be found in Appendix E.

In addition to the industrial uses of the river, efforts are being made to restore aquatic habitat within the river in order to remove the loss of fish and wildlife populations and habitat BUIs (BUI 3, BUI 14). For example, the Penn 7 ecosystem restoration site, which provides quality habitat for area fish and wildlife, was recently completed by the City of Toledo and is across the river from the Sway Bridge area.

In the vicinity of the Sway Bridge area, there are several property owners that may be impacted by the project. These include the TLCPA, several railroads, a pipeline company, and a real estate agency.

### 1.2.2 Wastewater Treatment Plant

The WWTP project area (see Figure 1-2) is located on the north side of the LMR, near the mouth of the river, and adjacent to the WWTP, located on Summit Street. The City of Toledo's Division of Water Reclamation operates the WWTP, which discharges to the Lower Maumee River. The WWTP has been in operation since 1932. Contaminated sediments have been observed in the vicinity of the WWTP's discharge to the river since the mid-1990's (EA 2014). Other uses along the shoreline of the river include active marinas and boat docks.

A concrete lake wall runs along the perimeter of the WWTP and includes several culverts, outfalls, and a discharge apron. The concrete appears to have been poorly consolidated in places, some spalling was observed. The pile shoreline downstream of the WWTP varies with respect to configuration (type, height, thickness, size, and shape) and condition. Details regarding the WWTP's shoreline structures can be found in Appendix E.

Recreational boaters frequent the mouth of the river, taking advantage of marinas and yacht clubs in the vicinity of the harbor and the WWTP (e.g., Toledo Yacht Club, Bay View Yacht Club, Harbor View Yacht Club).

In the vicinity of the WWTP area, there are four separate property owners that may be impacted by the project. These property owners include the US Coast Guard, USACE (Buffalo District Toledo Area Project Office), City of Toledo, a private marina, and a private dock operator.

## 1.3 Site Characterization

### 1.3.1 Previous Investigations

The analysis of alternatives presented in this FFS is supported by the understanding of the nature and extent of contamination in the LMR project area sediment, river, and ecological conditions based on data collected in 2011, 2013, and 2021.

EPA performed two initial sediment sampling characterization events in the LMR project area (phase 1 in 2011 and phase 2 in 2013), focusing on characterizing the chemical and physical nature of sediment outside of the federal navigation channel (Weston 2012 and EA 2014). The USACE was tasked with consolidating those results with the results of USACE's sediment characterizations from within the navigation channel, and subsequently identifying any gaps in this data needed to address areas of potential sediment contamination (USACE 2021c). Two decisions were made as a result of that data gap evaluation: (i) no further action was needed in the upstream portion of the river (Ohio EPA 2021b), and (ii) further investigation should occur in two distinct areas (WWTP and Sway Bridge) of apparent sediment contamination within the downstream portion of the LMR project area in order to determine appropriate remedial actions.

In 2021, several investigations were conducted by the Maumee AOC team (EPA, Ohio EPA, USACE, EPA Office of Research and Development, US Fish and Wildlife Service) to further characterize the chemical, biological, and physical nature of the sediments within the LMR. The data gap investigation involved the collection of sediment samples from 69 locations in the LMR project area, which included 63 sediment cores and 29 surface grab samples (USACE 2021c).

Sediments were analyzed for bulk chemistry and screened against the probable effects concentration (PEC), the sediment concentrations above which adverse effects may occur to benthic macroinvertebrates (MacDonald et al 2000). Toxicity and bioaccumulation assays were conducted on the sediments by exposing different benthic macroinvertebrates to the sediment samples collected from the river. In addition, chemical analysis of the sediment elutriate phase (which may result during potential disposal of any remediated sediments) was also performed. These results, which are reported in USACE 2022b, form the basis of the remedial alternatives developed in this FFS.

In addition to bulk chemistry and toxicity testing, the following lines of evidence were considered in the development of remedial alternatives:

- passive sampling of sediment porewater and bulk water concentrations,
- biological surveys of benthic macroinvertebrates,
- biological surveys of fish communities, and
- surveys of aquatic habitat types.

Passive samples of sediment porewater and bulk water concentrations were collected and analyzed by EPA's Office of Research and Development (ORD) (EPA 2021a). These data were collected because extensive research has demonstrated that direct measurement of polycyclic aromatic hydrocarbons (PAHs) in porewater provides much more reliable prediction of toxicity to benthic macroinvertebrates than do bulk sediment concentrations of PAHs (McDonough et al. 2010). As prescribed by EPA guidance (EPA 2003), the PAH porewater concentrations measured by EPA ORD were compared to values developed to protect 95% of tested benthic macroinvertebrate species from the toxic effects of PAHs, and then resulting fractions for each individual PAH were summed to develop a toxicity unit (TU) for that sample. This approach predicts that toxicity may occur when the TU exceeds a value of one. Concentrations of polychlorinated biphenyl (PCBs) were also measured in the porewater samples to provide an indication of the bioavailability of sediment-associated PCBs to aquatic life.

In addition, biological surveys of macroinvertebrate (Invertebrate Community Index or ICI) and fish communities (Index of Biotic Integrity or IBI and Modified Index of Well Being), as well as survey of habitat types (Qualitative Habitat Evaluation Index or QHEI) were conducted by the EPA ORD, US Fish and Wildlife Service, USACE, and Ohio EPA (EPA 2022, USACE 2022c). These data were collected to support the removal of several of the BUIs listed in Section 1.1 (not only the degradation of benthos BUI, which is the focus of this FFS).

The results of these sediment chemical analyses, toxicity testing, biological surveys, habitat quality, porewater, bulk water analyses are summarized in Section 1.3.2.

### 1.3.2 Nature and Extent of Contamination

The following sub-sections provide an overview of the nature and extent of sediment contamination in the two areas of the LMR project area (Sway Bridge and WWTP), based on the chemical, physical, and biological characterizations of sediment quality listed above. The "nature" of the contamination refers to the site-specific properties of the contaminants which include their bioavailability from within the sediment and subsequent ability to cause toxicity to aquatic life including benthic organisms (ITRC 2011). Figures presenting the extent of contamination also indicate the magnitude (i.e., chemical concentration) of the contaminants. Note that chemical concentrations are reported on a per dry weight basis for all contaminants.

#### 1.3.2.1 Sway Bridge

At the Sway Bridge area, the primary constituent of concern (COC) is total PAHs. Benthic macroinvertebrates are among the most sensitive organisms to PAH toxicity (EPA 2009). Other contaminants such as metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc) and PCBs are also found in the vicinity of the PAH contamination, although to a lesser extent than PAHs (see Figures in Sections 4 and 8 of USACE 2022b). Table 1-1 provides a summary of the 2021 sediment sampling results for all these constituents, and Table 1-2 compares 2013 and 2021 sediment sampling results for both total PAHs and PCBs in the Sway Bridge area. The magnitude and extent of the sediment PAH contamination is presented in Figures 1-3 (plan view) and 1-4 (vertical profile)[1].

Concentrations of PAHs in the vicinity of the Sway Bridge have remained elevated (greater than the PEC) over time, with concentrations greater than ten times the PEC of 22.8 mg/kg in both the surface and the subsurface. Higher concentrations were measured in 2013 than in 2021 (Table 1-2). The two sampling locations directly on either side of the Sway Bridge (LMR21-47 and 21-49) exhibited the highest total PAH surface sediment concentrations of samples collected in 2021 (1,522 and 1,177 mg/kg total 17PAHs, respectively), with a maximum subsurface concentration of 544 mg/kg. The maximum total 17PAHs sediment concentrations measured in this area (adjacent to the Sway Bridge) in 2013 were higher (3,859 and 29,450 mg/kg, surface and subsurface, respectively).

Passive sampling of porewater and analysis for both PCBs and PAHs was also performed at four sediment sample locations in the vicinity of the Sway Bridge, including at location LMR21-49, which also exhibited the highest 17PAH concentration in the surface (Tables 1-3 and 1-4). When compared to the toxicity benchmarks (final chronic values; EPA 2003), the porewater concentrations measured from sediment sampling location LMR21-49 results in a TU of almost three, indicating that PAHs from this location are bioavailable and have the potential to cause toxicity to benthic macroinvertebrates. The TUs for the other three sampling locations are all below one, indicating the PAHs from these locations are not expected to cause toxicity to benthic macroinvertebrates.

Toxicity testing was performed on surface sediments from the project area and also for a reference location (LMR21-69S) further upstream in the Maumee River for comparison purposes. The sediments from location LMR21-47S and -49S were acutely toxic to the two benthic macroinvertebrates subjected to toxicity testing (midges and amphipods), and also to the worms exposed for the purposes of measuring bioaccumulation. Reference sediment samples did not exhibit toxicity to these organisms. The bioaccumulation assays could not be completed on

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[1] Note that these figures have been updated relative to what was presented in the Sediment Characterization Report (USACE 2022b) by combining data from both the surface grab samples and the sediment cores, and utilizing the maximum detected total PAH17 concentration from either the surface grab sample (0-5 foot) or core (0-1foot) as the surface interval for that location.

worms exposed to sediments from LMR21-47S and -49S because the worms did not survive when exposed to these samples, which had very high levels of PAHs (USACE 2022b, Section 6.2). The next two highest concentrations of total PAHs (after LMR21-47S and -49S) were found in LMR21-45S and -53S, with 99.7 and 55.2 mg/kg tPAH34 (52.2 and 41.3 mg/kg tPAH17), respectively. Some reduction in survival or growth to one (but not all) of the organisms tested (relative to the reference sample) was exhibited in each of these two samples. Table 1-5 provides a comparison of toxicity testing results to sediment chemistry for all Sway Bridge sediment sampling locations which exhibited statistically significant differences in either growth or survival compared to the Maumee River reference location sediment sample.

Two lines of evidence (PCB porewater analysis and PCB worm uptake bioassays) indicate that despite the very low levels of total PCB congeners detected from Sway Bridge sample location LMR21-45S (only 0.013 mg/kg total congeners, approximately 2% of the PEC), that PCBs in surface sediment may be bioavailable to aquatic life. At location LMR21-45S, the biota-sediment accumulation factor, an indication of uptake of PCBs from sediment into the worms, is approximately four times greater than the biota-sediment accumulation factor measured in the worms exposed to sediment from the reference location (LMR21-69S). In addition, the LMR21-45S porewater concentration of total PCBs is also more than ten times the porewater concentration from the reference location. The actual PCB bioaccumulation risk, however, in the Sway Bridge area is minimal since the total concentrations of PCBs in sediment and worm tissue from location LMR21-45S are relatively low, and because the average surface concentration of PCBs is also very low (in the range of 0.1 to 0.2 mg/kg; see Table 1-1). Table 1-5 provides a summary of bulk sediment chemistry results in conjunction with toxicity, porewater analysis, and bioaccumulation assay (biota sediment accumulation factor) results.

The results of the benthic community survey indicate that benthic macroinvertebrate health is poor in the vicinity of the Sway Bridge. The "poor health" result may be attributed to the sediment contamination, although habitat quality is also very poor in this area. All of the fish survey locations in the vicinity of the Sway Bridge indicated that fish community structure is "fair" in this area of the river. Results of the habitat, benthic community, and fish community surveys, as well as porewater results for PAHs and PCBs are all presented on Figure 1-5 and included in Tables 1-3 and 1-4. Table 1-6 explains the condition rating used to display results in Figure 1-5.

Table 1-5 also summarizes results from these multiple lines of evidence for samples exhibiting some benthic toxicity.

#### 1.3.2.2 Wastewater Treatment Plant

At the WWTP, the primary COC is PCBs, although elevated concentrations (greater than the PECs) of PAHs and some metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc) are also present in the WWTP area sediments. Benthic macroinvertebrates are not as sensitive to toxic effects of PCBs as they are to PAHs. The highest concentrations of metals are co-located with the highest concentrations of PCBs (e.g., in the subsurface sediment samples collected from location LMR21-15C). The data indicate that concentrations of PCBs (and other constituents) are lower in surface sediments compared to sub-surface sediment samples. In addition, when compared to concentrations of PCBs measured in sediment samples collected in 2013, the PCB concentrations in sediments collected from the same (or nearby) sampling locations in 2021 were also lower, indicating some attenuation of sediment PCBs appears to be occurring over time. The attenuation could be the result of sediment transport: the fine-grained sediments in this area may have migrated and/or mixed with cleaner sediments over time, and also cleaner sediments may have deposited over time in this area of the river. Some sediment sampling locations in the vicinity of the WWTP still have PCBs above the PEC. Table 1-7 provides a summary of the 2021 sediment sampling results for all these constituents, and Table 1-8 compares 2013 and 2021 sediment sampling results for both total PAHs and PCBs in the WWTP area. The magnitude and extent of the sediment PCB contamination is presented in Figures 1-6 (plan view) and 1-7 (vertical profile)[2]. As shown in Table 1-8, the maximum concentrations of total PCBs (Aroclors) detected in 2021 surface and subsurface sediments were 1.7 and 9.8 mg/kg, respectively, and maximum concentrations measured in 2013 were higher (3.4 and 12.9 mg/kg, respectively).

Passive sampling of porewater and analysis for both PAHs and PCBs was also performed at six sediment sample locations (plus a duplicate at location LMR21-15) in the vicinity of the WWTP (Tables 1-9 and 1-10 and Figure 1-8). Results from the biological survey and reference locations are included on these tables for additional context. The PAH TUs for all of the samples in the vicinity of the WWTP are all well below 1, indicating that the sediment concentrations PAHs from these locations is not expected to cause toxicity to benthic macroinvertebrates.

The sediment toxicity tests support the conclusions from the porewater analysis of PAHs. Benthic macroinvertebrates are more sensitive to the presence of PAHs in sediment and porewater, which can cause narcosis (EPA 2009). The sediments within the WWTP did not show acute toxicity using the standard 10-day *Hylallela azteca* and *Chironomus dilutus* toxicity tests when interpreting the toxicity tests according to guidelines for dredged material management (USACE 2022b, Section 5 and 6.1). None of the surface sediment samples subjected to toxicity testing had total 17PAHs greater than the screening level (PEC of 22.8 mg/kg), and only a single surface sampling interval from any of the cores had total 17PAHs above the PEC (LMR21-18C 0-1 foot with 45 mg/kg total PAHs, or approximately twice the PEC). (No toxicity testing was conducted on sediments from location LMR21-18.)

Two lines of evidence (PCB porewater analysis, and PCB worm uptake bioassays) indicate that the concentration of total PCB detected from WWTP sample locations LMR21-15 (0.43 mg/kg total congeners or 0.92 mg/kg total Aroclors) and LMR21-17 (0.61 mg/kg total congeners or 1.74 mg/kg total Aroclors) are bioavailable and have the potential to bioaccumulate in benthic macroinvertebrates. The porewater concentrations of total PCBs from LMR21-15S and -17S are respectively more than 100 and 400 times greater than the porewater concentration from the reference location[3] (Table 1-10). The sediment bioaccumulation tests indicate that the surface

[2] Note that these figures have been updated relative to what was presented in the Sediment Characterization Report (USACE 2022b).) by combining data from both the surface grab samples and the sediment cores, and utilizing the maximum detected total PCB concentration from either the total PCB congener concentration measured in surface grab sample (0-5 foot) or total PCB aroclor concentration measured in cores (0-1 foot) as the surface interval for that location. The only location where the surface grab total PCB congener concentration significantly exceeded the co-located total PCB Aroclor concentration from the cores was at LMR21-19.

[3] Dissolved surface water concentrations of PCB were also greatest from sampling location LMR21-15.

sediment concentrations of PCBs are bioavailable, with statistically significantly greater accumulation of PCBs in worm tissues from the WWTP area than from reference area sediment. Table 1-11 provides a summary of bulk sediment chemistry results in conjunction with toxicity, porewater analysis, and bioaccumulation assay (biota sediment accumulation factor) results.

Despite the potential of PCBs from locations LMR21-15 and LMR21-17 to bioaccumulate, discrete, individual sediment hotspots (e.g., elevated surficial sediment concentrations from two sampling points) are not expected to impact fish or wildlife populations. PCB exposure to upper trophic levels (as opposed to in benthic macroinvertebrates) tends to occur over large spatial distances. Thus, surface weighted average concentrations (SWACs) across an ecological exposure unit better represent PCB bioaccumulation risk to upper trophic level organisms. The SWAC of total PCBs (either Aroclors or congeners) in WWTP areas A1, A2, and A3 are all less than 1 mg/kg (a common benchmark for Great Lakes sediment remedial action), although in area A3 the total PCB SWAC is greater than the sediment screening level ("probable effects concentration" or PEC) at 0.877 or 0.862 mg/kg total PCB Aroclors or congeners, respectively (Table 1-7, and Section 6. 1 of USACE 2022b).

Benthic macroinvertebrates are not as sensitive to the toxic effects of PCB contamination as piscivorous birds or wildlife. At the WWTP, there are seven locations where PCB concentrations exceed the PEC in surface sediment samples (either grab samples or 0-1foot interval from the cores), but these locations are not contiguous. Only one of the surface sediment samples subjected to benthic toxicity testing had total PCB concentrations above the PEC (0.676 mg/kg). This was sampling location LMR21-19S, which had 0.863 mg/kg total PCB congeners but did not result in any reduction of survival (no toxic effects) in comparison to the river reference location. The location with the second greatest concentration of PCBs measured in 2021 WWTP surface grab samples (e.g., LMR21-17S with 0.61 mg/kg total PCB congeners) also did not exhibit any toxicity to the two benthic macroinvertebrates tested (Table 5.1, USACE 2022b). This indicates that PCBs at or slightly above the PEC do not appear to be toxic to benthic macroinvertebrates. This is not unexpected, since the PECs do not, by themselves, provide a basis for determining if the measured concentrations of contaminants represent significant hazards to aquatic organisms (EPA 2002, ITRC 2011), and the PEC was only marginally exceeded. Other site-specific factors such as the biogeochemical properties of sediment affect the ability of chemicals to cause toxicity to benthic macroinvertebrates.

This weight of evidence indicates that the current risk to benthic macroinvertebrates due to surface sediment contamination at the WWTP is much lower than it is in the Sway Bridge area. However, due to the shallow water depth and the presence of elevated concentrations of both PCBs, PAHs, and heavy metals in the subsurface sediments (starting at one and extending through ten feet below sediment surface in location LMR21-15), remedial action to support BUI removal is warranted at the WWTP.

### 1.3.3 Hydrodynamic Conditions and Sediment Mobility

Numerous studies evaluating the hydrodynamic conditions and factors affecting sediment transport have been conducted in the LMR, mainly in the federal navigation channel. Appendix B provides a summary of those studies, focusing on the sediment transport aspects of the proposed remedial alternatives involving dredging. It should be noted that the project areas being evaluated in this FFS are outside the navigation channel and, thus, the deposition rates calculated for the navigation channel may not be representative of current deposition rates in the project areas. Instead, historic deposition rates outside the navigation channel, were they available, would likely reflect equilibrium conditions with no net deposition or erosion. However, once any areas outside the navigation channel are dredged, the cross-sectional area of flow in these areas will increase, causing velocities to decrease and leading to enhanced deposition of cleaner sediment, similar to what is observed in the adjacent navigation channel.

The major findings of the review described in Appendix B are as follows:

- Extremely large volumes of sediment (approximately 1.8 million tons/year) are transported down the Lower Maumee from its drainage area. These sediments are largely transported out into Maumee Bay, and further transported into Lake Erie, without creating a river delta. The lack of delta formation is thought to be due to the high lake energy levels rather than navigational dredging as the navigation channel is narrow relative to the expected width of any delta that might form there.
- Based on shoaling rate estimates for the navigation channel, sediment deposition in the project area ranges from 0.35 feet/year to 1.16 feet/year (an average of 1.16 feet/year in the vicinity of the WWTP and an average of 0.37 feet/year in all remaining proposed remediation areas, including in the vicinity of the Sway Bridge) (USACE, 2022). Figure 1-9 presents the estimated shoaling rates in the federal navigation channel along the areas of the Sway Bridge and WWTP under consideration in this FFS. Note that negative shoaling rates (less than 0 feet/year) indicate areas of potential scour (vs. sediment deposition or shoaling).
- The project areas are net depositional in the navigation channel and are expected to be equilibrium or net depositional in proposed dredge areas outside the navigation channel. However, based on several modeling studies and some bathymetric and shoaling rate data, these areas see significant inter-annual variability in deposition rates, and some areas could see years with net scour/erosion.
- The equilibrium water depths in the river are 17 feet for most of the river except at the mouth near the WWTP, where it decreases to 10 feet of water. This indicates the WWTP area may more depositional compared to the Sway Bridge area, and already near equilibrium conditions. The Sway Bridge area is less depositional and the shallow water depths along the shore are well above the equilibrium water depth of 17 feet, indicating these areas may not be at equilibrium and may be subject to erosion. This corresponds with the chemical data showing signs of attenuation at the WWTP location but less so along the Sway Bridge area.
- Sand as a cap on remediation dredge areas would be expected to be stable; this conclusion is based largely on the low velocities seen in models of the river during high flows and on the limited frequency of scour for predominantly silty and muddy sediments in the Lower Maumee. A detailed scour analysis would be required during design to specify granular cap grain size.

- Post remediation dredging, sediment/channel bottom elevations would be expected to return to current levels at about the average shoaling rates described above) with significant interannual and spatial variability.
- Additionally, any remediation dredge area side slopes would be expected to slough to slopes on the order of 10:1 [H:V], like those observed along the navigation channel. And for the sediment ridge that will remain between remedial dredge areas and the navigation channel (i.e., for the remediation areas near the Sway Bridge, especially remedial alternative S3 discussed in Section 4 and shown in Figure 4-3) this effect would occur on both sides of the ridge of remaining sediment and would likely result in some leveling of the ridge over time. See Appendix E for a detailed discussion on side slope stability.

### 1.3.4 Shoreline Stability

USACE performed a preliminary survey of the LMR project area by boat in August 2022 to identify each structural system existing in the potential dredge areas across the site. This visit identified five revetments of varying material, one levee, ten retaining walls (either steel sheet pile or concrete bulkhead construction), and one natural shoreline. In concurrence with the identification of the existing structures, the USACE also conducted a bathymetric survey of the dredge area to obtain approximate mudline elevations and the profile of the riverbed in the area. This bathymetric survey was combined with existing bare earth lidar information available for the Toledo Harbor and bathymetric data for the federal navigation channel.

In addition to surveys of existing shoreline structures, outreach was performed to local landowners to obtain any soil borings or stratigraphy information, as-built project drawings for any of the existing structures, or other pertinent information to assist in the shoreline stability analysis. Through this outreach, the USACE received limited information on the existing structures or stratigraphy information. Because of this, in order to perform feasibility level stability analyses of these structures, conservative estimates for soil stratigraphy data were generated by the geotechnical engineering section of USACE. These estimates were used to determine global stability of all shoreline structures and determine required offsets from the shorelines for dredging, as well to confirm that the dredging offsets did not increase the internal forces on any existing structure.

Additional evaluations of shoreline stability, to refine the required dredging offsets or other stability measures, would be required as part of the remedial action design.

# 2. REMEDIAL ACTION OBJECTIVES

The development of RAOs and Remedial Goals (RGs) are common components of feasibility studies at contaminated sediment sites. RAOs provide the framework for developing implementable and effective remedial alternatives that are protective of human health and the environment. Additionally, RAOs define the basis for evaluating different sediment remedy options and describe, in general terms, what the selected sediment remedial action is intended to accomplish. RGs establish the targets necessary to achieve the RAOs. The remedy evaluation process of the FFS is used to identify and evaluate the feasibility of remedial action alternatives to determine the extent to which remedy implementation is feasible and the extent to which remedies are expected to achieve the RAOs.

## 2.1 Remedial Action Objectives

The RAOs were developed to support removal of the Degradation of Benthos BUI. Therefore, the RAO for both the WWTP and Sway Bridge sites is to reduce the exposure of the benthic community to contaminants. Sediment remedies will be evaluated for their ability to reduce long-term benthic invertebrate exposure to COCs at each site. Remedial actions which improve the health of the benthic population may also serve to improve other fish and wildlife populations as their food source and the overall health of the river.

## 2.2 Sediment Remedial Goals

The Ohio EPA proposed the following sediment RGs for two primary groups of COCs (PCBs and PAHs), recognizing the general co-location of other COCs including metals, diesel, and oil range organics (Ohio EPA 2021a).

- PCBs (total Aroclors): 0.676 parts per million (ppm)
- Total PAH-17: 22.8 ppm

These RGs are consistent with PECs for protection of benthic macroinvertebrates as utilized to screen sediment sampling results (Section 1. 3.2). The PEC is a concentration above which adverse effects to the benthic community are likely to be observed.

## 2.3 Selection of Remediation Footprints

The remedial alternatives developed in this FFS targeted areas of sediment contamination ("remediation footprints") where contaminant concentrations exceeded the PEC, and adverse impacts to the benthic community were also apparent from toxicity testing and/or porewater sampling results supported by multiple lines of evidence (see Section 1.3.2).

**WWTP:** The remedial actions should address the footprint of contaminated surface and subsurface sediments above the PECs (RGs), including contaminated subsurface sediments at LMR21-15, as well as contaminated surface sediments at LMR21-17 and -19, which exhibited the greatest porewater and surface sediment total PCB congener concentrations, respectively (Figures 1-6, 1-7, and 1-8).

**Sway Bridge:** The remedial actions should address the footprint of contaminated surface and subsurface sediments above the PECs (RGs), including the highest and most toxic concentrations of PAHs that correspond with the mound of sediment on either side of the Sway Bridge (shallowest water depths), and extends approximately from sampling locations LMR21-54 upstream of the Sway Bridge, to LMR13-55 downstream of the Sway Bridge and non-contiguous areas at LMR21-38 and LMR13-57 (Figures 1-3, 1-4, and 1-5).

# 3. SCREENING OF TECHNOLOGIES AND PROCESSING OPTIONS

## 3.1 Technological and Processing Options Selection Criteria

Potential remedial technologies for addressing conditions at the site were identified based upon USACE project delivery team discussions and EPA guidance developed for the remediation of contaminated sediment sites (EPA 2005). Information collected during the various site investigations was used to identify feasible technologies for the site. The remedial technologies were then screened for their ability to achieve the sediment RGs for the Lower Maumee River, based on technical feasibility, implementability, environmental risk, relative cost, and public acceptance. Technologies that are retained as a result of the screening are carried through and utilized to develop the remedial alternatives presented in Section 4.

The following general response actions were identified as possible remedial technologies for the LMR sediment:

a. No action
b. Monitored natural recovery
c. Enhanced natural recovery
d. Capping
e. Sediment removal by dredging
f. Supporting technologies

A qualitative approach as described in the National Contingency Plan (NCP) at 40 CFR §300.430(e)(9) was used to screen technologies using three criteria: effectiveness and permanence, implementability, and cost.

<u>Effectiveness and permanence</u>: These criteria include an evaluation of whether or not the alternative is able to support BUI removal in the long-term.

<u>Implementability</u>: This criterion is used to evaluate the technical feasibility of the alternative, including construction and operation, reliability, monitoring, and the ease of undertaking an additional remedial action if the remedy fails. It also considers the administrative feasibility of activities needed to coordinate with other offices and agencies, such as for obtaining permits for off-site actions, rights of way, and institutional controls, and the availability of services and materials necessary to the alternative, such as treatment, storage, and disposal facilities (EPA 2005).

<u>Cost</u>: This criterion includes an evaluation of direct and indirect capital costs, including costs of treatment and disposal, annual costs of operation, maintenance, monitoring of the alternative, and the total present worth of these costs (EPA 2005).

## 3.2 No Action

Guidance for developing feasibility studies to address environmental contamination suggests that a No Action Alternative should be considered at every site (EPA 1988). A No Action alternative should include the site conditions as described in site characterization documents (e.g., USACE 2022b).

The No Action option included within this study does not include any treatment or engineering controls, institutional controls, or monitoring. It will be carried forward as an alternative because it is standard to evaluate this as a baseline for comparison.

A No Action alternative would not change the reported contaminant levels or extent of contaminants at the site, except for natural attenuation, which may include degradation and/or cover from infiltration of cleaner sediments over time. Because there is no action, there would be no health risks for the residential population and construction hazards during the remedial construction. The reported chemical concentrations in sediment would remain on site. This action is easily implementable, and no costs are associated with this action. The No Action option is retained for the Sway Bridge and WWTP areas for further evaluation as a baseline for comparison to other remedial actions.

## 3.3 Monitored Natural Recovery

Monitored natural recovery (MNR) is a remedy for contaminated sediment that uses ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment to reduce risk. Natural processes that contribute to MNR may include sediment burial, sediment erosion or dispersion, and contaminant sequestration or degradation (e.g., precipitation, adsorption, or transformation). Isolation and mixing of contaminants through natural sedimentation is the process most frequently relied upon for contaminated sediment. MNR can be used alone or in combination with engineered remediation technologies to meet RAOs (EPA 2005). These natural processes can reduce exposure to benthic macroinvertebrates (and thus support BUI removal) and contribute to the recovery of the aquatic habitat and the ecological resources that it supports.

MNR may reduce contamination concentrations to below levels of concern, however, time frames to achieve the RAOs would be longer than other remedies. The effectiveness of MNR is uncertain as the time frames to achieve RAOs are dependent on site conditions. For example, biological mediated dechlorination of PCBs is a natural occurring process that reduces the exposure risk to benthic macroinvertebrates, however, it is unclear that RAOs would be achieved in a reasonable time frame (EPA 2005). Similarly, natural sedimentation may not achieve remedial objectives in a reasonable time frame. Therefore, further evaluation would be needed to demonstrate that RGs are achieved within an acceptable time frame in the LMR project areas.

To be accepted as a remedial alternative, MNR must achieve the required reductions in toxicity and risk associated with elevated contaminant concentrations within an acceptable timeframe. The costs with hydrodynamic modeling may be high and represent the largest percentage of overall project costs. The costs of modeling are contingent on the area implementing the MNR technology.

As presented in Sections 1.3.2.1 and 1.3.2.2 for the Sway Bridge and WWTP, respectively, and discussed in Appendix A, natural recovery appears to be occurring in both sections of the river.

There are key limitations, however, that impact the relative effectiveness of MNR at WWTP and Sway Bridge: contaminated sediments are left in place and risk reduction is dictated by the rate of sedimentation.

The sediment profiles and toxicity results suggest that MNR may be more effective at the WWTP than at Sway Bridge. At Sway Bridge, surface sediment concentrations of PAHs are still considerably higher than the RG and are acutely toxic to the benthic macroinvertebrates. Not enough information is currently available to determine how long it would take for clean sediment to deposit and cover contamination at Sway Bridge site. At the WWTP, relatively clean sediments already cover the more heavily contaminated sediments that are found at depth and acute toxicity was not observed in surface sediments. Modeling would be required during engineering design to accurately predict the rate and amount of sediment infiltration for the area. MNR will be retained as a stand-alone technology for the WWTP.

### 3.4 Enhanced Natural Recovery

Enhanced natural recovery (ENR) includes placement of a thin layer (10 to 30 cm) of clean sediment (typically sand) on top of contaminated sediment. The sand layer reduces exposure to benthic organisms by decreasing contaminated concentrations of the surface sediments (through mixing with clean material). ENR is more effective in areas with relatively low surface sediment contamination. ENR may be used to accelerate natural attenuation in areas where MNR may be occurring too slowly.

ENR may be an effective technology and is more effective in impacted areas that exhibit low-current or flow zones. The benefit of placing a thin-layer cover verses a thicker engineered cap is that the loss of benthic habitat and loss of flood storage capacity is minimized. Evaluation of site conditions would be needed to verify that ENR would be effective. Institutional Controls to minimize the disturbance of the thin-layer cover may need to be implemented with ENR remedy. ENR is implementable and has a relatively low cost in comparison with other alternatives.

ENR would be retained for the WWTP, and not for the Sway Bridge area for several reasons. The first is that as indicated in Section 1.3.3., the WWTP area is more of a depositional environment than is the Sway Bridge, which may be subject to more erosion. In addition, the surface sediments within the WWTP did not show acute toxicity (as discussed in Section 1.3.2.2). Furthermore, the surficial concentrations of PCBs most recently measured in the WWTP are generally less than twice the PCB RG (Figure 1-6). For these reasons it is anticipated that application of a thin sand layer may immediately achieve RGs in the WWTP surface sediments. Since the current levels of PCBs in the surface are only slightly greater than the RGs, no monitoring of the sand cover would be required. For the Sway Bridge area, surface sediments at the Sway Bridge are acutely toxic to three different macroinvertebrates (Section 1.3.2.1), and surface concentrations of PAHs have remained over ten times the RGs since 2013 (Figure 1-3). Therefore, ENR alone is not likely to achieve RGs in surface sediments in the Sway Bridge in a reasonable time frame.

### 3.5 Capping

Capping refers to the placement of a subaqueous cap of clean material over the contaminated sediment to mitigate risk posed by those sediments. Generally, cap material consists of sand, sediments, soil, or any variety of synthetic or composite engineered fabrics. Caps can be designed to reduce risk through the following primary functions:

- Physical isolation of the contaminated sediment sufficient to reduce exposure due to direct contact and to reduce the ability of burrowing organisms to move contaminants to the surface;
- Stabilization of contaminated sediment and erosion protection of sediment and cap, sufficient to reduce resuspension and transport to other sites; and/or
- Chemical isolation of contaminated sediment sufficient to reduce exposure from dissolved and colloidally bound contaminants transported into the water column (EPA 2005).

A cap is designed and engineered to address the risk from specific contaminants and their concentrations. Potential limitations of capping include the risk of leaving the contaminants in place with the possibility of future disturbance, the reduction of water depth in navigable waters, and habitat alteration. Modeling would be required during engineering design to evaluate cap effectiveness, stability, and to identify appropriate cap materials and thickness.

Sediment caps are permanent features that require favorable hydrological conditions as well as monitoring and maintenance efforts to be effective. Institutional Controls such as anchoring, dredging, and/or other excavation restrictions may need to be implemented as part of the sediment capping remedy. It is also anticipated that the sediment cap sustainability and integrity may be difficult to maintain due to the heavy traffic of commercial vessels along the river, the periodic dredging of the federal navigation channel, and potential future commercial docking needs at the Sway Bridge location.

Capping costs are typically moderate. Capping usually has a lower cost than dredging but is more expensive than No Action and ENR. Capping technology requires identification of an entity that would commit staff and funds to monitor and maintain the cap. Monitoring costs associated with capping can be high, depending on the size of the cap and duration of the monitoring program. The ability to maintain the cap may be limited by staffing and funding resources and, thus, n engineered cap would not be retained as a remedial alternative.

## 3.6 Sediment Removal by Dredging

Environmental dredging consists of the removal of the sediment contaminated above established action levels from the site by mechanical or hydraulic dredge methods with measures to control the spread of contaminants during the work (e.g., silt curtains).

Sediment removal by environmental dredging is commonly used and requires lower technical expertise than remedial methods such as capping. Removal of the contaminated sediment from the site removes the associated risk from future use of the site. Issues with dredging methods may include:

- Lack of available appropriate disposal facilities;
- Lack of available sediment staging and processing areas;
- Inaccessible removal areas due to existing infrastructure, docks, and piers;
- Support of existing structures or shorelines near removal areas;
- Large areas of contaminated sediment requiring multi-year timeframes for remediation; and/or
- Disturbance of the benthic environment.

### 3.6.1 Dredging Technological Components

Dredging technological components include sediment dredging, processing the sediment as required by the disposal facility (*i.e.*, dewatering), and transport and disposal. Treatment of the drainage water during dewatering of the sediments (if needed for disposal) is also included as it is generally required prior to discharge to an approved water body.

#### 3.6.1.1 Dredging Methods

Sediment dredging can be performed either "mechanically" with an excavator bucket, or "hydraulically" by using a cutter head to cut the sediment and suspend it in water prior to pumping it out through a pipeline.

Mechanical dredging removes sediments through mechanical force, typically using an excavator or crane equipped with a traditional or environmental bucket placed on a working barge. Sediment is lifted to the surface and placed on a transport barge. Mechanical dredging is often needed for the removal of large debris, cemented material, or in tighter spaces where access with hydraulic dredge equipment and associated pipelines may be difficult.

Hydraulic dredging removes and transports sediment in the form of a slurry using large volumes of water in the process. Slurries from hydraulic dredging therefore have higher water content than mechanically dredged sediments, requiring more space and time for dewatering and water management.

For the purposes of this FFS, mechanical dredging and placement is assumed.

Sediment removal by dredging would effectively decrease contaminant mass through removal and support the removal of BUIs. However, dredging may cause stability issues with the shoreline in many of the project areas and, thus, would need to be further evaluated as part of a pre-design investigation.

In general, dredging costs are typically significantly higher than other methods due to the subsequent costs associated with sediment management and dewatering, water treatment, transportation, and disposal.

Dredging of sediment from the LMR, including disposal options at the nearby Toledo Harbor Facility 3 confined disposal facility (CDF) or landfill disposal (see Section 3.6.1.4), will be retained for further evaluation as a remedial alternative.

#### 3.6.1.2 Dredged Sediment Dewatering

Depending on the type and location for disposal, dewatering of the dredged sediment may be necessary. Specifically, dewatering would reduce the volume of material required for transportation and reduce the associated costs. This is only a consideration if the sediments need to be disposed of in a landfill. The extent of dewatering depends on the sediment physical properties, the method used for sediment removal (hydraulic dredge or mechanical dredge), and the disposal method selected for the remediation. Sediment dewatering technologies include gravity draining in stockpiles or geotextile tubes; mechanical processes such as filter presses or cyclones; and amendment solidification with polymers or cement additives. The dewatering method selection is based on the volume of sediment requiring dewatering; the amount of staging and processing area available for dewatering; the distance of the dewatering area from dredging operations and available transport methods between the locations; the proximity of treated effluent water disposal location to the dewatering area; and the required construction completion timeframe. Dewatering is generally time intensive, costly, and requires large operating areas.

Typical dewatering areas include a constructed dewatering pad to contain water runoff from the sediment, debris staging areas, transfer areas, decontamination areas, and water treatment areas. It is most economical to locate the dewatering area on site to reduce intermediate handling and transport of the sediment prior to disposal.

Water removed from the wet sediment must be managed and may require treatment prior to disposal. The quantity of water to be managed would depend on the selected dredging and dewatering methods. The required treatment would depend on the level and type of contaminants, and disposal requirements. The water removed from the sediment may be collected and transported to municipal water treatment facilities for treatment and disposal or may be treated at the project site using a temporary treatment plant with the ultimate goal of releasing the treated water back into the river. Water treatment would likely require removal of suspended solids and treatment of dissolved-phase contaminants prior to discharge. The water discharge would have to be permitted.

For dredging alternatives, which include disposal in a landfill, an area for sediment dewatering activities must be identified in addition to a staging area. These would be chosen during engineering design.

#### 3.6.1.3 Dredged Sediment Transport

Dredged sediment can be transported using barges, trucks, railroads, or pipelines. This FFS assumes that the dredged sediment would be mechanically dredged and offloaded. Depending on the disposal location, the sediment may be mechanically or hydraulically placed directly into the applicable CDF or dewatered and transported via trucks to an offsite landfill.

#### 3.6.1.4 Sediment Disposal

Following removal by dredging, contaminated sediments would require disposal in a manner that prevents future exposure to the contaminants. The sediment was determined to not be hazardous for purposes of disposal considerations (USACE 2022b). Options for disposal include disposal in a CDF located within the Toledo Harbor, or offsite disposal to a landfill. Offsite disposal is expected to be expensive depending on the location of the site relative to the disposal facility, volume of sediment involved, nature of contamination, and availability of different disposal options in the area.

The Facility 3 CDF is at the mouth of the Maumee River, a few miles from the WWTP and Sway Bridge sites, and is maintained by the TLCPA and USACE. Disposal of sediments in the TLCPA portion of Facility 3 is a potential option for disposal but would require approval from the TLCPA.

USACE's portion of Facility 3 is also being considered as a disposal option as part of this FFS, however, authorization is  unlikely.  USACE derives implementation guidance for Placement of Dredge Material in Federal Navigation Dredged Material Placement Facilities under Section 217(b) of the Water Resource Development Act of 1996, Public Law 104-303, as amended (33U.S.C. §2326a(b)). This guidance includes criteria requiring the USACE portion of Facility 3 to have at least 20 years of federal navigation related dredge capacity in order to be approved for placement of excess material.  The current USACE analysis for Toledo Harbor indicates a shortage of navigation related capacity over the required 20-year period.  The opportunity to use the USACE portion of Facility 3 will continue to be explored, however, given the unlikelihood for approval, this disposal option was not actively considered from a cost perspective.

Offsite landfills for disposal of the dredged sediments are available nearby and feasible. Dewatering and/or amendments would likely need to be used to modify the chemical and physical properties of the sediment to facilitate handling and disposal.

## 3.7 Supporting Technologies

### 3.7.1 Institutional Controls

Institutional Controls are often considered during the alternatives screening process to prevent or reduce exposure to contaminants. Common types of institutional controls at sediment sites include fish consumption advisories, commercial fishing bans, and waterway use restrictions, such as no anchor zones. In some cases, land use restrictions or structure maintenance agreements have also been important elements of an alternative (EPA 2005).

Some of the potential technologies reviewed for the FFS may require additional restrictions on activities in the area. For example, technologies that use a sand cover or cap may need to implement water use restrictions to ensure that the integrity of the cover or cap is maintained.

The effectiveness of institutional controls is largely based on the willingness of site users to abide by the advisory, bans or restrictions. The costs to implement these types of institutional controls are expected to be minimal. The effectiveness may also be limited by the ability of an entity to commit to maintenance agreements. The costs to implement maintenance agreements is contingent on the maintenance required. The use of institutional controls will be retained to incorporate into other remedial alternatives to prevent short-term exposure as well as to minimize activities that disturb the remedy.

### 3.7.2 Dredging Residual Cover

A residual cover is a type of clean cover that would be implemented in areas where residual contamination remains following dredging or other removal activities in order to decrease exposure by providing an extra level of protection. Its function is similar to that of ENR discussed above. A residual cover is intended to further mitigate any remaining risk associated with residual concentrations of COCs above RGs. Such a cover would be more stable than a cover installed above the existing sediment surface and would not create flow constrictions or increased risk of flooding because it would not be installed above stable grade.

A cover of clean material (likely sand) could be installed up to the original (pre-removal) or another stable grade (if desired) following the sediment removal action. These specifications would be determined during engineering design. Depending on the magnitude of residual concentrations remaining after dredging, the cover specifications may need to be designed to effectively decrease contact with and transport of any residual contamination in sediment following the removal action.

A dredging residual management plan would be developed during the design phase. The dredging residual management plan would outline the decision logic to be used to determine if multiple dredging passes would be implemented prior to application of residual cover and include a description of the sampling and analysis which may be needed to support this decision.

Installation of a residual cover following sediment removal is expected to be implementable. Cover material would need to be transported to the site and placed in the areas of sediment removal. It would not require excavation beyond the sediment removal action. Follow-up monitoring and maintenance would not be anticipated. Based on these factors, the cost of a residual backfill cover would also be relatively low. Cover placement may not be appropriate for areas where disturbance is planned in the near future.

A residual cover is retained for further evaluation as a technology to decrease potential exposure following sediment removal activities. For the purposes of this FFS, it is assumed that all areas being dredged would be covered with a thin layer (15 cm) of sand following dredging.

## 3.8 Sediment Technology and Processing Options Screening Results

The following remedial technologies were determined to be the most effective, implementable, and cost-effective and were retained for assembling the alternatives described in Section 4:

- No Action
- Monitored Natural Recovery (WWTP only)
- Enhanced Natural Recovery (WWTP only)
- Dredging with CDF (Facility 3) disposal or disposal in an off-site landfill if CDF disposal becomes unavailable.

- Supporting technologies (Institutional Controls, Dredging Residual Cover)

# 4. DEVELOPMENT OF REMEDIAL ALTERNATIVES

Based on the technology screening discussed in Section 3 and the RGs discussed in Section 2.2, preliminary alternatives were developed (Appendix A). These alternatives were further refined through discussions with the project partners (Ohio EPA, GLNPO) and through a series of meetings and discussions. Ultimately, three alternatives were carried forward for the Sway Bridge area and five alternatives were carried forward for the WWTP area for further development in the FFS.

## 4.1 Considerations Common to All Remedial Alternatives

### 4.1.1 Permitting

Execution of any proposed dredging alternatives may require compliance with Section 10 of the Rivers and Harbors Act if the federal navigation channel is impacted during dredging. They may also require demonstration of compliance with the Clean Water Act (e.g., Sections 401 and 404) if the dredged sediment is disposed of in a CDF (Facility 3). Otherwise, the dredged sediment would need to be dewatered (requiring compliance with permits regarding water discharges) and comply with landfill disposal criteria (if a landfill becomes the chosen disposal location).

All active alternatives would also require Section 106 coordination with the State Historic Preservation Office (SHPO). Preliminary SHPO coordination, including an archeological survey report and figures highlighting the WWTP and Sway Bridge target areas, can be found in Appendix H.

### 4.1.2 Cost Estimating

The rough order of magnitude cost estimates have been developed for purposes of the FFS and supporting potential alternative comparisons within a typical FS accuracy range of +50/-30% and are included in Appendix F. Cost estimates for each of the remedial alternatives comprise both capital (*i.e.*, construction) costs, and post-construction operation, monitoring and maintenance costs. Cost estimates are based on USACE guidance documents for developing cost estimates (USACE 1993, 2016, 2021a), engineering judgment, discussions with vendors, and other available information associated with each remedial alternative. The overall cost for each alternative is the sum of the capital and discounted annual costs. The discounted costs were calculated based on the net present value methods described in the EPA guidance document, A Guide to Developing and Documenting Cost Estimates during the Feasibility Study (EPA 2000b). The discount rate selected for the net present worth calculations is 6%.

The cost engineer made key assumptions to inform the costs of this project. All assumptions made can be found in Appendix F. The overall dredging operation is assumed to have a production rate of 2,000 cubic yards (CY)/day. This rate applies to each alternative and disposal method. The difference between alternatives and disposal options within them is the size of the dredging fleet and other labor and equipment needed to maintain a rate of 2,000 CY/day. This rate was developed comparing historical dredging production rates of the local area. All dredging would be mechanically dredged and placed. Soil placement where capping is an option is assumed to be completed via the method known as “bottom dump.” The main MII (second generation Micro-Computer Aided Cost Estimating System) estimate was created using the most up to date cost book, labor library information, and equipment library. Direct costs are based on anticipated equipment, labor and materials necessary to construct the project. Direct costs were calculated independent of the contractor assigned to perform the tasks. Following formulation of the direct cost, a determination is made as to whether the work would be performed by the prime contractor or a subcontractor. Sales tax was not included. Indirect costs are those costs which cannot be attributed to a single task of construction work. These costs include the prime contractor markups such as overhead, profit, bond, and certain taxes. Construction cost estimates, when finalized, must reflect the total estimated cost during the entire duration of construction. Estimate was escalated from early 2023 (when the cost estimates were being developed) to mid-2025 which is the anticipated midpoint of construction.

Engineer's estimates to construct the project would be completed during design and would reflect local labor and material costs, local market conditions, additional information regarding site conditions, final project scope, the implementation schedule, and other variables. The engineer's cost estimate to construct would likely vary from the FFS cost estimates.

The cost estimates detailed in Appendix F consider the costs associated with disposal of dredged sediment into Facility 3. In the event that Facility 3 disposal is not possible, the costs for disposal of dredged sediment in a landfill were also estimated.

#### 4.1.3 Volume Estimates

The volume estimates presented for each alternative were developed for purposes of the FFS. Assumptions were made for each of the alternatives where there was uncertainty associated with defining the bottom depth of contamination. This occurred because some sample cores placed in 2021 were not completed to a depth of refusal due to field conditions and/or sampling equipment limitations. In these locations, where the bottom interval of the 2021 cores were contaminated (with no indication of how deep the contamination may extend below the coring depth), the bottom depth was set at the bottom depth of the 2021 core. This was done because generally, the 2021 sample core depth was deeper than the closest 2013 core, and the 2013 sample cores went to depth of refusal. This was the case for all locations evaluated. Where applicable, the dredging volumes assumes a 25-foot offset from each side of the pipeline, a 25-foot offset from the Brenner 75 marina, and a 25-foot offset from the Sway Bridge. The tables in Appendix G detail the volume estimates, including dredge depth, for each of the alternatives.

### 4.2 Sway Bridge Alternatives

#### 4.2.1 Alternative S1 – No Action

The No Action alternative is the baseline case to which all other response actions and alternatives are compared.

Under the No Action response, no remedial activities would be conducted and there would not be any short- or long-term monitoring. Under the No Action alternative contaminated sediment would remain in place. Natural sedimentation may occur in depositional environments and could reduce the bioavailability and/or toxicity of contaminants over time, however, the measure of these processes would be unknown.

### 4.2.2 Alternative S2 – Extended Dredging

Alternative S2 removes all locations above the RGs at the surface down to depth of contamination, and within adjacent contiguous areas removes all locations with sediment contamination above RGs at any depth. Dredged sediments would be disposed of in a CDF (Facility 3) or a landfill. In addition, a dredging residual cover may be developed as part of remedial design to address areas of contamination remaining after dredging is implemented (as described in Section 3.7.2). The removal of impacted sediment, followed by a thin cover if needed to manage residuals, is protective of the environment and supports the removal of BUIs. Figures 4-1 and 4-2 show the dredge footprint for Alternative S2 in plan view and vertical profile, respectively.

Alternative S2 utilizes dredging to remove impacted sediment from the dredge footprint. There are underground utilities and bridge structures that may prevent dredging in some portions of the dredge area. An offset and/or the installation of sheet pile may be required in these areas, as well as areas of shoreline due to stabilization concerns. Offsets required for each of the reaches and assumptions made for calculations can be found in Appendix D and Appendix E. These offsets range in length from 45 to 90 feet from the shoreline. The length of impacted shoreline is 4,165 linear feet (LF). These offsets and/or sheet pile needs may be refined in engineering design after pre-design investigations occur. In the offset areas, a dredging residual cover may be needed to address the contamination that is left behind. This alternative removes 161,794 CY of contaminated sediments from the river.

For dredging alternatives, which include disposal in a landfill, an area for sediment dewatering activities must be identified in addition to a staging area. These would be chosen during engineering design.

### 4.2.3 Alternative S3 – Focused Dredging

Alternative S3 removes all locations above the RGs at the surface down to depth of contamination within a contiguous footprint near the Sway Bridge. Dredged sediments would be disposed of in a CDF (Facility 3) or a landfill. In addition, a thin cover may be needed in areas dredged as part of the remedial design to address areas of contamination remaining after dredging is implemented (as described in Section 3.7.2). There are areas of surface contamination downstream of the immediate Sway Bridge area that would not be dredged. These areas would rely on natural attenuation, predicted by modeling and confirmed through sampling, or a thin sand cover to achieve RGs in the surface. Hydrodynamic modeling would be required during engineering design to accurately predict the rate and amount of sediment infiltration for the area.

The removal of impacted sediment, followed by cover (if needed to manage residuals), is protective of the environment and supports the removal of BUIs. Figures 4-3 and 4-4 show the dredge footprint for Alternative S3 in plan view and vertical profile, respectively.

Alternative S3 utilizes dredging to remove impacted sediment from the dredge footprint. There are underground utilities and bridge structures that may prevent dredging in some portions of the dredge area. An offset and/or the installation of sheet pile may be required in these areas, as well as areas of shoreline that have been deemed necessary due to stabilization concerns. Offsets required for each of the reaches and assumptions made for calculations can be found in Appendix D and Appendix E. These offsets range in length from 45 to 90 feet from the shoreline. Less shoreline impacts are expected for Alternative S3 compared to S2. The length of impacted shoreline is 2,600 LF. These offsets and/or sheet pile needs may be refined in engineering design after pre-design investigations occur. In the offset areas, a dredging residual cover may be needed to address the contamination that is left behind. This alternative removes 78,989 CY of contaminated sediment from the river.

For dredging alternatives which include disposal in a landfill, an area for sediment dewatering activities must be identified in addition to a staging area. These would be chosen during engineering design.

## 4.3 WWTP Alternatives

### 4.3.1 Alternative W1 – No Action

The No Action alternative is the baseline case to which all other response actions and alternatives are compared.

Under the No Action response, no remedial activities would be conducted and there would not be any short- or long-term monitoring. Under the No Action alternative contaminated sediment would remain in place. Natural sedimentation may occur in depositional environments and could reduce the mobility and/or bioavailability of contaminants over time, however, the sediment transport processes in this area of the Maumee River have not been definitively characterized.

### 4.3.2 Alternative W2 – Monitored Natural Recovery

Alternative W2 involves leaving contaminated sediment in place, anticipating ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or mobility of contaminants in sediment to reduce risk. This alternative may be protective and support the removal of BUIs.

The key limitation of Alternative W2 is that it leaves contaminants in the river, albeit at levels that are not currently causing acute toxicity to benthic macroinvertebrates. There is the potential for buried contamination to become exposed at the surface in the future if the sediment were to be significantly disturbed. This alternative relies on natural sedimentation or transport processes to mitigate risks. This alternative would require hydrodynamic modeling during engineering design to evaluate the potential deposition of clean sediment and to determine how long it would take to achieve RGs.

The requirement and approval of a long-term monitoring plan would be necessary during engineering design. Monitoring would help ensure that protective measures are taken if the need arises.

### 4.3.3 Alternative W3 – Dredging Contiguous Areas Above RG

Alternative W3 is removing all contiguous locations above RGs at the surface down to the depth of contamination plus enhanced natural recovery. Dredged sediments would be disposed of in a CDF (Facility 3) or a landfill. The removal of impacted sediment, paired with enhanced natural recovery (e.g., thin cover placement over areas dredged if needed, as per a residual management plan as described in Section 3.7.2), is protective of the environment and supports the removal of BUIs. Figures 4-5 and 4-6 show the dredge footprint for Alternative W3 in plan view and vertical profile, respectively.

Alternative W3 utilizes dredging to remove impacted sediment from the dredge footprint. An offset and/or the installation of sheet pile may be required in areas of shoreline due to stabilization concerns. Offsets required for each of the reaches and assumptions made for calculations can be found in Appendix D and Appendix E. These offsets range in length from 45 to 55 feet from the shoreline. The length of impacted shoreline is 1,230 LF. These offsets and/or sheet pile needs may be refined in engineering design after pre-design investigations occur. In the offset areas, a thin sand cover, would be required to address the contamination that is left behind. This alternative removes 86,840 CY of contaminated sediment from the river.

For dredging alternatives which include disposal in a landfill, an area for sediment dewatering activities must be identified in addition to a staging area. These would be chosen during engineering design.

### 4.3.4 Alternative W4 – Focused Dredging (2x RG)

Alternative W4 is the focused dredging alternative that removes sediment exceeding two times (twice) the RGs, plus sample location LMR21-15C, and enhanced natural recovery (e.g., thin cover placement over areas dredged if needed, as per a residual management plan as described in Section 3.7.2). There would be some areas above RGs left in the surface, relying on natural attenuation predicted by modeling and confirmed through sampling, or thin sand cover to achieve RGs in the surface. Hydrodynamic modeling would be required during engineering design to accurately predict the levels of natural attenuation for the area. The removal of impacted sediment, paired with enhanced natural recovery, is protective of the environment and supports the removal of BUIs. Figures 4-7 and 4-8 show the dredge footprint for Alternative W4 in plan view and vertical profile, respectively.

Alternative W4 utilizes dredging to remove impacted sediment from the dredge footprint. No offsets or sheet pile would be required for this alternative. This alternative removes 47,481 CY of contaminated sediment from the river.

For dredging alternatives which include disposal in a landfill, an area for sediment dewatering activities must be identified in addition to a staging area. These would be chosen during engineering design.

#### 4.3.5 Alternative W5 – Cover Only (Enhanced Natural Recovery)

Alternative W5 includes covering contamination with a thin sand cover to enhance natural recovery (ENR). ENR is anticipated to be protective of the environment and achieve the RAOs since the surface sediments are not currently acutely toxic to benthic macroinvertebrates, and concentrations of PCBs are only slightly above RGs in the surface sediment. Figure 4-9 shows the area of surface contamination where cover material would be placed. Figure 4-10 shows the W5 cover footprint in vertical profile. The remedial footprint for W5 was selected based on the footprint of Alternative W3, which considers all contiguous locations above RGs at the surface.

Alternative W5 depends on proper engineering design to ensure that the cover can withstand anticipated river conditions. For the purposes of this FFS, a one-foot-thick sand cover is proposed, however, hydrological modeling during engineering design would be required to ensure adequate cover specifications. A properly designed cover, in conjunction with natural attenuation that is already occurring, are expected to result in long term risk reduction. Additional natural sedimentation which is expected to occur in this area of the river should act to keep the contamination buried. Any future intrusive activities at the site, such as excavation or even anchoring of recreational vehicles, may reduce the effectiveness of this technology. It is assumed that no monitoring is needed for this alternative.

# 5. REMEDY SELECTION CRITERIA

In Sections 6 and 7 (and Tables 6-1 and 7-1), the criteria developed for the National Contingency Plan (NCP; 40 CFR 300.430(e)(9)) was used as a basis to evaluate the Sway Bridge and WWTP, respectively. This section defines the criteria and explains how these criteria were applied and adapted to the goals of the to the GLLA , which is not subject to the legal stipulations of the NCP.

The nine modified NCP criteria include two threshold criteria, five balancing criteria, and two modifying criteria, as follows.

Threshold Criteria

1. Overall protection of human health and the environment
2. Contributes to the removal of Beneficial Use Impairments

Balancing Criteria

3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume of contaminated sediment.
5. Short-term effectiveness and impacts
6. Implementability
7. Cost

Modifying Criteria

8. State acceptance
9. Community acceptance

All alternatives must achieve both threshold criteria to be considered viable. If an alternative does not meet the threshold criteria, it will not be evaluated against the remaining criteria.

Balancing criteria support detailed comparative evaluation of five measures of remedy suitability. Modifying criteria typically are evaluated after community input.

## 5.1 Overall Protection of the Environment

The evaluation of the beneficial uses consider impacts to both human health and environment. The evaluation determined that the impairments are primarily linked to aquatic communities; the sediment contamination is specifically linked to benthic impairments. Therefore, the evaluation of the overall protection of the environment determines whether the alternative achieves adequate short- and long-term protection; describes how site risks are eliminated, reduced, or controlled through natural processes, treatment, engineering, or controls; and describes the extent to which each sediment remedy meets the goal of the RAO for benthic community established in Section 2 of this document.

## 5.2 Contributes to the Removal of Beneficial Use Impairments

The goal of the remedial alternatives developed in this FFS is to support removal of BUIs and eventual delisting of the AOC. This criterion will explicitly assess whether or not the remedial alternative will achieve the RAO as outlined in Sections 1 and 2 of this FFS. Only those remedial alternatives which support RAO, leading to the eventual delisting of the AOC, will be considered further.

## 5.3 Long-Term Effectiveness and Permanence

The evaluation included the assessment of long-term effectiveness and permanence. Long-term effectiveness is a measurement of long-term risk reduction and remedy permanence, including physical stability of the sediment. The remedial alternative's proven reliability at other sites with chemicals and conditions like those at the LMR was considered. Long-term effectiveness is determined by assessing potential residual risks likely to be present after response actions have been employed, and by predicting future surface sediment chemical concentrations. Remedy permanence is determined by evaluating the physical permanence of the remedy.

## 5.4 Reduction of Toxicity, Mobility, or Volume of Contaminated Sediment

This criterion will evaluate the effectiveness of each remedial alternative to reduce the toxicity, mobility, or volume of contaminated sediment in the river.

## 5.5 Short-Term Effectiveness and Impacts

Short-term effectiveness and impacts focus on a remedial alternative's ability to achieve the RAOs within a reasonable timeframe, and also to protect against short-term human and environmental risks during construction. This evaluation determines whether the remedy alternative increases short-term risks, and whether those risks can be eliminated or controlled through best management practices during remedy implementation. Overall, it includes an evaluation of the potential impacts to the community, site workers, and the environment during remedy implementation, and the time until the remedy is achieved (EPA, 1988, 2005). Effects of implementation on the community include quality of life impacts, such as noise, odors (vehicles and sediment), and traffic. Impacts to site workers include safety risks during remedy implementation. In general, potential short-term risks to community safety and worker safety are commensurate with the duration of remedy implementation and vehicle miles traveled during implementation. Depending on the remedial technology, the short-term impact of the physical disturbance on the environment may include removal of benthic organisms, alteration of water column depth, and short-term impacts on water quality.

## 5.6 Implementability

Implementability encompasses both the technical and administrative feasibility of implementing a remedial alternative. Technical feasibility refers to the ability to construct, operate, maintain, and monitor the action during and after construction and meet technology-specific regulations during construction. Technical feasibility also applies to the availability of necessary equipment, personnel, and services for implementation or construction and industry experience in implementing the remedy. Administrative feasibility refers to the ability to obtain approvals (both federal and state) to construct the remedy.

Examples of physical constraints that affect the remedial alternative implementability include:

- Accessibility
- Shoreline conditions and shoreline stability
- Cross-channel utilities and roadway or rail bridges
- River geometry and hydrodynamics
- Site topography and bathymetry
- Water depths and depths of sediment contamination
- Thickness and geotechnical properties of the sediments
- Types and quantity of submerged debris
- Available disposal options, and specifically available CDF capacity
- Available transportation and disposal routes
- Current and anticipated uses of the river

### 5.7 Cost and Cost Uncertainty

This criterion addresses the cost of the potential alternative and related uncertainty associated with the estimated cost. For example, complete dredging alternatives experience a higher cost uncertainty associated with the potential for encountering uncharacterized sediment or unknown conditions at depth to a greater extent than partial dredging and capping alternatives. Cost encompasses the administrative, engineering, and capital costs incurred during as part of the potential alternative, and the assessment with respect to this criterion is based on the estimated present worth of the costs for each alternative.

The rough order of magnitude cost estimates presented for each alternative have been developed for purposes of the FFS and supporting potential alternative comparisons within a typical FS accuracy range of +50 to -30% and are included in Appendix F. Cost estimates for each of the remedial alternatives comprise both capital (i.e., construction) costs, and post-construction operation, monitoring and maintenance costs (Appendix F). Cost estimates are based on engineering judgment, discussions with vendors, and other available information associated with each remedial alternative. The overall cost for each alternative is the sum of the capital and discounted annual costs. The discounted costs were calculated based on the net present value methods described in the EPA guidance document, A Guide to Developing and Documenting Cost Estimates during the Feasibility Study (EPA, 2000b). The discount rate selected for the net present worth calculations is 6%.

Engineer's estimates to construct the project would be completed during design and would reflect local labor and material costs, local market conditions, additional information regarding site conditions, final project scope, the implementation schedule, and other variables. The engineer's cost estimate to construct will likely vary from the FFS cost estimates.

The comparison of the alternatives presented in Tables 6-1 and 7-1 (Sway Bridge and WWTP, respectively) consider the costs associated with disposal of dredged sediment into Facility 3. However, the availability of Facility 3 as a viable disposal option is still being evaluated. As a backup, the costs for disposal of dredged sediment in a landfill are also provided in these tables. If the sediments dredged under Alternatives S2, S3, W3, and W4 cannot be disposed of in Facility 3, then alternatives will be re-evaluated using the more appropriate disposal costs.

# 6. COMPARATIVE ANALYSIS OF SWAY BRIDGE REMEDIAL ALTERNATIVES

This section evaluates the Sway Bridge alternatives against the criteria described in Section 5. A summary of this evaluation and comparison among the alternatives is presented in Table 6-1.

## 6.1 Overall Protection of the Environment

### 6.1.1 Alternative S1 – No Action

Alternative S1 is not protective of the environment.

### 6.1.2 Alternative S2 – Extended Dredging

Implementation of Alternative S2 is anticipated to be protective of the environment.

### 6.1.3 Alternative S3 – Focused Dredging

Implementation of Alternative S3 is anticipated to be protective of the environment.

## 6.2 Contributes to the Removal of Beneficial Use Impairments

### 6.2.1 Alternative S1 – No Action

Alternative S1 does not support removal of BUIs.

### 6.2.2 Alternative S2 – Extended Dredging

Implementation of Alternative S2 is anticipated to support removal of BUIs associated with contaminated sediment.

### 6.2.3 Alternative S3 – Focused Dredging

Implementation of Alternative S3 is anticipated to support removal of BUIs associated with contaminated sediment.

## 6.3 Long-Term Effectiveness and Permanence

### 6.3.1 Alternative S2 – Extended Dredging

The removal of impacted sediment (followed by cover if needed to manage residuals) in Alternative S2 would effectively mitigate residual risk by eliminating ecological exposure pathways to benthic macroinvertebrates in the Sway Bridge area. Compared to other alternatives, Alternative S2 would be most protective in the long term. However, underground utilities and bridge structures may prevent dredging in some portions of the area. Implementation of other remedial technology (enhanced natural recovery) may be required if contamination is left behind.

### 6.3.2 Alternative S3 – Focused Dredging

The removal of impacted sediment (followed by cover if needed to manage residuals) in Alternative S3 would effectively mitigate residual risk by eliminating ecological exposure pathways to benthic macroinvertebrates in the Sway Bridge area. Some areas of contamination above RGs will be left in the surface, relying on natural attenuation predicted by modeling and confirmed through sampling, or thin sand cover to achieve RGs in the surface. In addition, underground utilities and bridge structures may prevent dredging in portions of the remediation footprint. Implementation of other remedial technology (enhanced natural recovery) may be required if contamination is left behind.

## 6.4 Reduction of Toxicity, Mobility, or Volume of Contaminated Sediment

### 6.4.1 Alternative S2 – Extended Dredging

Alternative S2 reduces the volume of impacted sediment in the river through CDF or landfill disposal of the impacted sediment. This alternative utilizes industry-proven methods for removal of impacted sediment.

### 6.4.2 Alternative S3 – Focused Dredging

Alternative S3 reduces the volume of impacted sediment in the river through CDF or landfill disposal of the impacted sediment, but less volume is removed from the river than Alternative S2. This alternative utilizes industry-proven methods for removal of impacted sediment.

## 6.5 Short-Term Effectiveness and Impacts

### 6.5.1 Alternative S2 – Extended Dredging

Implementation of Alternative S2 is not anticipated to have a significant adverse effect on the community or environment during remedy implementation. Offsets and/or sheet pile would be incorporated into the remedy to avoid impacts to critical shoreline structures (e.g., bridges) and buried utilities in the vicinity of the remedy footprint. Construction-related traffic would be moderate and proper protective measures would be implemented to eliminate exposure risk to the community. Best management practices would be implemented during construction to minimize environmental impacts. The duration of Alternative S2 is expected to encompass 10.5 working months with disposal in Facility 3 (28 working months if disposal in landfill).

### 6.5.2 Alternative S3 – Focused Dredging

Implementation of Alternative S3 is not anticipated to have a significant adverse effect on the community or environment. Compared to other alternatives, this alternative reduces the impacts to the shoreline and to the other downstream bridge and associated pipelines. Construction-related traffic would be moderate and proper protective measures would be implemented to eliminate exposure risk to the community. Best management practices would be implemented during construction to minimize environmental impacts. The duration of Alternative S3 is expected to encompass nine working months with disposal in Facility 3 (28 working months if disposal in landfill).

## 6.6 Implementability

### 6.6.1 Alternative S2 – Extended Dredging

The equipment, materials, services, and the technical specialists necessary for dredging are available. Alternative S2 would require necessary access permissions and a plan for the management of dredged sediment. Offsets and/or sheet pile would need to be incorporated into the remedy to avoid impacts to critical shoreline structures (e.g., bridges) and buried utilities in the vicinity of the remedy footprint. In addition, the numerous shipwrecks within the downstream portion of the dredge area, and the apparent use of this area to scuttle ships, may affect the implementability of dredging efforts due to the presence of cultural resources and significant amounts of debris.

### 6.6.2 Alternative S3 – Focused Dredging

The equipment, materials, services, and the technical specialists necessary for dredging are available. Alternative S3 would require necessary access permissions and a plan for the management of dredged sediment. Compared to other alternatives, this alternative reduces the impacts to the shoreline and to the other downstream bridge and associated pipelines.

## 6.7 Cost and Cost Uncertainty

### 6.7.1 Alternative S2 – Extended Dredging

Alternative S2 has the highest construction cost of all the alternatives because of the volume of sediment being removed and the structural stability measures that are required in order to dredge. There is also a greater uncertainty in this cost estimate due to the uncertainty of the disposal location, and the need to complete engineering evaluations for shoreline stabilization measures.

### 6.7.2 Alternative S3 – Focused Dredging

Alternative S3 has the second highest construction cost of all the alternatives. It is less expensive than Alternative S2 because of the decrease in volume of sediment being removed and the quantity of structural stability measures that are required in order to dredge.

# 7. COMPARATIVE ANALYSIS OF WWTP REMEDIAL ALTERNATIVES

This section evaluates the WWTP alternatives against the criteria described in Section 5. A summary of this evaluation and comparison among the alternatives is presented in Table 7-1.

## 7.1 Overall Protection of the Environment

### 7.1.1 Alternative W1 – No Action

Alternative W1 is not protective of the environment.

### 7.1.2 Alternative W2 – Monitored Natural Recovery

Implementation of Alternative W2 is anticipated to be protective of the environment.

### 7.1.3 Alternative W3 – Dredging Contiguous Areas Above RG

Implementation of Alternative W3 is anticipated to be protective of the environment.

### 7.1.4 Alternative W4 – Focused Dredging (2x RG)

Implementation of Alternative W4 is anticipated to be protective of the environment.

### 7.1.5 Alternative W5 – Cover Only (Enhanced Natural Recovery)

Implementation of Alternative W5 is anticipated to be protective of the environment.

## 7.2 Contributes to Removal of Beneficial Use Impairments

### 7.2.1 Alternative W1 – No Action

Alternative W1 does not support removal of BUIs.

### 7.2.2 Alternative W2 – Monitored Natural Recovery

Implementation of Alternative W2 is anticipated to support removal of BUIs associated with contaminated sediment.

### 7.2.3 Alternative W3 – Dredging Contiguous Areas Above RG

Implementation of Alternative W3 is anticipated to support removal of BUIs associated with contaminated sediment.

### 7.2.4 Alternative W4 – Focused Dredging (2x RG)

Implementation of Alternative W4 is anticipated to support removal of BUIs associated with contaminated sediment.

#### 7.2.5 Alternative W5 – Cover Only (Enhanced Natural Recovery)

Implementation of Alternative W5 is anticipated to support removal of BUIs associated with contaminated sediment.

### 7.3 Long-Term Effectiveness and Permanence

#### 7.3.1 Alternative W2 – Monitored Natural Recovery

MNR in Alternative W2 is anticipated to be effective in the long-term. This alternative is anticipated to result in reduced risk to the environment over time but would require modeling to evaluate the potential deposition of clean sediment (natural recovery) to cover these areas and determine how long it would  take to achieve RGs. Monitoring would also be required to ensure RGs achieved. Because this alternative does not remove the sediment, it reduces disturbances to habitat and fish.

#### 7.3.2 Alternative W3 – Dredging Contiguous Areas Above RG

The removal of impacted sediment (followed by cover if needed to manage residuals) in Alternative W3 would effectively mitigate residual risk by eliminating ecological exposure pathways in the areas of concern. Implementation of other remedial technology (enhanced natural recovery) may be required if contamination is left behind.

#### 7.3.3 Alternative W4 – Focused Dredging (2x RG)

The removal of impacted sediment (followed by cover if needed to manage residuals) in Alternative W4 would effectively mitigate residual risk by eliminating human health and ecological exposure pathways in the areas of concern. Long-term effectiveness and permanence rely on additional steps. Some areas of contamination above RGs would  be left in the surface, relying on natural attenuation predicted by modeling and confirmed through sampling, or thin sand cover to achieve RGs in the surface (enhanced natural recovery).

#### 7.3.4 Alternative W5 – Cover Only (Enhanced Natural Recovery)

The long-term effectiveness and permanence of Alternative W5 depends on proper engineering design to ensure that the cover can withstand anticipated river conditions. The cover, in conjunction with natural attenuation that is already occurring, is expected to result in long-term risk reduction. This alternative would reduce the potential for exposure in the long term, assuming contaminated sediments are physically isolated, the cover is not damaged, and additional natural sedimentation keeps the contamination buried. Any future intrusive activities at the site, such as excavation or anchoring of recreational vehicles, may reduce the long-term effectiveness of this technology.

## 7.4 Reduction of Toxicity, Mobility, or Volume of Contaminated Sediment

### 7.4.1 Alternative W2 – Monitored Natural Recovery

Alternative W2 key limitation is that it generally leaves contaminants in the river, albeit at levels that are not currently causing acute toxicity to benthic macroinvertebrates. The buried contamination could become exposed at the surface in the future if the sediment were to be significantly disturbed. This alternative relies on natural sedimentation or transport processes to mitigate risks. Monitoring would help ensure that protective measures are taken if the need arises.

### 7.4.2 Alternative W3 – Dredging Contiguous Areas Above RG

Alternative W3 reduces the volume of impacted sediment in the river through CDF or landfill disposal of the impacted sediment. This alternative utilizes industry-proven methods for removal of impacted sediment.

### 7.4.3 Alternative W4 – Focused Dredging (2x RG)

Alternative W4 reduces the volume of impacted sediment in the river through CDF or landfill disposal of the impacted sediment, but less volume is removed from the river than Alternative W3. This alternative utilizes industry-proven methods for removal of impacted sediment. Some areas of contamination above RGs would be left in the surface, relying on natural attenuation or thin sand cover to achieve RGs in the surface (enhanced natural recovery).

### 7.4.4 Alternative W5 – Cover Only (Enhanced Natural Recovery)

The presence of the cover would reduce mobility of the contaminants and enhance the river's natural recovery. Cover materials and specifications would be selected and developed during engineering design.

## 7.5 Short-Term Effectiveness and Impacts

### 7.5.1 Alternative W2 – Monitored Natural Recovery

Implementation of Alternative W2 is not anticipated to have a significant adverse effect on the community or environment. It is not effective in the short-term since no contamination is removed. Modeling would be needed to estimate rate of new sediment infiltration and/or potential scour.

### 7.5.2 Alternative W3 – Dredging Contiguous Areas Above RG

Implementation of Alternative W3 is not anticipated to have a significant adverse effect on the community or environment. Offsets and/or sheet pile would be incorporated into the remedy to avoid impacts to critical shoreline structures in the vicinity of the remedy footprint. Construction-related traffic would be moderate and proper protective measures would be implemented to eliminate exposure risk to the community. Best management practices would be implemented during construction to minimize environmental impacts. The duration of Alternative W3 is expected to encompass nine working months with disposal in Facility 3 (28 working months if disposal in landfill).

### 7.5.3 Alternative W4 – Focused Dredging (2x RG)

Implementation of Alternative W4 is not anticipated to have a significant adverse effect on the community or environment. There would not be a need for sheet pile in this alternative, therefore having less short-term impacts than other alternatives that require offsets/sheet pile for stability. Construction-related traffic would be moderate and proper protective measures would be implemented to eliminate exposure risk to the community. Best management practices would be implemented during construction to minimize environmental impacts. The duration of Alternative W4 is expected to encompass six working months with disposal in Facility 3 (25 working months if disposal in landfill).

### 7.5.4 Alternative W5 – Cover Only (Enhanced Natural Recovery)

Implementation of Alternative W5 is not anticipated to have a significant adverse effect on the community or environment. It is effective in the short-term as cover immediately reduces exposure to surface sediment. Cover construction is less disruptive to the river ecosystem than implementation of other remedial alternatives involving dredging. Construction-related traffic would be moderate and proper protective measures would be implemented to eliminate exposure risk to the community. Best management practices would be implemented during construction to minimize environmental impacts. The duration of Alternative W5 is the shortest of active alternatives and is expected to encompass four working months.

## 7.6 Implementability

### 7.6.1 Alternative W2 – Monitored Natural Recovery

Alternative W2 is implementable and would require only site characterization such as sedimentation measurement, monitoring of contaminant levels in sediment and biota, and biological community surveys. This alternative would require the preparation and approval of a long-term monitoring plan and implementation of that plan.

### 7.6.2 Alternative W3 – Dredging Contiguous Areas Above RG

The equipment, materials, services, and the technical specialists necessary for dredging are available. Alternative W3 would require necessary access permissions and a plan for the management of dredged sediment. Offsets and/or sheet pile would need to be incorporated into the remedy to avoid impacts to critical shoreline structures in the vicinity of the remedy footprint, creating a more difficult construction.

### 7.6.3 Alternative W4 – Focused Dredging (2x RG)

The equipment, materials, services, and the technical specialists necessary for dredging are available. Alternative W4 would require necessary access permissions and a plan for the management of dredged sediment. There would not be a need for sheet pile in this alternative, therefore making it more easily implementable than other alternatives that require offsets/sheet pile for stability.

#### 7.6.4 Alternative W5 – Cover Only (Enhanced Natural Recovery)

Alternative W5 is implementable and is a readily available technology. The capping areas are accessible from the navigational channel. Implementation would require the design and installation of the cap, and preparation and approval of a long-term monitoring plan and implementation of that plan. Hydrological modeling also may be warranted during engineering design to ensure that reduced water depths would not significantly affect flood storage capacity or flow.

### 7.7 Cost and Cost Uncertainty

#### 7.7.1 Alternative W2 – Monitored Natural Recovery

Alternative W2 has a relatively low cost in comparison with other technologies such as removal or capping. Detailed cost estimates would be determined in design if chosen as preferred remedy. The costs can be significant if the monitoring is over a large area over a long period of time. Because the monitoring program may extend over many years, continued funding for the program may be difficult to maintain.

#### 7.7.2 Alternative W3 – Dredging Contiguous Areas Above RG

Alternative W3 has the second highest construction cost of all the alternatives because of the volume of sediment being removed and the structural stability measures that are required in order to dredge. There is also a greater uncertainty in this cost estimate due to the uncertainty of the disposal location, and the need to complete engineering evaluations for shoreline stabilization measures.

#### 7.7.3 Alternative W4 – Focused Dredging (2x RG)

Alternative W4 has the lowest construction cost of all the alternatives. It is less expensive than Alternative W3 because of the decrease in volume of sediment being removed and the decrease of structural stability measures that are required to dredge.

#### 7.7.4 Alternative W5 – Cover Only (Enhanced Natural Recovery)

Alternative W5 has the highest construction cost of all the alternatives.