Open Lake Disposal (Sediment and Water Quality Evaluation)

APPENDIX B1

GREELEY POLHEMUS

GROUP-REPORT

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Final:

OPEN LAKE DISPOSAL OF DREDGED MATERIALS FROM TOLEDO HARBOR: A REVIEW OF THE DATA

October 1998

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1776 Niagara Street
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1.0 INTRODUCTION

The U.S. Army Corps of Engineers (Corps), Buffalo District, is responsible for maintenance dredging of the Toledo Harbor shipping channel. Materials dredged from River Mile 7 of the Maumee River to Lake Mile 2 of Lake Erie have historically been placed in a confined disposal facility adjacent to the shipping channel. Materials dredged from Lake Mile 2 to Lake Mile 19 have been placed in an open lake disposal area near Lake Mile 12. Open lake disposal of dredged materials is regulated under Sections 401 and 404 of the Federal Clean Water Act and Chapter 3745-1 of the Ohio Administrative Code (Ohio Water Quality Standards). The Ohio Environmental Protection Agency (Ohio EPA) is delegated authority under Section 401 to issue Water Quality Certification for open lake disposal, provided State water quality criteria are not exceeded. In 1996, Ohio promulgated criteria for water quality and the Ohio Antidegradation Rule. In October 1997, Ohio promulgated additional revisions to water quality criteria. The 401 Water Quality Certification issued by Ohio for past open lake disposal will expire in 1998. At this time, it is uncertain if open lake disposal meets criteria established in the Ohio Water Quality Standards.

Dredging of the Toledo Harbor shipping channel is necessary to maintain Toledo as a functional and competitive port. A mutual agreement as to the disposal of dredged materials must be reached among the local, state, and Federal agencies with economic and environmental interests associated with maintenance dredging of the shipping channel. The City of Toledo, Ohio, U.S. Environmental Protection Agency (U.S. EPA), the U.S. Fish and Wildlife Service (U.S. FWS), and the U.S. Army Corps of Engineers all have a role in the decision. In order to continue open lake disposal, it must be demonstrated that criteria established by the Ohio Water Quality Standards will be met. If open lake disposal is discontinued, then alternative measures for disposal of dredged materials must be identified and implemented. A key step in this process is analysis of past open lake disposal relative to current criteria for water quality.

This document provides the results of an objective review of historical data related to dredging of Toledo Harbor and open lake disposal of dredged materials. The review was conducted in two phases. In Phase 1, 61 documents provided by the Buffalo District were reviewed. Those documents that clearly do not contain information or data relevant to open lake disposal of sediments were eliminated from further evaluation. In Phase 2, an in-depth review was conducted on those documents not eliminated in Phase 1. The in-depth review focused on data that could be used to evaluate past open lake disposal relative to State and Federal water quality criteria. Analyses conducted in preparation of this report were completed prior to the effective data of the 1997 Ohio Water Quality Standards. Ohio EPA is also in the process of developing biocriteria for river mouths and near shore reaches. Information regarding these biocriteria were not available at the time analyses for this report were conducted. Consequently, the evaluation presented in this report is based on comparison of historical data with the 1996 Ohio Water Quality Standards. Comparison of historical data to the 1997 Ohio Water Quality Standards and recent work on biocriteria could potentially change some of the conclusions of this report.

Section 2.0 of this report provides a discussion of the methodology used to evaluate open lake disposal. Section 3.0 presents the results of the Phase 1 and Phase 2 reviews. A discussion of the results is provided in Section 4.0. Section 5.0 identifies data gaps and provides recommendations for future sampling and analysis.

2.0 METHODOLOGY

The Buffalo District provided 61 documents that contain information or data related to dredging of Toledo Harbor and disposal of dredged materials. Sixty-two documents were identified in the Scope of Work (see Appendix A); one was not made available to the Buffalo District. The 61 documents were reviewed for data that could be used to determine if past open lake disposal would meet current State and Federal criteria. Review of the documents was conducted in two phases. In Phase 1, each document was reviewed in sufficient detail to determine if it contained information or data relevant to State and Federal water quality criteria. A document was eliminated from further evaluation for one or more of the following:

- The document did not present original chemical or biological data specific to Lake Mile 2 through Lake Mile 19 or the open lake disposal area;
- The document contained only data on physical characteristics (i.e., particle size, settling rates) of sediments collected from Lake Mile 2 through Lake Mile 19 and/or the open lake disposal area;
- The document cited data that were originally presented in other documents identified as applicable;
- Specific locations of samples at Lake Mile 2 through Lake Mile 19 or the open lake disposal area could not be identified;
- The document presented original data only for the confined disposal area and/or River Mile 7 through Lake Mile 2.

All documents containing information on biology, ecological toxicology (i.e., bioassays), sediment chemistry, water column chemistry, and elutriate chemistry specific to the project area (Lake Mile 2 through Lake Mile 19 and/or the open lake disposal site) were retained for further evaluation. The documents eliminated in Phase I are identified in Appendix B, along with a brief narrative explaining why each was eliminated. Results of the Phase I screening were submitted to the Buffalo District on August 12, 1997.

Phase 2 of the evaluation consisted of two components. The first component was a thorough review of the State and Federal regulations relevant to discharge of pollutants into open waters. As directed in the Scope of Work, the following regulations were reviewed:

- Chapter 3745-1 of the Ohio Administrative Code, which includes the Ohio Antidegradation Rule
- Section 401 of the Federal Clean Water Act
- Section 404 of the Federal Clean Water Act

Included in the review of Sections 401 and 404 of the Federal Clean Water Act were 40 CFR 129 (Toxic Pollutant Effluent Standards and Priorities) and 40 CFR 401.15 (Toxic Pollutants), which are referenced in Section 401, and 40 CFR 230 (Guidelines for Specifications of Disposal Sites for Dredged or Fill Material), which is referenced in Section 404.

The second component was an in-depth review of the documents not eliminated as a result of Phase 1 screening. Each document was reviewed for numeric or narrative data that could be used to evaluate open lake disposal relative to current water quality criteria. The in-depth review of State and Federal regulations identified specific criteria that could be used to evaluate past disposal activities. Because the Phase I screening was conservative in terms of eliminating documents, several documents retained for the Phase II in-depth review did not contain data that could be used in the evaluation.

3.0 RESULTS

3.1 State and Federal Regulations

Ohio EPA regulates discharge of dredged materials into State waters under the authority of Chapter 3745 (Ohio Water Quality Standards, which includes the Ohio Antidegradation Rule) and Section 401 of the Federal Clean Water Act. The U.S. Army Corps of Engineers regulates the discharge of dredged materials under Section 404 of the Federal Clean Water Act. A brief discussion of each regulatory authority and its applicability to open lake disposal of dredged materials is provided below.

Ohio Water Quality Standards: Chapter 3745-1 of the Ohio Administrative Code defines water quality objectives which are applicable to all waters of the State. Specifically, 3745-1-04 states that waters of the State shall be:

> *"... free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone ..."*

Tables 7-1 through 7-15 of Chapter 3745-1 identify numerical and narrative criteria for specific pollutants. Chapter 3745-1-32 provides criteria for temperature and hydrogen sulfide specific to Lake Erie. The effective date for Chapter 3745-1, which is also referred to as the Ohio Water Quality Standards, is October 1, 1996. Revisions to the Ohio Water Quality Standards were promulgated in 1997, after analyses conducted for this report were completed.

Criteria established in the Ohio Water Quality Standards are based on designated uses. Designated uses for Lake Erie are Exceptional Warmwater Habitat, Public Water Supply, Agricultural Water Supply, Industrial Water Supply, and Bathing Waters. Numerical and narrative criteria for Exceptional Warmwater Habitat, Public Water Supply, and Agricultural Water Supply uses are presented in Tables 7-1 through 7-17 of Chapter 3745-1. Criteria for Public Water Supply are applicable within 500 yards of surface water intakes.

Water quality criteria are used to monitor compliance of waters of the State with designated uses and develop permit limits for point discharges from wastewater treatment facilities regulated under the National Pollution Discharge Elimination System (NPDES). As such, emphasis is on water quality. Consistent with this emphasis, Ohio Water Quality Standards identify criteria only for water column concentrations of pollutants. There are no State (or Federal) criteria for sediments. Although Table 7-17 of the Chapter 3745-1 defines biological criteria that can be used to infer sediment quality (metrics for benthic communities), these criteria *"do not apply to ... lakes or Lake Erie river mouths"*. Because there are no chemical or biological criteria (State or Federal) for sediments, only the water component of dredged materials, elutriate, can be used to evaluate compliance with the Ohio Water Quality Standards. Use of elutriate concentrations should be interpreted with caution. The analytical protocols for extracting elutriate from sediment samples involves a high degree of the mechanical perturbation, which tends to maximize the release of pollutants from samples. The result is that elutriate concentrations are likely to be higher that would be expected to occur during open lake disposal of dredged materials.

The Ohio Water Quality Standards identify one to several criteria for a given pollutant within the water column. Individual criterion are dependent on location relative to the point of discharge (within or immediately outside a mixing zone) and time (30-day average or maximum concentration at any point in time). Maximum concentration is the only criterion defined within the mixing zone. For the area immediately outside

the mixing zone, criteria are provided for maximum concentration, 30-day average, and human health 30-day average. Criteria for 30-day averages are based on the implicit assumption that concentrations within the mixing zone are measured on a regular basis over a 30-day period. Exceedence of the 30-day average by an individual sample is not a violation of a specific criterion, provided there are other samples and the average of all samples collected during the 30-day period are below the criteria. In addition, 30-day averages are not statistically representative of conditions that are likely to occur during open lake disposal of dredged materials. Concentrations of regulated pollutants in the water column are likely to be highest immediately following disposal, then decrease, most likely logarithmically, over time. Use of an arithmetic mean as a statistical measure of central tendency for a logarithmic decay function tends to bias the 30-day average toward the higher concentrations that occur immediately after disposal. The 30-day averages are not appropriate criteria for open lake disposal unless (1) concentrations are measured throughout the entire 30 day monitoring period following disposal of dredged materials and (2) data for the 30-day period meet the assumptions for an arithmetic mean (i.e., normally distributed).

Mixing is another consideration that should be taken into account when selecting appropriate criteria for evaluation of open lake disposal. Water released from dredged material will undoubtedly mix with the receiving water. Assuming concentrations of pollutants in the receiving water are lower than concentrations in water released from dredged materials, dilution will occur. Because mixing is likely to occur, comparison of any data to criteria without accounting for dilution can only be used to screen for potential exceedences.

Given the constraints of 30-day averages, maximum concentrations within the mixing zone and outside the mixing zone are the criteria that provide the best opportunity to evaluate open lake disposal relative to the Ohio Water Quality Standards. The criteria for maximum within mixing zone are generally two times higher than the criteria for maximum outside mixing zone. In the absence of information on mixing and the degree of dilution that occurs upon disposal of dredged materials, comparison of elutriate concentrations with criteria within the water column of the receiving water must be interpreted with caution.

Ohio Antidegradation Rule: The Ohio Antidegradation Rule, which became effective October 1, 1996, is included as Chapter 3745-1-05 of the Ohio Water Quality Standards. It is applicable to discharges requiring Section 401 Water Quality Certification. As such, the Ohio Antidegradation Rule is applicable to open water disposal of dredged materials. The Rule essentially defines procedures and protocols for preparation and review of applications for discharges to surface waters. The Rule also states that an activity can not decrease the quality of the receiving water without demonstrating why the decrease in quality is the result of an important social or economic need. Furthermore, any decrease in quality can not be to the extent that the designated uses are degraded. The Rule does not identify criteria different from those in Tables 7-1 through 7-17 in Chapter 3745-1.

Section 401 Water Quality Certification: Under Section 401 of the Federal Clean Water Act, States are delegated authority to review discharges into waters of the United States that require Federal approval. In reviewing applications for Section 401 Water Quality Certification, the State in which a project is proposed evaluates the project in terms of impacts to water quality as defined by the State water quality criteria. Toxic pollutants that must be evaluated by the states in accordance with Section 307(a)(1) of the Federal Clean Water Act are identified in 40 CFR Section 401.15. Federal criteria are identified for selected pollutants in 40 CFR 129. Because projects are reviewed in terms of impacts to State water quality, the criteria applicable to Section 401 are those identified in Chapter 3745-1.

Section 404: Section 404 of the Federal Clean Water Act addresses permit requirements for activities involving discharge of dredged or fill material into waters of the United States. In particular, Section 404 provides protocols and guidelines for preparation and review of permits issued by the Corps. Among the requirements of Section 404 is review of a project for impacts to water quality. Portions of Section 404 that address water quality criteria reference the same sections of the Federal Clean Water Act that are referenced in Section 401 relating to Water Quality Certification (Section 307). Therefore, review of project impacts in accordance with Section 401 for Water Quality Certification also meets the requirements of Section 404 for water quality.

3.2 Comparison of Historical Data with Current Water Quality Criteria

3.2.1 Water Column

As discussed in the previous section, the most appropriate medium for evaluation is elutriate. The most appropriate criteria for comparison are the maximum concentration within the mixing zone and maximum concentration outside the mixing zone. Because the elutriate concentrations are single point values, 30-day averages are not appropriate. Elutriate concentrations identified through the in-depth review are presented in Table 3.1. Data are available for relatively few of the parameters identified in the Ohio Water Quality Standards. Data are limited to nutrients (phosphorus and nitrogen), a few metals, oil and grease, and phenols. Elutriate concentration exceeds the criterion for maximum concentration within the mixing zone only for cadmium and mercury. The one exceedence of cadmium was reported for one sample from Lake Mile 2 in the Document #56 (*Draft Results of Acute Toxicity Tests Performed on Toledo Harbor Channel Sediments in 1993*). One replicate sample (33ug/l) exceeds the criteria of 11 ug/l. The other replicate for this sample is an order of magnitude lower (3.4 ug/l), well below the criterion. Three exceedences for mercury were reported at Lake Mile 2, Lake Mile 5, and Lake Mile 10, with elutriate concentrations of 11, 4, and 3 ug/l, respectively (Document #38). The criterion for maximum concentration with the mixing zone is 2.2 ug/l.

All exceedences for maximum concentration within the mixing zone are also exceedences of the maximum outside the mixing zone. In addition to those exceedences of maximum within the mixing zone, elutriate concentration of copper exceeds the criteria for maximum outside the mixing zone (18 ug/l) for samples from Lake Miles 2, 3, and 4 (30, 20, and 20 ug/l, respectively); elutriate concentration of mercury exceeds the criteria for maximum outside the mixing zone (1.1 ug/l) for samples from Lake Miles 7, 8, and 10 (2, 2, and 3 ug/l, respectively).

The exceedences for cadmium, copper, and mercury should be interpreted with caution. The comparison of elutriate concentrations with the criteria for maximum concentrations within the mixing zone and outside the mixing zone does not take into account dilution, which will undoubtedly occur when water released from the dredged materials mixes with the receiving water. As an additional confounding factor, elutriate concentration represents the maximum that could be expected to be released from dredged materials. Given that the greatest exceedence is only five times the criteria for maximum within the mixing zone and 10 times the criteria for maximum outside the mixing zone, it is likely that the maximum concentration both within and outside the mixing zone following deposition of dredged materials would be below the criteria. Analysis of water column samples collected during open lake disposal is required to determine if this is the case.

Three of the documents present results of sampling conducted during open lake disposal of dredged materials in 1986 (Document #21) and 1987 ((Document #31 and Document #32). The 1986 study was conducted from March through June during disposal operations. An Analysis of Variance (ANOVA) showed there was no significant difference ($F=1.860$; $p=0.087$) in total phosphorus in the water column over time. The mean over the survey period was 29 ppb. The criterion for total phosphorus presented in the Ohio Water Quality Standards is qualitative:

> *"Total phosphorus as P shall be limited to the extent necessary to prevent nuisance growths of algae, weeds, and slimes . . ."*

Based on above information, there appears to have been no violation of this criterion.

In the 1986 study, soluble reactive phosphorus (SRP) did show significant change ($F=12.207$; $p<.001$) over time. It was hypothesized that SRP was quickly depleted by the spring phytoplankton bloom. SRP decreased from 15 ppb in March to undetectable concentrations in June. The mean of the SRP was 5 ppb. This is below the mean of 8 ppb observed during 1975. Information presented is insufficient to determine if the spring phytoplankton blooms were at *"nuisance"* levels.

Document #21 also presents water column concentrations of arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc over time. Data are presented as scatter plots and can only be approximated. The scatter plots indicate some of the samples for copper and mercury exceeded the 30-day average outside the mixing zone. These "exceedences" also need to be interpreted with caution. The 30-day average is based on continuous readings over time. A single point above the 30-day average should not be evaluated as a stand alone value; it needs to be considered in the context of all other data points within the time frame of interest.

In Document #31, Stevenson alleges that dredging activities and overboard disposal of dredged materials introduced nutrients into Lake Erie, resulting in algal blooms. If substantiated, this would be an exceedence of the criterion for total phosphorus. Stevenson analyzed data between 1970 and 1986 and presents a series of graphs that he maintains shows a correlation between dredging activities and algal blooms. No statistical tests were performed. The data presented are insufficient to show any correlation between dredging activity and water quality degradation within the vicinity of the water intake. Water quality measurements taken in 1986 are presented. However, the measurements were not associated with monitoring during disposal activities.

Fraleigh (1987) reports changes in dissolved oxygen and turbidity associated with open lake disposal activities. None of the levels for dissolved oxygen dropped below the criterion of 6 mg/l. There are no criteria for turbidity. Fraleigh further reports that both dissolved oxygen and turbidity return to background levels after open lake disposal is completed.

3.2.2 Aquatic Toxicity Tests

Several documents contain information regarding toxicity of sediments. Although there are no sediment- or elutriate-specific criteria for toxicity identified in the Ohio Water Quality Standards, the results of the toxicity tests are useful in evaluating potential biological impacts that might occur as a result of open lake disposal.

Aquatic toxicity tests have been conducted on whole sediments, pore waters, and sediment elutriates using both sediment dwelling and free-swimming test organisms. Tests have been conducted to elucidate both acute (lethality) or chronic (reproduction and growth) effects. Whereas many of the studies have utilized similar sampling locations within the areas of dredging and open water disposal, a variety of reference or control stations have been used. To further complicate evaluation of data, investigators have utilized a variety of reporting methods ranging from point estimates of effect levels (e.g., LC_{50} or no observable adverse effect concentrations) to use of a sediment classification scale to characterize the sediments as non-polluted, moderately, or heavily polluted. Thus, direct comparison of the results derived from studies characterizing sediments as moderately polluted to studies which report statistically significant differences between the sample and control responses may not be appropriate. Results of the toxicity tests are summarized in Table 3.2 (Prater-Anderson exposure system) and Table 3.3 (sediment, elutriate, and pure water test system). Brief discussions of toxicity tests presented in each document are provided below.

***The Analysis of Sediment from the Proposed Open-Lake Disposal Site at Toledo, Ohio* (Document #25):** This document reports the results of toxicity tests were conducted utilizing a Prater-Anderson exposure system for sediments collected within a proposed disposal area in the vicinity of Lake Mile 16. Two sediment samples from a proposed disposal area as well as a reference sediment were collected and tested. Tests were conducted using *Pimephales promelas* (fathead minnow), *Daphnia magna* (water flea), and *Hexagenia limbata* (mayfly) as test species. The Prater-Anderson exposure system contains both sediment and overlying water. This allows the concurrent exposure of all three test species. The endpoint for these tests was mortality. The results were used to characterize the sediments as non-polluted (< 10% mortality), moderately polluted (10-50% mortality), or heavily polluted (> 50% mortality).

Sediments from the proposed disposal site were characterized as moderately polluted. Similarly, sediments from the reference site were also characterized as moderately polluted based on the results of two test species (*D. magna* and *H. limbata*) and non-polluted based on the results of *P. promelas* (Table 3.2). It is important to note that these tests were conducted to characterize sediments in a proposed open lake disposal area prior to the actual disposal of the dredged material. Thus, these tests indicate some level of toxicity naturally exists in these sediments.

***The Analysis of Sediment from the Proposed Open-Lake Disposal Site at Toledo, Ohio* (Document #35):** This document reports the results of sediment toxicity tests were conducted utilizing a Prater-Anderson exposure system for sediments collected within a proposed disposal area. Tests were conducted using *P. promelas*, *D. magna* and *H. limbata* as test species. Mortality was used as a test endpoint. The results were used to characterize the sediments as non-polluted (< 10% mortality), moderately polluted (10-50% mortality), or heavily polluted (> 50% mortality).

Based on the results of both *D. magna* and *H. limbata*, all samples, including reference site sediments, were characterized as moderately polluted. In contrast, the sediments are characterized as non-polluted based on the survival of *P. promelas*. As is the case for Document #25, tests reported in this document were conducted to characterize sediments in a proposed open lake disposal area prior to the actual disposal of the dredged material. The results indicate that some level of toxicity naturally exists. This is consistent with Document #25.

Analysis of Sediment from Toledo Harbor B Maumee River **(Document #6):** This document reports the results of sediment toxicity tests conducted utilizing a Prater-Anderson exposure system for sediments collected at regular intervals from River Mile 7 to Lake Mile 7. Only those sediments collected from Lake Mile 2 through Lake Mile 7 are relevant to this analysis. Reference sediments were not collected; however, a control sediment collected from the Pere Marquette River, Michigan, was utilized. Tests were conducted using *P. promelas*, *D. magna* and *H. limbata* as test species. The test also utilized the sediment classification system described for Document #25.

Based on *P. promelas* survival, sediments from LM3-4 and LM4-5 were characterized as moderately polluted. All other sites were classified as non-polluted. The results of the *H. limbata* tests are uncertain because of the relatively high level of mortality observed in the control sediment (22%). However, based on mortality, all sites would be classified as either moderately or heavily polluted (Table 3.2). Based on the results for *D. magna*, sediments from LM3-4 and LM6-7 are classified as moderately polluted. With the exception of the results of *H. limbata*, a majority of the sediments exhibit a relatively low level of acute toxicity (maximum mortality of 29.8%).

The Analysis of Sediments from Toledo Harbor **(Document #38):** This document reports the results of aquatic toxicity tests conducted utilizing the Prater-Anderson testing system on 24 sediment samples collected within the channel, 4 samples from a disposal area located adjacent to LM10-11, and a control sample collected from an unperturbed area of the Waupaca River, Wisconsin. Tests were conducted for a duration of 96 hours. Mortality was the observational endpoint. Test species were *H. limbata*, *D. magna* and *P. promelas*. Sediments were classified as non-polluted, moderately polluted, or heavily polluted using the classification criteria previously discussed.

Based on the mortality observed for *H. limbata*, all sediments are classified as moderately polluted (Table 3.2). Based on the mortality of *D. magna*, all sites with the exception of disposal site 2 (D-2) and LM8-9, are classified as non-polluted. Sediments from D-2 and LM8-9 are classified as moderately polluted. Based on the mortality of *P. promelas*, all of the sites would be characterized as non-polluted.

In consideration of all of data, the following conclusions can be drawn. *Hexagenia limbata*, is the most sensitive of the species tested. However, test results for this species indicate that an unperturbed site (control) would be characterized as moderately polluted. Thus, the interpretation of these data is unclear. Further, only two sites resulted in similar classification for at least two of the test species. Sites D-2 and LM8-9 were similarly classified as moderately polluted using data from *H. limbata*, and *D. magna*.

Chemical and Bioassay Analysis, Lake Erie Western Basin, Toledo Harbor **(Document #3).** This document presents the results of toxicity tests conducted using a Prater-Anderson exposure system. Tests were conducted using *D. magna*, *Ascellus intermedius* (sowbug), and *H. limbata* as the test organisms. Mortality was used as the endpoint. Significant mortality was observed for *D. magna* with sediments from LM7-8 and LM13-14. Significant mortality was observed for *A. intermedia* in sediments from one of the reference sites and LM11-12.

Application of the Chironomus tentans Survival and Growth Bioassay in Evaluating Sediment Quality from Four Great Lakes Harbors **(Document #55):** In this study, ten sediment samples were tested with two samples serving as reference sediment (deep and shallow water reference sites). The freshwater midge, *Chironomus tentans*, was used as the test organism. The test was conducted using whole sediments. Test endpoints were survival and growth. Reduced survival compared to the deep-water reference (DWR) site was observed at sites LM2-3, LM3-4, LM4-5 and LM7-8 (Table 3.3). Reduced growth relative to the DWR

was observed at sites LM4-5 and LM7-8. When compared to the shallow water reference (SWR) site, reduced survival was observed at sites LM3-4 and LM4-5. Sites LM3-4 and LM4-5 exhibited significant decreases in either growth or survival when compared to both DWR and SWR.

Evaluation of Proposed U.S. Environmental Protection Agency Dredged Material Bioassays Using Great Lakes Sediments **(Document #58):** A series of tests were conducted to technically evaluate sediment toxicity test methods proposed for the characterization of dredged material. The tests included:

- Whole sediment, 10-day survival bioassays with the amphipod (*Hyalella azteca),*
- Sediment elutriate, 7-day survival and growth bioassays with the fathead minnow, a freshwater fish (*Pimephales promelas*), and
- Sediment elutriate, 21-day survival and reproduction bioassays with the water flea, a cladoceran (*Daphnia magna*).

Both shallow water and deep-water sediments (SWR and DWR) were utilized as reference sediments.

For *H. azteca*, sediment from site LM2-3 resulted in significantly reduced survival compared to the SWR (42.9 percent). Survival at all other sites was 80% or greater. These results should be viewed with caution because both sediments from both SWR and DWR were composed of coarse-grained material compared to the silt-clay composition of sediments from LM2-3. Thus, the coarse-grained reference sediments would have provided unsuitable habitat for this test species.

Sediment elutriate tests conducted with the *P. promelas* resulted in significantly decreased survival for all sites compared to a control. Reference sediment elutriates were not tested; survival in sediment elutriates were compared to survival in a laboratory control. Differences between sediments collected in potential dredging areas and sediments representative of non-dredged, Lake Erie sediments areas are unknown. Thus, although significantly reduced survival was observed, the importance of this effect relative to non-impacted, Lake Erie sediments is not known.

Sediment elutriate tests conducted with the *D. magna* resulted in significantly reduced survival at LM11-12. Many of the individual tests did not exhibit a typical dose response curve in which mortality increases with increasing concentrations of sediment elutriate. Reduced reproduction was observed in tests conducted with elutriates from sites LM7-8 and LM11-12. Neither site exhibited a typical dose response curve. As with the *P. promelas* tests, reference sediment elutriates were not tested; survival and reproduction in sediment elutriates were compared to a laboratory control. Thus, while the data suggest potential impacts, differences between sediments collected in dredging areas and reference sediments are unknown. Recognizing the limitations of these data, there was very little correlation between the results for the three test species. Significant effects for *H. azteca* with sediments from LM2-3 were not supported by test data from the other species with the exception of a significant effect for fathead minnows using site LM2-3 sediments.

Evaluation of Sediments from the Toledo Harbor Area. **(Document #60):** Whole sediment, 10-day survival toxicity tests were conducted using *H. azteca* and *C. tentans* as test species. Tests were conducted with sediments collected from several dredging sites as well as a reference site located north/northwest of Lake Mile 10. Of the sediments tested, only the survival of *C. tentans* exposed to sediments collected from LM2-3 site was significantly reduced compared to the reference sediment. There were no other significant differences identified in the study. Results of this study area summarized in Table 3.3.

Draft Results of Acute Toxicity Test Performed on Toledo Harbor Channel Sediments in 1993 **(Document #56):** This document summarizes the results of toxicity tests conducted on sediments from eight management units within the Toledo Harbor navigation channel. In addition, two reference sediments, shallow and deep water sites (SWR and DWR respectively), were also collected and tested. The following tests were conducted:

- Sediment elutriate 7-day survival bioassays with the fathead minnow, a freshwater fish (*P. promelas*),
- Whole sediment, 10-day survival bioassays with the amphipod (*H. azteca)*, and
- Whole sediment, 10-day survival bioassays with the freshwater midge, *C. tentans.*

Significantly reduced survival was observed for *C. tentans* in LM2-3 when compared to the SWR site, but no differences were noted when compared to the DWR site. For the *P. promelas* tests, all sites (with the exception of LM11-12) showed significant reductions in survival when compared to the DWR site. When compared to the SWR site, only sites LM3-4 and LM4-5 exhibited significantly decreased survival. In summary, the results were mixed with some species indicating potential toxicity and other species indicating no adverse acute effects.

Bioassessment of Toronto-Toledo Sediments **(Document #19):** This document presents data on the impact of sediment elutriates on the C^{14} uptake of ultraplankton (5-20 um) and microplankton (> 20 um). Sediments were collected at LM9-10 and LM10-11. The test endpoint was the reduction in uptake of C^{14} as a function of exposure concentration. The EC_{50} value, which is the elutriate concentration that reduces C^{14} uptake by 50%, was calculated for each sediment. In general, uptake of C^{14} by ultraplankton was reduced by 50% upon exposure to 40-45% sediment elutriates from sites LM9-10 and LM10-11. Similarly, reduced uptake of C^{14} by microplankton was observed for all sediment elutriates tested.

Toxicity of Sediments from Western Lake Erie and the Maumee River at Toledo, Ohio, 1987: Implications for Current Dredged Material Disposal Practices **(Document #47):** This document summarizes numerous sediment toxicity test data utilizing four test species: *Photobacterium phosphoreum* (Microtox7), *C. tentans*, *C. dubia* and *P. promelas.* Sediments were collected throughout the dredging area (LM2-3 through LM15-16) as well as numerous reference sites (Middle Sister Reference (MSR), Open Lake Reference (OLR)).

Tests conducted with Microtox7 on sediment elutriate indicated potential effects at LM15-16, LM13-14, LM5-6 as well as the MSR and OLR sites. No adverse effects were observed utilizing sediment pore waters as the test media. No significant differences were observed between reference and test sediments for the test species, *C. tentans*. Sediment elutriate tests conducted with *C. dubia* only indicated potential impacts at LM3-4 and LM7-8 based on decreased reproduction. However, the report notes that these differences may be due to quality control problems. Similarly, sediment elutriate tests conducted with *P. promelas* indicated adverse effects on growth when the organisms were exposed to 100% elutriate prepared from sediments collected from the disposal site and LM9-10. Further, effects on survival were observed for 100% elutriates prepared from sediments collected at sites LM3-4 and LM5-6.

The document concludes that sediments collected from the Lake Erie portion of the navigation channel were suitable for open lake disposal and the toxicity of sediments collected from the disposal area were similar in toxicity to sediments collected from areas not impacted by dredging activities.

4.0 DISCUSSION

An abundance of data associated with the dredging of Toledo Harbor and open lake disposal of dredged materials have been accumulated. Unfortunately, relatively few can be used to objectively evaluate past or future open lake disposal relative to the Ohio Water Quality Standards and requirements under the Federal Clean Water Act. Numerical and narrative criteria presented in the Ohio Water Quality Standards are applicable only to concentrations of toxic pollutants and other water quality parameters in the water column. There are no applicable State or Federal criteria for sediments. Similarly, there are no applicable sediment- or elutriate-specific criteria for toxicity testing or metrics for biological communities (i.e., benthos). Table 7-17 of the Chapter 3745-1 defines criteria for benthic communities. However, these criteria do not apply to lakes or river mouths to Lake Erie. Ohio EPA is currently developing biocriteria for river mouths and near shore reaches which may be applicable to future sampling events. Based on a thorough review of the both State and Federal regulations governing open lake disposal, it is the interpretation of the authors that concentrations in the water column are the most appropriate criteria for evaluation.

Evaluation of past and future open lake disposal is further complicated by two other factors. One is the physical composition of dredged materials. Dredged materials are a mixture of sediments and water. Because criteria are based on concentrations of pollutants in the water column, dredged materials must be put through a process that extracts the water component. Because the methods used to extract elutriate from dredged materials involve a high degree of mechanical perturbation, concentrations of pollutants in laboratory extracted elutriates are likely to be higher than would occur during open lake disposal. A second complicating factor is dilution that is likely to occur when dredged materials mix with receiving waters. None of the documents reviewed delineate a mixing zone. Delineation of this zone is critical to an objective and unqualified evaluation because the Ohio Water Quality Standards identify criteria for "within" and "outside" the mixing zone.

Two basic approaches were employed to evaluate open lake disposal. The first approach compared concentrations of pollutants in elutriates extracted from sediments collected in the shipping channel to the criteria for maximum within the mixing zone and maximum outside the mixing zone. This approach is conservative because (1) concentrations in laboratory elutriates are likely to be higher than those likely to be released from dredged materials during open lake disposal, and (2) dilution is not taken into account. Using the most conservative comparison, maximum concentration outside the mixing zone, only one sample of cadmium, three samples of copper, and five samples of mercury exceeded the criteria. None of the "exceedences" were greater than ten times the criteria. Based on data available, it was not possible to determine if criteria for these parameters would have been exceeded during open lake disposal.

A second approach was to evaluate those limited number of documents that presented data collected during actual open lake disposal activities. The primary assumption with use of this approach is that the samples were collected within the mixing zone. Accordingly, the appropriate criteria are the maximum and potentially the 30-day average within the mixing zone. In addition to the limited number of documents, sampling and analysis of samples collected during open lake disposal addressed a limited number of parameters. Criterion for minimum concentration of dissolved oxygen was not exceeded. Available data indicate that total phosphorus did not exceed the narrative criterion identified in Chapter 3745-1. Also, concentrations of several metals (arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc) do not appear to have exceeded criteria for the maximum concentration within the mixing zone. Sufficient data are not available to evaluate reported concentrations relative to the 30-day average. As discussed in Section 3.1, certain statistical assumptions must be met by use of the 30-day average.

Although there are no sediment- or elutriate-specific criteria for aquatic toxicity, the results of numerous toxicity tests presented in several of the documents were reviewed in order to identify potential adverse effects on aquatic life. Results of the numerous toxicity tests are inconclusive. One of the primary factors is the absence of a standardized procedure for conducting tests and identifying ecologically relevant endpoints. Test species, endpoints, and presentation of results were highly variable among documents. This makes any meaningful evaluation extremely difficult, if not impossible. Another major factor contributing to the inconclusive nature of the toxicity data is that several of the documents presented evidence that sediments within the disposal site, even before deposition of any dredged materials, have at least some degree of ecological toxicity. These confounding factors preclude any definite conclusion regarding toxicity of dredged materials. Overall, the results presented in the documents reviewed suggest that any toxicological impacts to aquatic life as result of open lake disposal are minor.

5.0 DATA GAPS AND RECOMMENDATIONS FOR FUTURE SAMPLING

Based on available data and use of the criteria for maximum concentration within the mixing zone, and outside the mixing zone, cadmium, copper, and mercury are the only parameters that potentially exceeded the Ohio Water Quality Standards. As pointed out throughout this report, comparison of elutriate concentrations with the criteria for maximum concentration does not take mixing or dilution into account. Identification of an appropriate mixing zone is critical to a meaningful and unqualified evaluation of compliance with Ohio Water Quality Standards. Because of this deficiency, any additional studies of open lake disposal should include collection of data necessary and sufficient to define a mixing zone. This will allow evaluation of both concentrations within the mixing zone and concentrations at the edge of the mixing zone.

Both the Ohio Water Quality Standards and requirements for Section 401 Water Quality Certification identify parameters that should be considered in evaluating compliance with State and Federal standards. Data are not available for all of the pollutants identified in the regulatory documents. Table 5.1 identifies the parameters listed in the regulatory documents along with those for which data are available and those for which data are not available. Absence of data for all listed parameters can be conservatively viewed as a "data gap". To completely fill the gap, future sampling would include analysis for all parameters listed in Table 5.1. Given that cadmium, copper, and mercury are the only parameters that the in-depth review identified as potentially exceeding current criteria, analysis for all parameters is not necessary. Alternatively, future sampling should focus on parameters that (1) past sampling has indicated may exceed current criteria (e.g., cadmium, copper, and mercury); (2) nutrients that can cause eutrophication and problems with public water uses (i.e, total phosphorus); (3) parameters indicative of potential pollution from the prevailing land uses in the western basin of Lake Erie (i.e., agriculture); and (4) parameters of concern to the state and Federal regulatory agencies. Based on this approach, four groups of chemicals are recommended for analysis in future sampling events. A fifth group is conditionally recommended. Table 5.2 identifies the parameters recommended for future sampling. Because criteria are available only for the water column, analyses for the recommended parameters would be conducted for surface water and elutriates.

One group of parameters is metals. In particular, those metals for which the Ohio Water Quality Standards identify criteria for maximum concentration within the mixing zone. This groups includes:

Antimony	Lead
Arsenic	Mercury
Beryllium	Nickel
Cadmium	Selenium
Chromium	Silver
Copper	Thallium
Cyanide	Zinc

As metals are reduced, they adhere to sediment particles. Particles, because of the high surface area and functional surface groups, are scavengers for metal ions. As a result, particles play an important role in the transport and accumulation of metals in sediments. Metals can impact aquatic life (flora and fauna) in a variety of ways. Some metals, such as cadmium, lead, and mercury, are of special concern because of their tendency to accumulate in biological tissues. Metals have been historically introduced from a variety of industrial sources and may be widespread in Lake Erie. The three parameters identified as potentially exceeding criteria, cadmium, copper, and mercury, are metals. Iron is not included in the recommended list of metals. The Ohio

Water Quality Standards list criteria for lead only for 30-day averages. As discussed in Section 3.1, 30-day averages may not be statistically valid for open lake disposal.

A second group of compounds is nutrients. One of the concerns expressed by the City of Toledo is fouling of the drinking water treatment plant, which draws water from Lake Erie. In addition, eutrophication of Lake Erie can adversely effect more general designed uses, such as boating, swimming and fishing. The Ohio Water Quality Standards identify criteria for ammonia, nitrate-nitrite, and total phosphorus. Criteria for ammonia and nitrate-nitrite are numerical. The criterion for total phosphorus is qualitative. The criterion limits increases in total phosphorus "*. . .to the extent necessary to prevent nuisance growths of algae, weeds, and slimes . . .*". Any future sampling or analysis should be designed to quantitatively address the issue of phosphorus.

A third group of parameters is pesticides and fertilizers, which are likely to be introduced into the western basin of Lake Erie as a result of the heavy agricultural land use. The *Inland Testing Manual* (EPA, 1994) identifies acenapthene, aldrin, dieldrin, endrin, heptachlor, hexachlorobenzene (HBC), and toxaphene as associated with agricultural land uses. The Ohio Water Quality Standards identify criteria for maximum concentrations for acenapthene and dieldrin. Criteria only for 30-day averages are identified for aldrin, endrin, heptachlor, HBC, and toxaphene. For reasons discussed in Section 3.1, comparison of sample results to 30-day averages should be made with caution. Comparison of point values to 30-day averages should be used only as a screening tool.

A fourth group of parameters consists of percent total volatile residue, percent total residue, total Kjeldahl nitrogen, chemical oxygen demand, PCBs, and PAHs. This group of parameters was recommended by Ohio EPA.

A fifth group of parameters is recommended, but only if sampling and analysis is conducted during open lake disposal operations. This fourth group is dissolved oxygen and pH. Both are potentially limiting to aquatic life and both are best measured during actual disposal operations. Sampling during open lake disposal provides the best opportunity to evaluate compliance with the Ohio Water Quality Standards. The mixing zone can be delineated. Concentrations of pollutants within and outside the mixing zone can be directly measured as a function of time and distance from disposal operations. The most toxic form of most metals, dissolved, can also be better evaluated. Therefore, it is recommended that future sampling should be conducted during the next open water disposal event.

One of the basic principles of the Ohio Water Quality Standards is protection of aquatic life. Achieving this principle requires physical/chemical characterizations and/or analysis of biological indicators to evaluate impacts of a proposed activity. Use of biological indicators, including toxicity tests, is a more direct method to evaluate ecological effects than chemical analysis. At best, ecological impacts can only be inferred from chemical data. Because of the information that can be obtained, it is recommended that future sampling and analysis should include an integrated sediment assessment approach that includes bioassay testing and physicochemical characterization. Bioassay tests are recommended because these tests provide important additional information to chemical analyses. Specifically, the test organisms utilized in these tests

integrate factors such as compound bioavailability and toxicity and directly address the potential for adverse water and sediment quality impacts due to dredged material disposal. Recommendations for bioassay testing include:

- Development and implementation of a consistent program which includes testing of local Lake Erie reference sediments as well as control sediments.

- Implementation of a battery of toxicity tests including both elutriate (to evaluate potential impacts to water quality during dredged material disposal) and whole sediment (to evaluate impacts to sediment quality) tests.

Development of a consistent testing program would allow for comparison of test results collected over a long time frame and identify trends in sediment and elutriate quality. Further, use of both Lake Erie reference and control sediments in all tests would allow any significant effects identified in the sediment testing program to be placed into perspective with reference and control sediment quality.

Recommended elutriate phase tests include the 7-day survival and reproduction test using *Ceriodaphnia dubia* and/or the 7-day larval survival and growth test with the fathead minnow, *Pimephales promelas*. These tests are well documented, can be provided quickly by a variety of contract laboratories, and have been generally accepted within the scientific and regulatory community. Further, Microtox testing may also be used as a low-cost screening tool for identifying sediments (specifically sediment elutriates) for more intense biological investigations.

Recommended whole sediment tests include the 14-day survival and growth tests utilizing *Hyalella azteca* and/or *Chironomus riparius*. Similar to the elutriate phase tests, the recommended whole sediment tests are widely accepted and provide a measurement of potential effects due to exposure to bulk sediments.

TABLE 3.1:

ELUTRIATE CONCENTRATIONS OF SEDIMENTS FROM LAKE MILE 2 THROUGH LAKE MILE 19

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

	Criteria					
Parameter	**Maximum Within Mixing Zone**	**Maximum Outside Mixing Zone**	**Lake Mile**	**Reported Result**	**Adjusted Result[1]**	**Reference Document**
Arsenic	720 ug/l	360 ug/l	2	< 0.004 mg/l	< 4 ug/l	6
				7 ug/l	7 ug/l	38
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
			3	0.007 mg/l	7 ug/l	6
				6 ug/l	6 ug/l	38
				< 0.003 mg/l *	< 3 ug/l	56
				7 ug/l	7 ug/l	38
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
			4	< 0.004 mg/l	< 4 ug/l	6
				11 ug/l	11 ug/l	38
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
			5	0.005 mg/l	5 ug/l	6
				5 ug/l	5 ug/l	38
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
			6	0.006 mg/l	6 ug/l	6
				< 5 ug/l	< 5 ug/l	38
			7	0.009 mg/l	9 ug/l	6
				5 ug/l	5 ug/l	38
			8	< 5 ug/l	< 5 ug/l	38
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
			9	< 5 ug/l	< 5 ug/l	38
			10	< 5 ug/l	< 5 ug/l	38
			11	< 5 ug/l	< 5 ug/l	38
			12	< 5 ug/l	< 5 ug/l	38
				0.003 mg/l *	3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
				< 0.003 mg/l *	< 3 ug/l	56
			13	< 5 ug/l	< 5 ug/l	38
				< 5 ug/l	< 5 ug/l	38
			14	< 5 ug/l	< 5 ug/l	38
			15	< 5 ug/l	< 5 ug/l	38
			16	< 5 ug/l	< 5 ug/l	38

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Cadmium	11 ug/l	5.6 ug/l	2	< 0.01 mg/l	< 10 ug/l	6
				< 0.05 ug/l	< 0.05 ug/l	19
				< 1 ug/l	< 1 ug/l	19
				< 1 ug/l	< 1 ug/l	38
				0.033 mg/l *	33 ug/l	56
				0.0034 mg/l *	3.4 ug/l	56
				0.0003 mg/l *	0.3 ug/l	56
			3	< 0.01 mg/l	< 10 ug/l	6
				< 1 ug/l	< 1 ug/l	38
				< 0.0003 mg/l *	< 0.3 ug/l	56
				< 1 ug/l	< 1 ug/l	38
				< 0.0003 mg/l *	< 0.3 ug/l	56
				0.0011 mg/l *	1.1 ug/l	56
			4	< 0.01 mg/l	< 10 ug/l	6
				< 1 ug/l	< 1 ug/l	38
				0.0008 mg/l *	0.8 ug/l	56
				0.0022 mg/l *	2.2 ug/l	56
				0.0003 mg/l *	0.3 ug/l	56
			5	< 0.01 mg/l	< 10 ug/l	6
				< 1 ug/l	< 1 ug/l	38
				0.0004 mg/l *	0.4 ug/l	56
				0.0004 mg/l *	0.4 ug/l	56
				0.0021 mg/l *	2.1 ug/l	56
			6	< 0.01 mg/l	< 10 ug/l	6
				< 1 ug/l	< 1 ug/l	38
			7	< 0.01 mg/l	< 10 ug/l	6
				< 1 ug/l	< 1 ug/l	38
			8	< 1 ug/l	< 1 ug/l	38
				< 0.0003 mg/l *	< 0.3 ug/l	56
				0.0045 mg/l *	4.5 ug/l	56
				< 0.0003 mg/l *	< 0.3 ug/l	56
			9	< 1 ug/l	< 1 ug/l	38
			10	< 0.05 ug/l	< 0.05 ug/l	19
				< 1 ug/l	< 1 ug/l	19
				< 1 ug/l	< 1 ug/l	38
			11	< 1 ug/l	< 1 ug/l	38
			12	< 1 ug/l	< 1 ug/l	38
				0.0007 mg/l *	0.7 ug/l	56
				0.0003 mg/l *	0.15 ug/l	56
				0.0042 mg/l *	4.2 ug/l	56

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result		Adjusted Result[1]		Reference Document
Cadmium *(continued)*	11 ug/l	5.6 ug/l	13	< 1	ug/l	<	1 ug/l	38
				< 1	ug/l	<	1 ug/l	38
			14	< 1	ug/l	<	1 ug/l	38
			15	< 1	ug/l	<	1 ug/l	38
			16	< 1	ug/l	<	1 ug/l	38
Chromium	3600 ug/l	1800 ug/l	2	0.02	mg/l		20 ug/l	6
				< 30	ug/l	<	30 ug/l	38
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
			3	0.02	mg/l		20 ug/l	6
				< 30	ug/l	<	30 ug/l	38
				< 0.013	mg/l *	<	13 ug/l	56
				< 30	ug/l	<	30 ug/l	38
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
			4	< 0.02	mg/l	<	20 ug/l	6
				< 30	ug/l	<	30 ug/l	38
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
			5	< 0.02	mg/l	<	20 ug/l	6
				< 30	ug/l	<	30 ug/l	38
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
			6	< 0.02	mg/l	<	20 ug/l	6
				< 30	ug/l	<	30 ug/l	38
			7	< 0.02	mg/l	<	20 ug/l	6
				30	ug/l		30 ug/l	38
			8	31	ug/l		31 ug/l	38
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
			9	< 30	ug/l	<	30 ug/l	38
			10	< 30	ug/l	<	30 ug/l	38
			11	< 30	ug/l	<	30 ug/l	38
			12	< 30	ug/l	<	30 ug/l	38
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56
				< 0.013	mg/l *	<	13 ug/l	56

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Chromium *(continued)*	3600 ug/l	1800 ug/l	13	< 30 ug/l	< 30 ug/l	38
				< 30 ug/l	< 30 ug/l	38
			14	< 30 ug/l	< 30 ug/l	38
			15	< 30 ug/l	< 30 ug/l	38
			16	< 30 ug/l	< 30 ug/l	38
Copper	35 ug/l	18 ug/l	2	0.03 mg/l	30 ug/l	6
				16 ug/l	16 ug/l	19
				< 20 ug/l	< 20 ug/l	38
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
			3	0.02 mg/l	20 ug/l	6
				< 20 ug/l	< 20 ug/l	38
				< 0.014 mg/l *	< 14 ug/l	56
				< 20 ug/l	< 20 ug/l	38
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
			4	0.02 mg/l	20 ug/l	6
				< 20 ug/l	< 20 ug/l	38
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
			5	0.01 mg/l	10 ug/l	6
				< 20 ug/l	< 20 ug/l	38
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
			6	0.01 mg/l	10 ug/l	6
				< 20 ug/l	< 20 ug/l	38
			7	0.01 mg/l	10 ug/l	6
				< 20 ug/l	< 20 ug/l	38
			8	< 20 ug/l	< 20 ug/l	38
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
			9	< 20 ug/l	< 20 ug/l	38
			10	11 ug/l	11 ug/l	19
				< 20 ug/l	< 20 ug/l	38
			11	< 20 ug/l	< 20 ug/l	38

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Copper *(continued)*	35 ug/l	18 ug/l	12	< 20 ug/l	< 20 ug/l	38
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
				< 0.014 mg/l *	< 14 ug/l	56
			13	< 20 ug/l	< 20 ug/l	38
				< 20 ug/l	< 20 ug/l	38
			14	< 20 ug/l	< 20 ug/l	38
			15	< 20 ug/l	< 20 ug/l	38
			16	< 20 ug/l	< 20 ug/l	38
Cyanide	92 ug/l	46 ug/l	2	0.01 mg/l	10 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
			3	< 0.01 mg/l	< 10 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
				< 0.01 mg/l	< 10 ug/l	38
			4	0.02 mg/l	20 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
			5	0.01 mg/l	10 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
			6	0.02 mg/l	20 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
			7	< 0.01 mg/l	< 10 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
			8	< 0.01 mg/l	< 10 ug/l	38
			9	< 0.01 mg/l	< 10 ug/l	38
			10	< 0.01 mg/l	< 10 ug/l	38
			11	< 0.01 mg/l	< 10 ug/l	38
			12	< 0.01 mg/l	< 10 ug/l	38
			13	< 0.01 mg/l	< 10 ug/l	38
				< 0.01 mg/l	< 10 ug/l	38
			14	< 0.01 mg/l	< 10 ug/l	38
			15	< 0.01 mg/l	< 10 ug/l	38
			16	< 0.01 mg/l	< 10 ug/l	38
Lead	260 ug/l	130 ug/l	2	< 0.02 mg/l	< 20 ug/l	6
				< 0.5 ug/l	< 0.5 ug/l	19
				< 5 ug/l	< 5 ug/l	38
				0.022 mg/l *	22 ug/l	56
				< 0.022 mg/l *	< 22 ug/l	56
				< 0.022 mg/l *	< 22 ug/l	56
				< 0.02 mg/l	< 20 ug/l	6
				< 5 ug/l	< 5 ug/l	38

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Lead *(continued)*	260 ug/l	130 ug/l	3	< 0.002 mg/l *	< 2 ug/l	56
				< 5 ug/l	< 5 ug/l	38
				0.0025 mg/l *	2.5 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
			4	< 0.02 mg/l	< 20 ug/l	6
				< 5 ug/l	< 5 ug/l	38
				< 0.002 mg/l *	< 2 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
			5	< 0.02 mg/l	< 20 ug/l	6
				< 5 ug/l	< 5 ug/l	38
				< 0.002 mg/l *	< 2 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
			6	< 0.02 mg/l	< 20 ug/l	6
				< 5 ug/l	< 5 ug/l	38
			7	< 0.02 mg/l	< 20 ug/l	6
				< 5 ug/l	< 5 ug/l	38
			8	< 5 ug/l	< 5 ug/l	38
				< 0.002 mg/l *	< 2 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
			9	< 5 ug/l	< 5 ug/l	38
			10	< 0.5 ug/l	< 0.5 ug/l	19
				< 5 ug/l	< 5 ug/l	38
			11	< 5 ug/l	< 5 ug/l	38
			12	< 5 ug/l	< 5 ug/l	38
				< 0.002 mg/l *	< 2 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
				< 0.002 mg/l *	< 2 ug/l	56
			13	< 5 ug/l	< 5 ug/l	38
				< 5 ug/l	< 2.5 ug/l	38
			14	6 ug/l	6 ug/l	38
			15	5 ug/l	5 ug/l	38
			16	< 5 ug/l	< 5 ug/l	38

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Mercury	2.2 ug/l	1.1 ug/l	2	0.0004 mg/l	0.4 ug/l	6
				11 ug/l	11 ug/l	38
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
			3	0.0008 mg/l	0.8 ug/l	6
				< 2 ug/l	< 2 ug/l	38
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 2 ug/l	< 2 ug/l	38
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
			4	< 0.0004 mg/l	< 0.4 ug/l	6
				< 2 ug/l	< 2 ug/l	38
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
			5	< 0.0004 mg/l	< 0.4 ug/l	6
				4 ug/l	4 ug/l	38
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
			6	0.0008 mg/l	0.8 ug/l	6
				< 2 ug/l	< 2 ug/l	38
			7	< 0.0004 mg/l	< 0.4 ug/l	6
				2 ug/l	2 ug/l	38
			8	2 ug/l	2 ug/l	38
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
			9	< 2 ug/l	< 2 ug/l	38
			10	3 ug/l	3 ug/l	38
			11	< 2 ug/l	< 2 ug/l	38
			12	< 2 ug/l	< 2 ug/l	38
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
				< 0.0002 mg/l *	< 0.2 ug/l	56
			13	< 2 ug/l	< 2 ug/l	38
				< 2 ug/l	< 2 ug/l	38
			14	< 2 ug/l	< 2 ug/l	38
			15	< 2 ug/l	< 2 ug/l	38
			16	< 2 ug/l	< 2 ug/l	38

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Nickel	3100 ug/l	1600 ug/l	2	0.06 mg/l	60 ug/l	6
				< 0.5 ug/l	< 1 ug/l	19
				30 ug/l	15 ug/l	38
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
			3	0.08 mg/l	80 ug/l	6
				< 30 ug/l	< 30 ug/l	38
				0.023 mg/l *	23 ug/l	56
				< 30 ug/l	< 30 ug/l	38
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
			4	0.06 mg/l	60 ug/l	6
				< 30 ug/l	< 30 ug/l	38
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
			5	0.05 mg/l	50 ug/l	6
				< 30 ug/l	< 30 ug/l	38
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
			6	< 0.02 mg/l	< 20 ug/l	6
				< 30 ug/l	< 30 ug/l	38
			7	0.03 mg/l	30 ug/l	6
				< 30 ug/l	< 30 ug/l	38
			8	< 30 ug/l	< 30 ug/l	38
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
			9	< 30 ug/l	< 30 ug/l	38
			10	0.5 ug/l	0.5 ug/l	19
				< 30 ug/l	< 30 ug/l	38
			11	< 30 ug/l	< 30 ug/l	38
			12	< 30 ug/l	< 30 ug/l	38
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56
				< 0.023 mg/l *	< 23 ug/l	56

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Nickel *(continued)*	3100 ug/l	1600 ug/l	13	< 30 ug/l	< 30 ug/l	38
				< 30 ug/l	< 30 ug/l	38
			14	< 30 ug/l	< 30 ug/l	38
			15	< 30 ug/l	< 30 ug/l	38
			16	< 30 ug/l	< 30 ug/l	38
Oil & Grease	10 g/l	n/a	2	0.7 mg/l	0.7 mg/l	6
				1 mg/l	1 mg/l	38
			3	1.1 mg/l	1.1 mg/l	6
				< 1 mg/l	< 1 mg/l	38
				< 1 mg/l	< 1 mg/l	38
			4	0.6 mg/l	0.6 mg/l	6
				< 1 mg/l	< 1 mg/l	38
			5	0.6 mg/l	0.6 mg/l	6
				< 1 mg/l	< 1 mg/l	38
			6	0.6 mg/l	0.6 mg/l	6
				8 mg/l	8 mg/l	38
			7	1.1 mg/l	1.1 mg/l	6
				< 1 mg/l	< 1 mg/l	38
			8	3 mg/l	3 mg/l	38
			9	< 1 mg/l	< 1 mg/l	38
			10	2 mg/l	2 mg/l	38
			11	1 mg/l	1 mg/l	38
			12	< 1 mg/l	< 1 mg/l	38
			13	2 mg/l	2 mg/l	38
				2 mg/l	2 mg/l	38
			14	< 1 mg/l	< 1 mg/l	38
			15	< 1 mg/l	< 1 mg/l	38
			16	1 mg/l	1 mg/l	38
Phenol[2]	11000 ug/l	5300 ug/l	2	< 0.03 mg/l	< 30 ug/l	6
Pentachlorophenol	11 ug/l	3.2 ug/l		< 0.01 mg/l	< 10 ug/l	38
			3	< 0.03 mg/l	< 30 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
				< 0.01 mg/l	< 10 ug/l	38
			4	< 0.03 mg/l	< 30 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
			5	< 0.03 mg/l	< 30 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38
			6	< 0.03 mg/l	< 30 ug/l	6
				< 0.01 mg/l	< 10 ug/l	38

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Phenol Pentachlorophenol *(continued)*	11000 11 ug/l	5300 ug/l 3.2 ug/l	7	0.07 mg/l < 0.01 mg/l	70 ug/l < 10 ug/l	6 38
			8	< 0.01 mg/l	< 10 ug/l	38
			9	0.01 mg/l	10 ug/l	38
			10	0.05 mg/l	50 ug/l	38
			11	< 0.01 mg/l	< 10 ug/l	38
			12	< 0.01 mg/l	< 10 ug/l	38
			13	< 0.01 mg/l < 0.01 mg/l	< 10 ug/l < 10 ug/l	38 38
			14	< 0.01 mg/l	< 10 ug/l	38
			15	< 0.01 mg/l	< 10 ug/l	38
			16	< 0.01 mg/l	< 10 ug/l	38
Phosphorus	Total phosphorus as P shall be limited to the extent necessary to prevent nuisance growths of algae, weeds, and slimes.		2	0.5 mg/l 0.048 mg/l < 0.1 mg/l	0.5 mg/l 0.05 mg/l < 0.1 mg/l	6 19 38
			3	0.03 mg/l < 0.1 mg/l < 0.1 mg/l	0.03 mg/l < 0.1 mg/l < 0.1 mg/l	6 38 38
			4	0.04 mg/l < 0.1 mg/l	0.04 mg/l < 0.1 mg/l	6 38
			5	0.07 mg/l < 0.1 mg/l	0.07 mg/l < 0.1 mg/l	6 38
			6	0.03 mg/l < 0.1 mg/l	0.03 mg/l < 0.1 mg/l	6 38
			7	0.07 mg/l < 0.1 mg/l	0.07 mg/l < 0.1 mg/l	6 38
			8	< 0.1 mg/l	< 0.1 mg/l	38
			9	< 0.1 mg/l	< 0.1 mg/l	38
			10	0.012 mg/l < 0.1 mg/l	0.01 mg/l < 0.1 mg/l	19 38
			11	< 0.1 mg/l	< 0.1 mg/l	38
			12	< 0.1 mg/l	< 0.1 mg/l	38
			13	< 0.1 mg/l < 0.1 mg/l	< 0.1 mg/l < 0.1 mg/l	38 38
			14	< 0.1 mg/l	< 0.1 mg/l	38
			15	< 0.1 mg/l	< 0.1 mg/l	38
			16	< 0.1 mg/l	< 0.1 mg/l	38

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result		Adjusted Result[1]		Reference Document
Selenium	40 ug/l	20 ug/l	2	< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
			3	< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
			4	< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
			5	< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
			8	< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
			12	< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
				< 0.003	mg/l *	<	3 ug/l	56
Zinc	230 ug/l	120 ug/l	2	0.02	mg/l		20 ug/l	6
				30	ug/l		30 ug/l	19
				34	ug/l		34 ug/l	38
				< 0.02	mg/l *	<	20 ug/l	56
				< 0.02	mg/l *	<	20 ug/l	56
				< 0.02	mg/l *	<	20 ug/l	56
			3	0.03	mg/l		30 ug/l	6
				46	ug/l		46 ug/l	38
				< 0.023	mg/l *	<	23 ug/l	56
				61	ug/l		61 ug/l	38
				< 0.02	mg/l *	<	20 ug/l	56
				< 0.024	mg/l *	<	24 ug/l	56
			4	0.03	mg/l		30 ug/l	6
				54	ug/l		54 ug/l	38
				0.051	mg/l *		51 ug/l	56
				0.042	mg/l *		42 ug/l	56
				0.06	mg/l *		60 ug/l	56
			5	0.06	mg/l		60 ug/l	6
				37	ug/l		37 ug/l	38
				0.025	mg/l *		25 ug/l	56
				0.02	mg/l *		20 ug/l	56
				0.033	mg/l *		33 ug/l	56

Table 3.1: Elutriate Concentrations of Sediments from Lake Mile 2 Through Lake Mile 19

Parameter	Maximum Within Mixing Zone	Maximum Outside Mixing Zone	Lake Mile	Reported Result	Adjusted Result[1]	Reference Document
Zinc *(continued)*	230 ug/l	120 ug/l	6	0.05 mg/l	50 ug/l	6
				41 ug/l	41 ug/l	38
			7	0.03 mg/l	30 ug/l	6
				53 ug/l	53 ug/l	38
			8	23 ug/l	23 ug/l	38
				< 0.02 mg/l *	< 20 ug/l	56
				0.05 mg/l *	50 ug/l	56
				0.02 mg/l *	20 ug/l	56
			9	34 ug/l	34 ug/l	38
			10	4 ug/l	4 ug/l	19
				41 ug/l	41 ug/l	38
			11	25 ug/l	25 ug/l	38
			12	< 20 ug/l	< 20 ug/l	38
			13	< 0.02 mg/l *	< 20 ug/l	56
				0.026 mg/l *	26 ug/l	56
				0.027 mg/l *	27 ug/l	56
				35 ug/l	35 ug/l	38
				29 ug/l	29 ug/l	38
			14	42 ug/l	42 ug/l	38
			15	33 ug/l	33 ug/l	38
			16	35 ug/l	35 ug/l	38

* Analyte originally reported as elutriate in units of mg/kg. Changed to mg/l.

[1] The adjusted result represents conversion from units originally reported to units for the criteria.

[2] The analytical methods used in Documents #6 and #38 utilized a 4.AAP method for phenols. This. is a non-specific method that measures aggregate concentration of phenol-based compounds. Because the specific compounds are not known, the range of water quality criteria for phenol-based compounds is provided for comparison purposes

TABLE 3.2:

RESULTS OF TOXICITY TESTS USING THE PRATER-ANDERSON EXPOSURE SYSTEM

Table 3.2: Results of Toxicity Tests Using the Prater-Anderson Exposure System

Site	Test Organism	Sediment Classification	Reference Document
Control	*Pimephales promelas*	Non-Polluted	6
	Hexagenia limbata	Moderately Polluted	6
	Daphnia magna	Non-Polluted	6
Reference Site 1	*Pimephales promelas*	Non-Polluted	25
		Non-Polluted	35
	Hexagenia limbata	Moderately Polluted	25
		Moderately Polluted	35
		No Significant Mortality	35
	Daphnia magna	Moderately Polluted	25
		Moderately Polluted	35
		No Significant Mortality	3
	Ascellus intermedia	No Significant Mortality	3
Reference Site 2	*Hexagenia limbata*	No Significant Mortality	3
	Hexagenia limbata	No Significant Mortality	3
	Ascellus intermedia	Significant Mortality	3
Disposal Site 1	*Pimephales promelas*	Moderately Polluted	25
		Non-Polluted	35
		Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	25
		Moderately Polluted	35
		Moderately Polluted	38
	Daphnia magna	Moderately Polluted	25
		Moderately Polluted	35
		Non-Polluted	38
Disposal Site 2	*Pimephales promelas*	Non-Polluted	35
		Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	35
		Moderately Polluted	38
	Daphnia magna	Moderately Polluted	35
		Moderately Polluted	38
Disposal Site 3	*Pimephales promelas*	Non-Polluted	35
		Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	35
		Moderately Polluted	38
	Daphnia magna	Moderately Polluted	35
		Non-Polluted	38
Disposal Site 4	*Pimephales promelas*	Non-Polluted	35
		Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	35
		Moderately Polluted	38

Table 3.2: Results of Toxicity Tests Using the Prater-Anderson Exposure System

Site	Test Organism	Sediment Classification	Reference Document
	Daphnia magna	Moderately Polluted	35
		Non-Polluted	38
Disposal Site 5	*Pimephales promelas*	Non-Polluted	35
	Hexagenia limbata	Moderately Polluted	35
	Daphnia magna	Moderately Polluted	35
Disposal Site 6	*Pimephales promelas*	Non-Polluted	35
	Hexagenia limbata	Moderately Polluted	35
	Daphnia magna	Moderately Polluted	35
Disposal Site 7	*Pimephales promelas*	Non-Polluted	35
	Hexagenia limbata	Moderately Polluted	35
	Daphnia magna	Moderately Polluted	35
Disposal Site 8	*Pimephales promelas*	Moderately Polluted	25
		Non-Polluted	35
	Hexagenia limbata	Moderately Polluted	25
		Non-Polluted	35
	Daphnia magna	Moderately Polluted	25
		Non-Polluted	35
Lake Mile 2-3	*Pimephales promelas*	Non-Polluted	6
		Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	6
		Non-Polluted	38
	Daphnia magna	Non-Polluted	6
		Non-Polluted	38
Lake Mile 3-4	*Pimephales promelas*	Moderately Polluted	6
		Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	6
		Moderately Polluted	38
		No Significant Mortality	3
	Daphnia magna	Moderately Polluted	6
		Non-Polluted	38
		No Significant Mortality	3
	Ascellus intermedia	No Significant Mortality	3
Lake Mile 4-5	*Pimephales promelas*	Moderately Polluted	6
		Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	6
		Moderately Polluted	38
	Daphnia magna	Non-Polluted	6
		Non-Polluted	38

Table 3.2: Results of Toxicity Tests Using the Prater-Anderson Exposure System

Site	Test Organism	Sediment Classification	Reference Document
Lake Mile 5-6	*Pimephales promelas*	Non-Polluted	6
		Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	38
		Moderately Polluted	38
		No Significant Mortality	3
	Daphnia magna	Non-Polluted	6
		Non-Polluted	38
		No Significant Mortality	3
	Ascellus intermedia	No Significant Mortality	3
Lake Mile 6-7	*Pimephales promelas*	Non-Polluted	6
		Non-Polluted	38
	Hexagenia limbata	Highly Polluted	6
		Moderately Polluted	38
	Daphnia magna	Moderately Polluted	6
		Non-Polluted	38
Lake Mile 7-8	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	38
		No Significant Mortality	3
	Daphnia magna	Non-Polluted	38
		Significant Mortality	3
	Ascellus intermedia	No Significant Mortality	3
Lake Mile 8-9	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Moderately Polluted	38
	Daphnia magna	Moderately Polluted	38
Lake Mile 9-10	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Non-Polluted	38
		No Significant Mortality	3
	Daphnia magna	Moderately Polluted	38
		No Significant Mortality	3
	Ascellus intermedia	Significant Mortality	3
Lake Mile 10-11	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Non-Polluted	38
	Daphnia magna	Moderately Polluted	38
Lake Mile 11-12	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Non-Polluted	38
		No Significant Mortality	3
	Daphnia magna	Moderately Polluted	38
		No Significant Mortality	3
	Ascellus intermedia	Significant Mortality	3
Lake Mile 12-13	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Non-Polluted	38
	Daphnia magna	Moderately Polluted	38

Table 3.2: Results of Toxicity Tests Using the Prater-Anderson Exposure System

Site	Test Organism	Sediment Classification	Reference Document
Lake Mile 13-14	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Non-Polluted	38
		No Significant Mortality	3
	Daphnia magna	Moderately Polluted	38
		Significant Mortality	3
	Ascellus intermedia	No Significant Mortality	3
Lake Mile 14-15	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Non-Polluted	38
	Daphnia magna	Moderately Polluted	38
Lake Mile 15-16	*Daphnia magna*	Significant Mortality	3
	Hexagenia limbata	No Significant Mortality	3
	Ascellus intermedia	No Significant Mortality	3
Lake Mile 16-17	*Pimephales promelas*	Non-Polluted	38
	Hexagenia limbata	Non-Polluted	38
	Daphnia magna	Moderately Polluted	38

TABLE 3.3:

RESULTS OF TOXICITY TESTS USING SEDIMENTS AND ELUTRIATES AS TEST MEDIA LAKE MILE 2 THROUGH LAKE MILE 19

Table 3.3: Results of Toxicity Tests Using Sediments and Elutriates as Test Media

Site	Test Species	Test Media	Test Duration	Endpoint	Reference Site	Result	Reference Document
MSR	*Ceriodaphnia dubia*	Elutriate	7 days	NOAEC	n/a	> 100	39/47
	Chironomus tentans	Sediment	10 days	NOAEC	n/a	Not Toxic	39/47
	Micrtotox	Pore Water	15 minutes	EC50	n/a	Not Toxic	39/47
		Elutriate	15 minutes	EC50	n/a	Not Toxic - 19.73	39/47
OLR	*Pimephales promelas*	Elutriate	7 days	NOAEC	n/a	>100	39/47
	Micrtotox	Pore Water	15 minutes	EC50	n/a	Not Toxic	39/47
		Elutriate	15 minutes	EC50	n/a	35.6	39/47
Disposal Site	*Pimephales promelas*	Elutriate	7 days	NOAEC	n/a	Effect on Growth	39/47
	Ceriodaphnia dubia	Elutriate	7 days	NOAEC	n/a	> 100	39/47
	Microtox	Elutriate	15 minutes	EC50	n/a	Not Toxic	39/47
Lake Mile 2-3	*Pimephales promelas*	Elutriate	7 days	Survival	Shallow	No Significant Effect	56
					Deep	Significant Effect	56
					n/a	Significant Effect	58
				NOAEC		56	39/47
	Chironomus tentans	Sediment	10 days	Growth	Shallow	No Significant Effect	55
						No Significant Effect	56
					Deep	No Significant Effect	55
						No Significant Effect	56
				Survival	Shallow	No Significant Effect	55
					Deep	Significant Effect	55
					n/a	Significant Effect	60
	Daphnia magna	Elutriate	21 days	Reproduction	n/a	No Significant Effect	58
				Survival	n/a	No Significant Effect	58
	Hexagenia azteca	Sediment	10 days	Survival	Shallow	Significant Effect	56
						Significant Effect	58
					Deep	No Significant Effect	56
						No Significant Effect	58
					n/a	No Significant Effect	60
	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47

Table 3.3: Results of Toxicity Tests Using Sediments and Elutriates as Test Media

Site	Test Species	Test Media	Test Duration	Endpoint	Reference Site	Result	Reference Document
Lake Mile 3-4	*Pimephales promelas*	Elutriate	7 days	Survival	Shallow	Significant Effect	56
					Deep	Significant Effect	56
					n/a	Significant Effect	58
				NOAEC	n/a	56	39/47
	Certodaphnia dubia	Elutriate	7 days	NOAEC	n/a	1	39/47
	Chironomus tentans	Sediment	10 days	Growth	Shallow	No Significant Effect	55
						No Significant Effect	56
					Deep	No Significant Effect	55
						No Significant Effect	56
				Survival	Shallow	Significant Effect	55
					Deep	Significant Effect	55
				NOAEC	n/a	No Significant Effect	39/47
	Daphnia magna	Elutriate	21 days	Reproduction	n/a	No Significant Effect	58
				Survival	n/a	No Significant Effect	58
	Hexagenia azteca	Sediment	10 days	Survival	Shallow	No Significant Effect	56
						No Significant Effect	58
					Deep	Significant Effect	56
						No Significant Effect	58
	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
Lake Mile 4-5	*Pimephales promelas*	Elutriate	7 days	Survival	n/a	Significant Effect	58
					Shallow	Significant Effect	56
					Deep	Significant Effect	56
	Chironomus tentans	Sediment	10 days	Growth	Shallow	No Significant Effect	55
					Deep	Significant Effect	55
					Shallow	No Significant Effect	56
					Deep	No Significant Effect	56
				Survival	Shallow	Significant Effect	55
					Deep	Significant Effect	55
					n/a	No Significant Effect	60

Table 3.3: Results of Toxicity Tests Using Sediments and Elutriates as Test Media

Site	Test Species	Test Media	Test Duration	Endpoint	Reference Site	Result	Reference Document
Lake Mile 4-5 *(Continued)*	*Daphnia magna*	Elutriate	21 days	Reproduction	n/a	No Significant Effect	58
				Survival	n/a	No Significant Effect	58
	Hexagenia azteca	Sediment	10 days	Survival	Shallow	No Significant Effect	56
						No Significant Effect	58
					Deep	Significant Effect	56
						No Significant Effect	58
					n/a	No Significant Effect	60
	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
Lake Mile 5-6	*Ceriodaphnia dubia*	Elutriate	7 days	NOAEC	n/a	>100	39/47
	Chironomus tentans	Sediment	10 days	Survival	n/a	No Significant Effect	60
				NOAEC	n/a	No Significant Effect	39/47
	Hexagenia azteca	Sediment	10 days	Survival	n/a	No Significant Effect	60
	Microtox	Elutriate	15 minutes	EC50	n/a	40.25 - Non Toxic	39/47
				EC50	n/a	Non Toxic	39/47
Lake Mile 6-7	*Pimephales promelas*	Elutriate	7 days	Survival	Shallow	No Significant Effect	56
					Deep	Significant Effect	56
					n/a	Significant Effect	58
Lake Mile 7-8	*Pimephales promelas*	Elutriate	7 days	NOAEC	n/a	>100	39/47
	Ceriodaphnia dubia	Elutriate	7 days	NOAEC	n/a	1	39/47
	Chironomus tentans	Sediment	10 days	Growth	Shallow	No Significant Effect	55
						No Significant Effect	56
					Deep	Significant Effect	55
						No Significant Effect	56
				Survival	Shallow	No Significant Effect	55
					Deep	Significant Effect	55
				NOAEC	n/a	Nol Significant Effect	39/47
	Daphnia magna	Elutriate	21 days	Reproduction	n/a	Significant Effect	58
				Survival	n/a	No Significant Effect	58
	Hexagenia azteca	Sediment	10 days	Survival	Shallow	No Significant Effect	58

Table 3.3: Results of Toxicity Tests Using Sediments and Elutriates as Test Media

Site	Test Species	Test Media	Test Duration	Endpoint	Reference Site	Result	Reference Document
Lake Mile 7-8 *(Continued)*					Deep	No Significant Effect	58
					Shallow	No Significant Effect	56
					Deep	Significant Effect	56
	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
		Pore Water	15 minutes	EC50	n/a	Non Toxic	39/47
Lake Mile 8-9	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
Lake Mile 9-10	*Pimephales promelas*	Elutriate	7 days	NOAEC	n/a	Effect on Growth	39/47
	Ceriodaphnia dubia	Elutriate	7 days	NOAEC	n/a	>100	39/47
	Chironomus tentans	Sediment	10 days	NOAEC	n/a	No Significant Effect	39/47
	Microplankton	Elutriate	4 hours	EC50	n/a	45%	19
	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
	Ultraplankton	Elutriate	4 hours	EC50	n/a	45%	19
Lake Mile 10-11	Microplankton	Elutriate	4 hours	EC50	n/a	40%	19
	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
	Ultraplankton	Elutriate	4 hours	EC50	n/a	22%	19
Lake Mile 11-12	*Pimephales promelas*	Elutriate	7 days	Survival	Shallow	No Significant Effect	56
					Deep	No Significant Effect	56
					n/a	Significant Effect	58
	Chironomus tentans	Sediment	10 days	Growth	Shallow	No Significant Effect	55
						No Significant Effect	56
					Deep	No Significant Effect	55
						No Significant Effect	56
				Survival	Shallow	No Significant Effect	55
					Deep	No Significant Effect	55
				NOAEC	n/a	No Significant Effect	39/47
	Daphnia magna	Elutriate	21 days	Reproduction	n/a	Significant Effect	58
				Survival	n/a	Significant Effect	58

Table 3.3: Results of Toxicity Tests Using Sediments and Elutriates as Test Media

Site	Test Species	Test Media	Test Duration	Endpoint	Reference Site	Result	Reference Document
Lake Mile 11-12 *(Continued)*	*Hexagenia azteca*	Sediment	10 days	Survival	Shallow	No Significant Effect	56
						No Significant Effect	58
					Deep	No Significant Effect	56
						No Significant Effect	58
	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
Lake Mile 12-13	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
Lake Mile 13-14	*Pimephales promelas*	Elutriate	7 days	NOAEC	n/a	>100	39/47
	Ceriodaphnia dubia	Elutriate	7 days	NOAEC	n/a	>100	39/47
	Chironomus tentans	Sediment	10 days	NOAEC	n/a	No Significant Effect	39/47
	Microtox	Pore Water	15 minutes	EC50	n/a	Non Toxic	39/47
		Elutriate	15 minutes	EC50	n/a	87.6 - Non Toxic	39/47
Lake Mile 14-15	*Chironomus tentans*	Sediment	10 days	NOAEC	n/a	No Significant Effect	39/47
	Microtox	Elutriate	15 minutes	EC50	n/a	Non Toxic	39/47
Lake Mile 15-16	*Chironomus tentans*	Sediment	10 days	NOAEC	n/a	No Significant Effect	39/47
	Microtox	Elutriate	15 minutes	EC50	n/a	44.5 - Non Toxic	39/47
		Pore Water	15 minutes	EC50	n/a	Non Toxic	39/47

TABLE 5.1:

COMPARISON OF AVAILABLE DATA TO PARAMETER LIST FOR THE OHIO WATER QUALITY STANDARDS

Table 5.1: Comparison of Available Data to Parameter List for the Ohio Water Quality Standards

Parameter	Outside Mixing Zone			Inside Mixing Zone	Available Data
	Maximum	30-Day Average	Human 30-Day Average	Maximum	
Antimony (Total Recoverable)	ALH	ALH	ALH, PWS	ALH	
Cyanide	ALH	ALH	PWS	ALH	
Acetone	ALH	ALH		ALH	
Acrolein			ALH, PWS		
Acrylonitrile	ALH	ALH	ALH, PWS	ALH	
Aldrin		ALH	ALH, PWS		
Ammonia-N	ALH	ALH			Elutriate
Aniline	ALH	ALH		ALH	
Antimony (Total Recoverable)	ALH	ALH	ALH, PWS	ALH	Elutriate
Arsenic (Total Recoverable)	ALH	ALH, AWS	PWS	ALH	
Asbestos			PWS		
Barium			PWS		Elutriate
Benzenes					
Benzene	ALH	ALH	ALH, PWS	ALH	
Chlorobenzene	ALH	ALH	PWS	ALH	
Dichlorobenzenes			ALH, PWS		
1,2-Dichlorobenzene	ALH	ALH		ALH	
1,3-Dichlorobenzene	ALH	ALH		ALH	
1,4-Dichlorobenzene	ALH	ALH	PWS	ALH	
Ethylbenzene	ALH	ALH	ALH, PWS	ALH	
Hexachlorobenzene			ALH, PWS		
Nitrobenzene	ALH	ALH	ALH, PWS	ALH	
1,2,4-Trichlorobenzene	ALH	ALH		ALH	
Benzidines					
Benzidine			ALH, PWS		
3,3-Dichlorobenzidine			ALH, PWS		
Beryllium	ALH	ALH, AWS	ALH, PWS	ALH	
2-Butanone	ALH	ALH		ALH	
Cadmium (Total Recoverable)	ALH	ALH, AWS	PWS	ALH	Elutriate
Carbon Tetrachloride	ALH	ALH	ALH, PWS	ALH	
Chlordane		ALH	ALH, PWS		

Table 5.1: Comparison of Available Data to Parameter List for the Ohio Water Quality Standards

Parameter	Outside Mixing Zone			Inside Mixing Zone	Available Data
	Maximum	30-Day Average	Human 30-Day Average	Maximum	
Chlorides			PWS		
Chlorine (Total Residual)	ALH	ALH			
Chromium, Total (Total Recoverable)	ALH	ALH, AWS	ALH, PWS	ALH	Elutriate
Chromium , Hexavalent (Dissolved)	ALH	ALH		ALH	
Ciodrin		ALH			
Copper (Total Recoverable)	ALH	ALH, AWS	PWS	ALH	Elutriate
Coumaphos		ALH			
Cyanide (Free)	ALH	ALH	PWS	ALH	Elutriate
2,4-Dichlorophenoxyacetic acid			PWS		
Dalapon		ALH			
DDT		ALH	ALH, PWS		
Demeton		ALH			
Diazinon		ALH			
Dicamba		ALH			
1,3-Dichloropropene			ALH, PWS		
Dichlorvos		ALH			
Dieldrin			ALH, PWS	ALH	
Diethylamine	ALH	ALH		ALH	
1,2-Diphenylhydrazine			ALH, PWS		
Diquat		ALH			
Dissolved Oxygen	ALH[1]				Water Column - OLD
Dissolved Solids	ALH	ALH			
Dursban		ALH			
Endosulfan		ALH	ALH, PWS		
Endrin		ALH	ALH, PWS		
Ethanes					
1,2-Dichlorethane	ALH	ALH	ALH, PWS	ALH	
Hexachloroethane			ALH, PWS		
1,1,2,2-Tetrachloroethane	ALH	ALH	ALH, PWS	ALH	
1,1,1-Trichloroethane	ALH	ALH	ALH, PWS	ALH	
1,1,2-Trichloroethane	ALH	ALH	ALH, PWS	ALH	

Table 5.1: Comparison of Available Data to Parameter List for the Ohio Water Quality Standards

Parameter	Outside Mixing Zone			Inside Mixing Zone	Available Data
	Maximum	30-Day Average	Human 30-Day Average	Maximum	
Ethers					
Bis (2-chloroethyl) ether			ALH, PWS		
Bis (2-chloroisopropyl) ether			ALH, PWS		
Ethylenes					
1,1-Dichloroethylene	ALH	ALH	ALH, PWS	ALH	
trans-1,2-Dichloroethylene	ALH	ALH		ALH	
Tetrachloroethylene	ALH	ALH	ALH, PWS	ALH	
Trichloroethylene	ALH	ALH	ALH, PWS	ALH	
Ethylene glycol	ALH	ALH		ALH	
Fluoride		AWS	PWS		
Guthion		ALH			
Halomethanes			ALH, PWS		
Bromoform (Tribromomethane)	ALH	ALH		ALH	
Chloroform (Trichloromethane)	ALH	ALH		ALH	
Methylene Chloride (Dichloromethane)	ALH	ALH		ALH	
Heptachlor		ALH	ALH, PWS		
Heptachlor epoxide			PWS		
Hexachlorobutadiene			ALH, PWS		
Hexachlorocyclohexane (Benzene hexachloride)		ALH			
alpha-Hexachlorocyclohexane			ALH, PWS		
beta-Hexachlorocyclohexane			ALH, PWS		
gamma-Hexachlorocyclohexane		ALH	ALH, PWS		
Hexachlorocyclopentadiene			PWS		
Iron (Total Recoverable)		ALH, AWS			Elutriate
Iron (Soluable)			PWS		
Isophorone	ALH	ALH	ALH, PWS	ALH	
Lead (Total Recoverable)	ALH	ALH, AWS	PWS	ALH	Elutriate
Malathion		ALH			
Manganese (Total Recoverable)			PWS		Elutriate
MBAS (Foaming Agents)	ALH				
Mercury (Total Recoverable)	ALH	ALH, AWS	ALH, PWS	ALH	Elutriate

Table 5.1: Comparison of Available Data to Parameter List for the Ohio Water Quality Standards

Parameter	Outside Mixing Zone			Inside Mixing Zone	Available Data
	Maximum	30-Day Average	Human 30-Day Average	Maximum	
Methoxychlor		ALH	PWS		
Mirex		ALH			
Nalad		ALH			
Nickel (Total Recoverable)	ALH	ALH, AWS	ALH, PWS	ALH	Elutriate
Nitrate-N			PWS		Elutriate
Nitrates + Nitrites	AWS				
Nitrosamines					
N-Nitrosodimehtylamine			ALH, PWS		
N-Nitrosodi-n-propylamine			ALH, PWS		
N-Nitrosoldiphenylamine	ALH	ALH	ALH, PWS	ALH	
Oil & Grease	ALH				Elutriate
Parathion		ALH			
pH	ALH[2]				
Phenols					
Phenol	ALH	ALH	PWS	ALH	
2-Chlorophenol	ALH	ALH	PWS	ALH	
2,4-Dichlorophenol	ALH	ALH	PWS	ALH	
2,4-Dinitrophenol			ALH, PWS		
2,6-Dinitro-o-cresol (4,6,-Dinitro-2-methylphenol)			ALH, PWS		
2-Methylphenol	ALH	ALH		ALH	
4-Methylphenol	ALH	ALH		ALH	
4-Nitrophenol	ALH	ALH		ALH	
Pentachlorophenol	ALH	ALH	PWS	ALH	
2,4,6-Trichlorophenol	ALH	ALH	ALH, PWS	ALH	
Phosphamidon		ALH			
Phosphorus	ALH		PWS		Elutriate Water Column - OLD
Phthalates					
Bis (2-ethlyhexyl) phthalate	ALH	ALH	ALH, PWS	ALH	
Butyl benzyl phthalate	ALH	ALH		ALH	
Diethyl phthalate	ALH	ALH	ALH, PWS	ALH	

Table 5.1: Comparison of Available Data to Parameter List for the Ohio Water Quality Standards

Parameter	Outside Mixing Zone			Inside Mixing Zone	Available Data
	Maximum	30-Day Average	Human 30-Day Average	Maximum	
Dimethyl phthalate	ALH	ALH	ALH, PWS	ALH	
Di-n-butyl B16phthalate	ALH	ALH	ALH, PWS	ALH	
Polychloronated Biphenyls		ALH	ALH, PWS		
Polynuclear Aromatic Hydrocarbons (PAH)			ALH, PWS		
Acenaphthene	ALH	ALH	PWS	ALH	
Fluoranthene	ALH	ALH	ALH, PWS	ALH	
Napthalene	ALH	ALH		ALH	
Selenium (Total Recoverable)	ALH	ALH, AWS	PWS	ALH	Elutriate
Silver ((Total Recoverable)	ALH	ALH	PWS	ALH	
Silvex (2,3,5-TP, 2-[2,4,5-Trichlorophnoxy] propionic acid)			PWS		
Simizine		ALH			
Styrene	ALH	ALH		ALH	
Sulfates			PWS		
Temperature	ALH	ALH			
TEPP (Tetraethylpyrophosphate)		ALH			
2,3,7,8-Tetrachlorodebenzo-p-dioxin			ALH, PWS		
Thallium	ALH	ALH	ALH, PWS	ALH	
Toluenes					
Toluene	ALH	ALH	ALH, PWS	ALH	
2,4-Dinitrotoluene			ALH, PWS		
2,6-Dinitrotoluene	ALH	ALH		ALH	
Toxaphene		ALH	ALH, PWS		
Vinyl Chloride			ALH, PWS		
Zinc (Total Recoverable)	ALH	ALH, AWS	PWS	ALH	Elutriate

[1] Criterion for Dissolve Oygen is a minimum value

[2] Criterion for pH is a range

[3] No criteria calculations pursuant to QAC 3745-1 were needed

ALH - Criterion for Aquatic Life Habitat

AWS - Criterion for Agricultural Water Supply

PWS - Criterion for Public Water Supply

ODL - Data collected during open lake disposal

TABLE 5.2:

RECOMMENDED PARAMETERS FOR FUTURE SAMPLING EVENTS

Table 5.2: Recommended Parameters for Future Sampling Events

Group	Description	Parameters	Rationale
I	Metals	Antimony Arsenic Beryllium Cadmium Chromium Copper Cyanide Lead Mercury Nickel Selenium Silver Thallium Zinc	Accumulate in sediments Impacts to aquatic life (flora and fauna) Cadmium, lead, and mercury accumlate in tissue Introduced by variety of industrial sources May be widespread and persistent in Lake Erie
II	Nutrients	Ammonia Nitrate + Nitrite Total Phosphorus	Cause fowling of water treatment plants Cause eutrophication
III	Pesticides and Fertilizers	Acenapthene Aldrin Dieldrin Endrin Heptachlor Hexachlorobenzene Toxaphene	Characteristic of agricultural land use Persistent in the environment Impacts to aquatic life
IV	Other Parameters of Concern	Percent Total Volatile Residue Percent Total Residue Total Kjeldahl Nitrogen Chemical Oxygen Demand PCBs PAHs	Recommended by Ohio EPA
V	Water Quality During Open Lake Disposal	Dissolved Oxygen pH	Potentially limiting to aquatic life Good indicators of impacts during open lake disposal

APPENDIX A:

DOCUMENTS REVIEWED

Attachment A
List of Documents to be Reviewed

1."Report on the Degree of Pollution of Bottom Sediments-Toledo Ohio," U.S. EPA, Great Lake National Program Office, September 11, 1975, 11 pages.
2."Frequency and Extent of Wind-Induced Resuspension of Bottom Material in the U.S. Great Lakes Nearshore Waters," Water Resources Center, University of Wisconsin, Madison, Wisconsin. Gordon Chesters and Joseph J. Delfino, 1978, 80 pages.
3."Chemical and Bioassay Analysis, Lake Erie Western Basin, Toledo Harbor," Recra Research, Inc. September 1981, 90 pages.
4. "Western Basin Nearshore 1978-1979 Nutrient Distributions," The Ohio State University Center for Lake Erie Area Research, Columbus, Ohio. CLEAR Technical Report No.204;4. Julie Letterhos, 1981, 93 pages.
5."Evaluation of Dredged Material Disposal Options for two Great Lakes Harbors Using the Water Quality Board's Dredging Subcommittee Guidelines", April, 1983, 72 pages.
6."Analysis of Sediment from Toledo Harbor. Maumee River, Toledo, Ohio (1983)," Technical Report no G0130-05, Floyd Browne Associates Limited, February 1984, 78 pages.
7."Fluvial Transport and Processing of Sediments and Nutrients in Large Agricultural River Basins," USEPA, Athens, Georgia, 1984, 135 pages.
8."Biological Considerations for Open-Water Disposal of Dredged Material in the Great Lakes,"P.G.Sly, Environment Canada. Scientific Series No.137, 1984, 18 pages.
9."Western Basin Nearshore Study 1978-1979; An Evaluation of the Temperature and Dissolved Oxygen Data," The Ohio State University Center for Lake Erie Area Research, Columbus, Ohio. CLEAR Technical Report No 203;3. Laura A. Fay, 1984, 50 pages.
10."Western Basin Nearshore 1978-1979; Water Quality Findings Summary," The Ohio State University Center for Lake Erie Area Research, Columbus, Ohio. CLEAR Technical Report No.204;2. Laura A. Fay, 1984, 22 pages.
11."Western Basin Nearshore 1979-1979; Introduction, Methods and Quality Control," The Ohio State University Center for Lake Erie Area Research, Columbus, Ohio. CLEAR Technical Report No. 204;1. Charles E. Henderdorf and Laura A. Fay, 1984, 61 pages.
12."Analysis of Sediment from the Toledo Dike Disposal Facility-Toledo, Ohio", Tech Paper G0159-02, Aqua Tech, December 1984, 38 pages.
13."Evaluation of Open-Lake Disposal Operations in Lake Erie- 1985," U.S. Army Corps of Engineers, Buffalo District, 1985, 73 pages.
14."Analysis of Sediment and Water Samples from Toledo

Harbor, Toledo, Ohio," Technical Report NO. G0159-05, Aqua Tech Environmental Consultants Inc. August 1985, 53 pages.
15."Column Leach Testing of Sediments from the Toledo Dike Disposal Facility- Toledo, Ohio (1984)," Technical Report G0159-020B, Aqua Tech Environmental Consultants, Inc., August 1985, 35 pages.
16. "The Analysis of Sediments from Toledo Dike Disposal Facility- Toledo, Ohio (1984)," Technical Report No. G0159-12, Aqua Tech Environmental Consultants Inc. October 1985, 21 pages.
17."Bioaccumulation of PCBs and Mercury from Toronto and Toledo Harbor Sediments," In: Evaluation of Sediment Bioassessment Techniques. pp.81-90. Report of the Dredging Subcommittee to the Great Lakes Water Quality Board, International Joint Commission. M.J. Mac and W.A. Williford, 1986, 10 pages.
18."Assessment of Potential Bioaccumulation from Toledo and Toronto Harbor Sediments. " In: Evaluation of Sediment Bioassessment Techniques. pp.51-80. Report of the Dredging Subcommittee to the Great Lakes Water Quality Board, International Joint Commission. V.A. McFarland, V.A, Peddicord, 1986, 30 pages.
19. "Bioassessment of Toronto-Toledo Sediments. In: Evaluation of Sediment Bioassessment Techniques,". pp 9-50 Report of the Dredging Subcommittee to the Great Lakes Water Quality Board, International Joint Commission. M. Munawar and R. L. Thomas, 1986, 42 pages.
20."Effects of Open-Lake Disposal of Toledo Harbor Dredged Material on Bioavailable Phosphorus in Lake Erie Western Basin". J. DePinto, T. Young and L. Terry. September 1986, 57 pages.
21."Evaluation of Open Lake Disposal Operations in Lake Erie-1986," U.S. Army Corps of Engineers, Buffalo District, 1986, 52 pages.
22."The Analysis of Water Samples from the Toledo Confined Disposal Facility," Technical Report No. G0176-04, Aqua Tech Environmental Consultants Inc., January 1986, 15 pages.
23."Monitoring of Open Lake Disposal Program at Toledo Harbor-Toledo, Ohio- July 1986," Aqua Tech Environmental Consultants Inc. August 1986, 72 pages.
24."The Analysis of Water Samples form the Toledo Confined Disposal Facility Overflow-Toledo, Ohio," Technical Report No. G0176-13, Aqua Tech Environmental Consultants Inc., October 1986, 94 pages.
25."The Analyses of Sediments from the Proposed Open-Lake Disposal Sites at Toledo, Ohio," Technical Report No. G0176-17, Aqua Tech Environmental Consultants Inc., October, 1986, 87 pages.
26."Sediment Re-Classification, Toledo Harbor," City of Toledo, October 1986, 27 pages.
27."Report on the Toxicity and Chemistry of Sediments for

Toronto and Toledo Harbors" In: Evaluation of Sediment Bioassessment Techniques pp 91-118. Report of the Dredging Subcommittee to the Great Lakes Water Quality Board, International Joint Commission. G. Chapman, M. Carnes, D. Krawczyk, K. Mulueg, N. Nebeker and G. Schuytema, 1986, 28 p
28."Reuse Alternatives, Toledo Harbor Dredged Disposal," Toledo Metropolitan Area Council of Governments, 196 pages, 2 volumes.
29."Open-Lake Disposal of Dredge Material at Toledo Harbor. Violations of Lake Erie Water Quality Standards," Peter Fraleigh, 1986, 3 pages.
30."Preliminary Report of Alternative Dredge Disposal Methods for the Toledo, Ohio Harbor," Prepared for Toledo Metropolitan Council of Governments, Toledo-Lucus County Port Authority and Ohio Department of Transportation by Hull Consulting, 1987, 31 pages.
31."Open-Lake Disposal of Dredge Material", a memorandum by Robert Stevenson, 1987, 30 pages.
32."Effects of Open-Lake Disposal at Toledo Harbor," P. Fraleigh, January 1987, 10 pp, 10 pages.
33."Concern Regarding Open-Lake Disposal of Dredged Material," a memorandum, P. Fraleigh, 4 pages.
34."Report on the results of the monitoring study of open-lake disposal of dredged material at Toledo Harbor, Ohio," P. Fraleigh. March 1987, 3 pages.
35."The Analysis of Sediments from the Proposed Open-Lake Disposal Site at Toledo, Ohio," Technical Report No I0175-06A, TP Associates International, December 1987, 79 pages.
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38."The Analysis of Sediments from Toledo Harbor," Technical Report No. I0175-12, T.P. Associates International Inc., June 1988, 94 pages.
39."Toxicity of Sediment from Western Lake Erie and the Maumee River at Toledo, Ohio,": John Giesy & Robert Hoke, Michigan State University, August 1988, 86 pages.
40."Use of SPOT HRV data in the Corps of Engineers Dredging Program," Carolyn Merry, Harlem McKin and Nancy LaPotin (US Army Cold Regions Research and Engineering Laboratory) and John Adams (ISECE, Buffalo), Photogrammetric Engineering and Remote Sensing, vol.54, No. 9, September 1988, 5 pages.

41."1986 Open Lake Water Quality Conditions for Lake Erie's Western, Central and Eastern Basins," CLEAR Technical Report No.317. Laura A. Fay, Helen E. Kundtz and David E. Rathke, 1988, 211 pages.
42."Final Environmental Impact Statement, Confined Disposal Facility," USACE, Buffalo, 1990, 300 pages.
43."Environmental Assessment and Finding of No Significant Impact, Operations and Maintenance Toledo Harbor, Ohio." USACE, Buffalo, 1989, 59 pages.
44."Maumee Bay Bottom Characterization Study- 1988," Science Applications International Corporation, March, 1989, 325 pages, 2 volumes.
45."Toledo Confined Disposal Facility Mitigation Planning Supplement to Final Fish and Wildlife Coordination Act Report," U.S. Fish and Wildlife Service, Reyoldsburg, Ohio, April 28, 1989, 57 pages.
46."Use of Linear Orthogonal Constraints in Analysis of Environmental Data," Robert Hoke (Michigan State University) and John R. Adams (USACE, Buffalo), Environmental Toxicology and Chemistry, vol. 9, 1990, pp 815-819, 5 pages.
47."Toxicity of Sediments from Western Lake Erie and Maumee River at Toledo, Ohio," 1987 :Implications for Current Dredged Material Disposal Practices," R.A. Hoke, J.P. Giesy, G.T. Ankley, J.L. Newsted (Michigan State University) and J.R. Adams (USACE, Buffalo), Journal of Great Lakes Research, vol. 16, No, 3, 1990, pp 457-470, 14 pages.
48."Toledo Harbor Dredge Material-Beneficial Reuse Alternatives-Status and Needs Report," Toledo Metropolitan Area Council of Governments, May 1990, 12 pages.
49."Environmental Assessment and Section 404 (b) (1) Evaluation, Dredging & Disposal of Dredged Material at Island 18 CDF, Toledo Harbor, Ohio," USACE, November 1990, 143 pages.
50."Monitoring Well Design and Placement- Toledo CDF," Buffalo District, January 1991, 5 pages.
51."ARDL Report No. 6227, Corps of Engineers-Buffalo District, Toledo Harbor Site," ARDL, Inc., October 1992, 17 pages.
52."ARDL Report No.:6256, Corps of Engineers- Buffalo District, Grain Size Analysis Data Package, Toledo Harbor Site," ARDL, Inc., December 1992, 9 pages.
53."ARDL Report No. 6255, Corps of Engineers, Buffalo District, Toledo Harbor- Column Settling Test", ARDL Inc., September 1993, 16 pages.
54."Transmittal of Results of Soil Tests, Samples RM1-2, LM0-1, and LM2-3, Toledo Harbor OH", Waterways Experiment Station, October 1993, 35 pages.
55."Application of Chironomus tentans Survival and Growth Bioassay in Evaluating Sediment Quality from Four Great Lakes Harbors," University of Wisconsin-Superior, December

1993, 51 pages.
56."Draft Results of Acute Toxicity Tests Performed on Toledo Harbor Channel Sediments in 1993", USACE, 1993, 52 pages.
57."ARDL Report No. 6351/6352, Toledo Harbor Site, Corps of Engineers-Buffalo District", ARDL,Inc., January 1994, 87 pages.
58."Evaluation of Proposed Environmental Protection Agency Dredged Material Bioassays Using Great Lakes Sediments," Miscellaneous Paper EL-99-11,US Engineer Waterways Experiment Station, November 1994, 431 pages.
59."Particle Size Summary Report No. 6372 Toledo Harbor Site," ARDL Inc., October 13, 1994, 24 pages.
60."Evaluation of Sediments from the Toledo Harbor Area," Volumes 1 and 2 Environmental Science & Engineering, Inc January 25, 1995, 410 pages.
61."Monitoring Well Installation and Groundwater Sampling Report Toledo Harbor, Ohio," Parsons Engineering Science, February 22, 1996, 327 pages.
62."Monitoring Well and Confined Disposal Facility Sampling Toledo Harbor, OH", Volume 1&2 Engineering & Environment Inc, July 1996, 166 pages, 2 volumes.

APPENDIX B:

TOLEDO HARBOR, SCREENING OF DOCUMENTS FOR NON-APPLICABILITY TO OPEN LAKE DISPOSAL OF DREDGED MATERIAL

DACW49-97-C-0021
Task 1

Prepared for
U.S. Army Corps of Engineers
Buffalo District
Buffalo, New York

Task One Report:

Toledo Harbor, Screening of Documents for Non-Applicability to Open Lake Disposal of Dredged Material

August 12, 1997

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Task One Report:

Toledo Harbor, Screening of Documents for Non-Applicability to Open Lake Disposal of Dredged Material

Prepared for

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Under Contract DACW49-97-C-0021, Task Order 1

By

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers, Buffalo District, has identified 62 documents that potentially contain data and other information that will allow an objective evaluation of open lake disposal of sediments dredged from the Toledo Harbor navigation channel. Sixty-one of the 62 documents provided by the Buffalo District were reviewed. One of the documents (Document No. 41) has not yet been received by the District. Material dredged from River Mile 7 to Lake Mile has historically been placed in a Confined Disposal Facility. Open lake disposal has been used for material dredged from Lake Mile 2 to Lake Mile 19. The review focused on Lake Mile 2 through Lake Mile 19 and the Open Lake Disposal Area. This report identifies those of the 62 documents that have been identified as non-applicable because they do not contain data or information relevant to open lake disposal.

In general, a document was determined to be non-applicable if it did not contain original chemical or biological data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area. Several documents contained data on physical characteristics of sediments within the area of interest. A review of the applicable State (Ohio Water Quality Standards) and Federal (Sections 401 and 404 of the Clean Water Act) criteria indicated that physical characteristics, such as particle size, are not parameters for water quality. Several other documents presented data only for River Mile 7 to Lake Mile 2 and/or the Confined Disposal Facility. Because data from these areas cannot be used to evaluate quality of material from Lake Mile 2 to lake Mile 19 or open lake disposal, documents that fell into this category were identified as non-applicable. More specifically, documents were identified as non-applicable if one or more of the following conditions were met:

- The document did not present original chemical or biological data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area;
- The document contained only data on physical characteristics (i.e, particle size, settling rates) of sediments collected from Lake Mile 2 through Lake Mile 19 and/or the Open Lake Disposal Area;
- The document cited data that were originally presented in other documents identified as applicable;
- Specific locations of samples at Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area could not be identified from review of the document; and
- The document presented original data only for the Confined Disposal Area and/or River 7 through Lake Mile 2.

The documents identified as non-applicable are listed below. The number of the document assigned by the Buffalo District, title of the document, and a brief narrative explaining why the document was identified as non-applicable are also provided.

2.0 NON-APPLICABLE DOCUMENTS

2. "Frequency and Extent of Wind-Induced Resuspension of Bottom Material in the U.S. Great Lakes Nearshore Waters," Water Resources Center, University of Wisconsin, Madison, Wisconsin. Gordon Chesters and Joseph H. Delfino, 1978, 80 pages.

This document is a literature review of sediment resuspension in response to wind and wave forces within nearshore areas of the Great Lakes. The document does not include any data on sediments or water quality specific to Lake Mile 2 to Lake Mile 19 or the Open Water Disposal Area. Although the document contributes to the understanding of the dynamics of sediment resuspension, information contained within the document cannot be used to determine if water quality standards have been met or exceeded.

7. "Fluvial Transport and Processing of Sediments and Nutrients in Large Agricultural River Basins," USEPA Athens, Georgia, 1984, 135 pages.

This document presents an analysis of sediment and nutrient loading to fluvial systems in watersheds with heavy agricultural use, including the Maumee River watershed. Because the document does not present data or methods that can be used to quantify nutrient loads or concentrations at Lake Mile 2 through Lake Mile 19 or the Open Water Disposal Area, it was identified as non-applicable for assessing compliance with water quality criteria.

8. "Biological Considerations for Open-Water Disposal of Dredged Material in the Great Lake," P.G. Sly, Environmental Canada. Scientific Series No. 137, 1984, 18 pages.

This document is a review paper that discusses general biological characteristics of aquatic communities within the Great Lakes. It also identifies impacts that can result from open lake disposal of dredged material. The document is very general and does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area. This document cannot be used to determine if water quality criteria have been met or exceeded with open lake disposal.

12. "Analysis of Sediment from the Toledo Dike Disposal Facility-Toledo, Ohio," Tech Paper G0159-02, Aqua Tech Environmental Consultants Inc., December 184, 38 pages.

This document presents results of particle size analysis, chemical analysis of bulk sediments, and column leach testing for samples from the Confined Disposal Facility. Because this document does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it cannot be used to assess open lake disposal.

14. "Analysis of Sediment and Water Samples from Toledo Harbor, Ohio," Technical Report No. G0159-05, Aqua Tech Environmental Consultants Inc., August 1985, 53 pages.

This document presents results of settling tests from the Confined Disposal Facility, River Mile 7 through Lake Mile 2, and Lake Mile 2 through Lake Mile 7 and chemical analyses of bulk sediment and water samples collected from the Confined Disposal Facility. Because this document does not contain chemical or biological data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it was identified as non-applicable.

15. **"Column Leach Testing of Sediments from the Toledo Dike Disposal Facility - Toledo, Ohio (1984)," Technical Report No. G0159-020B, Aqua Tech Environmental Consultants Inc., August 1985, 35 pages.**

This document reports the results of column leach testing of sediments collected from three locations within the Confined Disposal Facility. Chemical analyses of sediments from 20 time intervals during testing are presented. Because the samples were collected from the Confined Disposal Facility, the origin of the sediments cannot be identified. Because the document does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it was identified as non-applicable.

16. **"The Analysis of Sediments from Toledo Dike Disposal Facility - Toledo, Ohio (1984)," Technical Report No. G0159-12, , Aqua Tech Environmental Consultants Inc., October 1985, 21 pages.**

This document presents the results of grain size analysis and chemical analyses of three samples (sand, silt, and silt T) collected from the Confined Disposal Facility. Because the samples were collected from the Confined Disposal Facility, the origin of the sediments cannot be identified. Because the document does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it was identified as non-applicable.

17. **"Bioaccumulation of PCBs and Mercury from Toledo Harbor Sediments," In: Evaluation of Sediment Bioassessment Techniques. pp. 81-90. Report of the Dredging Subcommittee to the Great Lakes Water Quality Board, International Joint Commission. M.J. Mac and W.A. Williford, 1986, 10 pages.**

This document presents results of bioassays on sediments collected from Toledo Harbor (and Toronto Harbor) using *Pimephales promelas* and *Lumbricus terrestris* as test organisms. This document is one in series of alternative bioassay techniques evaluated with the goal of developing a standardized bioassay protocol for dredged materials. Because the locations of the samples collected from Toledo Harbor are not identified, it is not possible to assign effects to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area. This document was identified as non-applicable based on lack of site-specific data.

18. **"Assessment of Potential Bioaccumulation from Toledo and Toronto Harbor Sediments," In: Evaluation of Sediment Bioassessment Techniques. pp. 51-80. Report of the Dredging Subcommittee to the Great Lakes Water Quality Board, International Joint Commission. V.A. McFarland, V.A. Peddicord, 1986, 30 pages.**

This document presents results of bioassays on sediments collected from Toledo Harbor (and Toronto Harbor) using *Pimephales promela, Oryzias latipes, Notemigonus crysoleucas,* and *Corbicula fluminea* as test organisms. As is Document No. 17, this document is one in series of alternative bioassay techniques evaluated with the goal of developing a standardized bioassay protocol for dredged materials. Because the locations of the samples collected from Toledo Harbor are not identified, it is not possible to assign effects to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area. This document was identified as non-applicable based on lack of site specific data.

22. **"The Analysis of Water Samples from the Toledo Confined Disposal Facility," Technical Report No. G0176-04, , Aqua Tech Environmental Consultants Inc., January 1986, 15 pages.**

This document presents the results of analyses of five water samples collected from the Confined Disposal Facility. Because the samples were collected from the Confined Disposal Facility, the source of chemicals in the samples cannot be identified. Because the document does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it was identified as non-applicable.

24. **"The Analysis of Water Samples from the Toledo Confined Disposal Facility Overflow - Toledo, Ohio," Technical Report No. G0176-13, , Aqua Tech Environmental Consultants Inc., October 1986, 94 pages.**

This document presents the results of analyses of water samples collected at or near the overflow weir of the Confined Disposal Facility. Because the samples are associated with the Confined Disposal Facility, the source of chemicals in the samples cannot be identified. Because the document does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it was identified as non-applicable.

26. **"Sediment Re-Classification, Toledo Harbor," City of Toledo, October 1986, 27 pages.**

This document compares data presented in Document No. 6 with three sets of sediment criteria: 1) U.S. Environmental Protection Agency; 2) Ontario MOE; and 3) those proposed by the State of Wisconsin. This document was identified as non-applicable for two reasons. First, original data specific to Lake Mile 2 through Lake Mile 19 are contained in Document No. 6. Second, the three sets of criteria presented in this document are not identified as relevant within the contracted scope of work.

27. **"Report on the Toxicity and Chemistry of Sediments for Toronto and Toledo Harbors," In: Evaluation of Sediment Bioassessment Techniques. pp. 91-118. Report of the Dredging Subcommittee to the Great Lakes Water Quality Board, International Joint Commission. G. Chapman, M. Carnes, D. Krawczyk, K. Mulueg, N. Nebeker and G. Schuytema, 1986, 28 pages.**

This document presents results of bioassays on sediments collected from Toledo Harbor (and Toronto Harbor) using *Hexagenia limbata, Daphnia magna, Hyallela azteca, Chrionomus tentans,* and *Pimephales promelas* as test organisms. As are Document No. 17 and No. 18, this document is one in series of alternative bioassay techniques evaluated with the goal developing a standardized bioassay protocol for dredged materials. Because the samples were composited and the locations of the samples collected are not identified, it is not possible to assign effects to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area. This document was identified as non-applicable based on lack of site specific data.

28. **"Reuse Alternatives, Toledo Harbor Dredged Disposal," Toledo Metropolitan Area Council of Governments, 196 pages, 2 volumes.**

This document addresses several alternatives for the reuse of materials dredged from Toledo Harbor. Although the document does contain some references to water and sediment quality, it lacks data specific to Lake Mile 2 through Lake Mile 19 and the Open Lake Disposal Area. The document was identified as

non-applicable because it cannot be used to assess compliance with water quality criteria for open lake disposal.

29. "Open-Lake Disposal of Dredge Material at Toledo Harbor. Violations of Lake Erie Water Quality Standards," P. Fraleigh, 1986, 3 pages.

This document provides comparison of data collected during the 1986 sampling during open water disposal of dredged material to water quality criteria in effect at that time. This document was identified as non-applicable because 1) the original data are presented in Document No. 31; and 2) the October 1996 criteria supersede the criteria at the time this document was prepared.

30. "Preliminary Report of Alternative Dredge Disposal Methods for the Toledo, Ohio Harbor," prepared for Toledo Metropolitan Council of Governments, Toledo-Lucas County Port Authority and Ohio Department of Transportation by Hull Consulting, 1987, 31 pages.

Similar to Document No. 28, this document addresses several alternatives for the reuse of materials dredged from Toledo Harbor. Although the document does contain some references to water and sediment quality, it lacks data specific to Lake Mile 2 through Lake Mile 19 and the Open Lake Disposal Area. The document was identified as non-applicable because it cannot be used to assess compliance with water quality criteria for open lake disposal.

33. "Concern Regarding Open-Lake Disposal of Dredged Material," a memorandum, P. Fraleigh, 4 pages.

This document identifies concerns regarding sediment and phosphorus loads resulting from open lake disposal of dredged materials. The document cites phosphorus concentrations at Lake Mile 2, Lake Mile 4, and the Open Lake Disposal Area. These data are originally presented in Document No. 20. Because data relevant to Lake Mile 2 through Lake Mile 19 and the Open Lake Disposal Area are originally presented in another document, this document was identified as non-applicable.

34. "Report on the Results of the Monitoring Study of Open-Lake Disposal of Dredged Material at Toledo Harbor, Ohio," P. Fraleigh, March 1987, 3 pages.

This document addresses some of the problems encountered in interpreting data from the 1985 and 1986 studies conducted during open lake disposal operations. The three page document references one table and six tables, none of which are included or attached to the document. Because the text does not present any quantitative data or identify specific sampling locations, this document cannot be used to determine if water quality criteria have been met or exceeded.

36. "Entrainment of Sediments and Dredged Material in Shallow Lake Water," Department of Mechanical and Environmental Engineering, University of California, Santa Barbara, California, In: J. Great Lakes Res. 13(4):619-627. Internat. Assoc. of Great Lakes Res., 1987.

This document is an article published in the *Journal of Great Lakes Research* that addresses the relationship among particle size, cohesion, and deposition of dredged materials in shallow lake waters. The document reports the results of a series of entrainment and deposition experiments on sediments collected from Lake Erie, including a site near the intake for the City of Toledo. Although the document provides

useful information on the transport of sediments in Lake Erie, it does not present water quality data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area.

37. **"A Determination of the Optimal Sampling Strategy for Assessing Open Lake Water Quality and Tracking Trends in the Western Basin of Lake Erie," The Ohio State University Center for Lake Erie Area Research, Columbus, Ohio. CLEAR Technical Report No. 305: Laura A. Fay and David E. Rathke, 1987, 126 pages.**

This document is a technique paper that describes a method for defining sampling areas and the number of samples required annually to characterize the water quality of the western basin of Lake Erie. The document does not present any data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area. The document was identified as non-applicable because it cannot be used to assess compliance with water quality criteria for open lake disposal.

40. **"Use of SPOT HRV Data in the Corps of Engineers Dredging Program," Carolyn Merry, Harlem McKin and Nancy LaPotin (U.S. Army Cold Regions Research and Engineering Laboratory) and John Adams (USACE, Buffalo), Photogrammetric Engineering and Remote Sensing, Vol. 54, No. 9, September 1988, 5 pages.**

This document is an article published in *Photogrametric Engineering and Remote Sensing* that reports the results of an evaluation on the use of satellite imagery to correlate suspended solids and turbidity with spectral characteristics. Data on suspended solids and turbidity are from the 1986 study during open lake disposal, which are contained in Document No. 21. Because the original data are presented in another document, this document was identified as non-applicable.

41. **"Open Lake Water Quality Conditions for Lake Erie's Western, Central and Eastern Basins," CLEAR Technical Report No. 317. Laura A. Fay, Helen E. Kundtz and David E. Rathke, 1988, 211 pages.**

As acknowledged by the Buffalo District, this document was not included in the materials provided to the Contractor. Therefore, a determination of non-applicability could not be made.

42. **"Final Environmental Impact Statement. Confined Disposal Facility," USACE, Buffalo, 1990, 300 pages.**

This document is the Environmental Impact Statement for the Confined Disposal Facility. Original data for sediments cited in this document for Lake Mile 2 through Mile 19 are contained in Document No. 38. Because original data relevant to open lake disposal are contained in another document, this document was identified as non-applicable.

43. **"Environmental Assessment and Finding of No Significant Impact, Operations and Maintenance Toledo Harbor, Ohio," USACE, Buffalo, 1989, 59 pages.**

This document is an Environmental Assessment and Finding of No Significant Impact (FONSI) for disposal of materials dredged from Lake Mile 2 to Lake Mile 10 in a new Open Lake Disposal site. Original data relevant to open lake disposal presented in this document are presented in Document No. 35 and

Document No. 38. Because original data are contained in other documents, this document was identified as non-applicable.

45. "Toledo Confined Disposal Facility Mitigation Planning Supplement to Final Fish and Wildlife Coordination Act Report," U.S. Fish and Wildlife Service, Reyoldsburg, Ohio, April 28, 1989, 57 pages.

This document presents an evaluation of current and future habitat conditions, using Habitat Evaluation Procedures (HEP), for the Confined Disposal Facility and nine alternative mitigation plans for reuse of dredged materials. Data on water and/or sediment quality used to evaluate the alternative plans were based on data contained within other documents or on assumptions of future conditions. This document was identified as non-applicable because 1) the study areas do not include Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area; and 2) no original data on sediment or water quality relevant to open lake disposal are presented.

48. "Toledo Harbor Dredge Material - Beneficial Reuse Alternatives - Status and Needs Report," Toledo Metropolitan Area Council of Governments, May 1990, 12 pages

Similar to Document No. 28 and No. 30, this document addresses several alternatives for the reuse of materials dredged from Toledo Harbor. Although the document does contain some references to water and sediment quality, it lacks data specific to Lake Mile 2 through Lake Mile 19 and the Open Lake Disposal Area. The document was identified as non-applicable because it cannot be used to assess compliance with water quality criteria for open lake disposal.

49. "Environmental Assessment and Section 404)b)(1) Evaluation, Dredging & Disposal of Dredged Materials at Island 18 CDF, Toledo Harbor, Ohio," USACE, November 1990, 143 pages.

This document is the Environmental Assessment and Section 404(b)(1) evaluation for the Island 18 Confined Disposal Facility. Original data for Lake Mile 2 through Lake Mile 19 and the Open Lake Disposal Area cited in this document are contained in Document No. 35, No. 38 and No. 44. Because original data relevant to open lake disposal are contained other documents, this document was identified as non-applicable.

50. "Monitoring Well Design and Placement - Toledo CDF," Buffalo District, January 1991, 5 pages.

This document presents the locations and technical specifications for the installation of three monitoring wells in the Confined Disposal Facility. Because this document addresses only the Confined Disposal Facility and does not present any data relevant to open lake disposal, it was identified as non-applicable.

51. "ARDL Report No. 6227, Corps of Engineers - Buffalo District, Toledo Harbor Site," ARDL, Inc., October 1992, 17 pages.

This document reports the results of analysis for total suspended solids and particle size for six samples collected from Toledo Harbor on September 8, 1992. The text of the document references Figure

1, but there are no figures included in the document. Percent total solids are presented for each of the six samples. This document was identified as non-applicable because the results could not be related to sample locations at Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area with any level of certainty.

52. "ARDL Report No. 6256, Corps of Engineers - Buffalo District, Grain Size Analysis Data Package, Toledo Harbor Site," ARDL, Inc., December 1992, 9 pages.

This document reports the results of grain size analysis of three samples collected from Toledo Harbor. One of the sample locations is located between Lake Mile 2 and Lake Mile 3. Because this document addresses only grain size analysis, which is not a parameter for water quality criteria, this document was identified as non-applicable.

53. "ARDL Report No. 6255, Corps of Engineers, Buffalo District, Toledo Harbor - Column Settling Test," ARDL, Inc. September 1993, 16 pages.

This document reports the results of column settling tests of three samples collected from Toledo Harbor. One of the sample locations is located between Lake Mile 2 and Lake Mile 3. Because this document addresses only column settling, which is not a parameter for water quality criteria, this document was identified as non-applicable.

54. "Transmittal of Results of Soil Tests, Samples RM1-2, LM0-1, and LM2-3, Toledo Harbor OH," Waterways Experiments Station, October 1993, 35 pages.

This document contains tables and charts relative to grain size analysis and consolidation tests of sediments from Toledo Harbor. The document has no text or narrative. Based on the title of the document and the tables and charts, samples were collected from three sites, one of which is between Lake Mile 2 and Lake Mile 3. Because this document addresses only grain size analysis, which is not a parameter for water quality criteria, this document was identified as non-applicable.

57. "ARDL Report No. 6351/6352, Toledo Harbor Site, Corps of Engineers-Buffalo District," ARDL, Inc. January 1994, 87 pages.

This document is the data verification package for five sediment samples from the Confined Disposal Facility. Analyses include bulk sediments and grain size analysis. Because the samples are associated with the Confined Disposal Facility, the source of chemicals in the samples cannot be identified. Because the document does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it was identified as non-applicable.

59. "Particle size Summary Report No. 6372 Toledo Harbor Site," ARDL, Inc., October 13, 1994, 24 pages.

This document reports the results of grain size analysis of 10 samples collected from Toledo Harbor. Sample locations include Lake Mile 2-3, Lake Mile 3-4, Lake Mile 4-5, and Lake Mile 5-6. Because this document addresses only grain size analysis, which is not a parameter for water quality criteria, this document was identified as non-applicable.

61. **"Monitoring Well Installation and Groundwater Sampling Report Toledo Harbor, Ohio," Parsons Engineering Science, February 22, 1996, 327 pages.**

This document describes the installation and monitoring of three groundwater monitoring wells within the dike of the Confined Disposal Area. The purpose of the monitoring wells is to provide data on background conditions in the area of the dike. Because the samples are associated with the Confined Disposal Facility and the document does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it was identified as non-applicable.

62. **"Monitoring Well and Confined Disposal Facility Sampling Toledo Harbor, OH," Volume 1 & 2, Engineering & Environmental Inc., July 1996, 166 pages, 2 volumes.**

This document describes the sampling of three groundwater monitoring wells and three surface water grab samples from within the dike of the Confined Disposal Area. Because the samples are associated with the Confined Disposal Facility and the document does not contain data specific to Lake Mile 2 through Lake Mile 19 or the Open Lake Disposal Area, it was identified as non-applicable.