CENWS-OD-TS-DM 14 September 2006

# MEMORANDUM FOR RECORD

**SUBJECT: SUPPLEMENTAL DETERMINATION ON THE SUITABILITY OF DREDGED MATERIAL TESTED FOR DIOXIN/FURANS WITHIN THE OLYMPIA HARBOR FEDERAL/PORT NAVIGATION PROJECT EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT FOR OPEN-WATER DISPOSAL AT THE ANDERSON/KETRON ISLAND NON-DISPERSIVE DISPOSAL SITE, AND FOR BENEFICIAL USE.**

1. The following summary reflects the consensus suitability determination of the Agencies that comprise the regional Dredged Material Management Program (DMMP) for the State of Washington on supplemental testing conducted for the maintenance dredging of the Olympia Harbor Federal/Port of Olympia deep-draft navigation project. The agencies include the Corps of Engineers, Department of Ecology, Department of Natural Resources, and the Environmental Protection Agency. The agencies are charged with determining the suitability of the proposed 458,734 cy of dredged material from the Olympia Harbor joint Federal/Port of Olympia project, located in Budd Inlet, Olympia, Washington for open-water disposal at the Anderson/Ketron Island disposal site and/or for beneficial use at the proposed beneficial uses placement site.

2. **Table 1** documents the regulatory tracking information and dates for the supplemental testing conducted.

## *Table 1. Regulatory Tracking Information and Dates*

| | |
|---|---|
| Corps Public Notice #: | CENWS-OD-TS-NS-23 |
| Initial Suitability Determination (635,000 cy Project) | May 17, 2000 |
| Recency Extension Determination (478,000 cy Project) | May 24, 2005 |
| Final SAP submittal date: | February 28, 2006 |
| SAP approval letter date: | March 3, 2006 |
| Sampling date(s): | March 6-10, 2006 |
| Initial Phase 1 data characterization data report submittal:<br>Validation Report on Phase 1 Dioxin Data | April 7, 2006<br>May 8, 2006 |
| Phase 2 data characterization report submittal:<br>Validation Report on Phase 2 Dioxin Analyses: | June 8, 2006<br>July 19, 2006 |
| Volume Tested (# DMMUs), Sampling Method: | 458,734 cy; (29 DMMUs + 2 analyses at proposed BU placement site); Vibracorer |
| DAIS Tracking Number | OHDSD-1-A-F-224 |
| **Recency Determination Date(s):**<br>**High: (Berthing Area, Navigation channel including minor widening) = 2 + 2 (BPJ) = 4** | March 2010 (**High**) |

3. The Project was initially ranked Low for the 1999 characterization, but the berthing area was re-ranked moderate/high for supplemental dioxin/furans testing. The DMMP agencies have assigned a high rank to entire project based on recent test results. The Agencies have agreed to extend the 2 year recency on high ranked areas for this project only by 2 years to 4 years. The rationale for the Agencies' decision to extend the recency for this project's data is recognition that the conditions represented by the data are unlikely to change in this time frame.

Specifically, the likely source (e.g., Cascade Pole) for dioxins/furans to the project area is no longer active. Furthermore, the horizontal and vertical distribution of dioxins/furans in the 2006 dataset reflect activities ongoing in the harbor area (e.g., resuspension of surface sediments due to shipping traffic and natural deposition of sediments from the Deschutes River and Capital Lake system) that are unlikely to change significantly in the recency timeframe. Additional considerations for extending the recency are documented in 2002 DMMP clarification paper on this topic (http://www.nws.usace.army.mil/publicmenu/DOCUMENTS/dmmo/Recencyclarification1.pdf).

## Background:

4. A white paper (**Attachment 1**) provides a review summary of previous testing conducted for the Olympia Harbor Project in 1988 and 1999, and describes data gaps leading to supplemental testing, required by the DMMP, the results of which are described in detail in this supplemental suitability determination. Concerns about data gaps and area ranking for previous testing led to a requirement by the DMMP agencies to require supplemental testing for dioxins/furans within the entire project area and to conduct limited PAH retesting in several locations.

5. The revised 458,734 cy project was subjected to dioxin/furans testing. The method for determining estimated volumes for dredged material management units is based on the original DMMP approved Sampling and Analysis Plan (SAP) for the 1999 characterization that delineated dredged materials management unit boundaries. After initial sampling in 1999, Olympia Harbor volume estimates were decreased because advance maintenance dredging depth was not justified in the Federal channel. The Supplemental Suitability Determination estimated volumes were calculated from current bathymetric survey information with surface (top 4 ft) volumes and subsurface volumes correlated to the dredging prism and subsequent sediment analysis data that required the recapitulation of suitable and unsuitable volumes.

## Sampling:

6. The DMMP consensus determination on supplemental testing (see **Attachment 1** White Paper) required collection of Vibracore samples at 21 locations within the joint Federal/Port project area (**Table 2**, **Figures 1** and **2** for Station locations, and **Figure 3** for DMMU boundaries). The sampling collected surface, subsurface DMMUs, and Z-samples at each location, for a total of 29 DMMUs. The Sampling and Analysis Plan was submitted to the DMMP agencies on February 28, 2006, and approved on March 3, 2006.

7. The vibracore sampling was initiated on March 6, 2006 and completed on March 10, 2006. Samples were submitted for sediment conventionals, PAHs, and Dioxins/Furans analyses. Samples slated for dioxin/furans analyses using U.S. EPA Method 1613B were sent to Alta Analytical Laboratory, Inc in El Dorado Hills, California. Five samples were submitted for PAH analyses. Forty-five dioxin/furan analyses were performed on the 29 DMMUs in 2 phases (Phase 1 = 20; Phase 2 = 25), including 8 Z-sample analyses. The emphasis of the Phase 1 analyses was evaluation of the surface DMMUs for dioxins/furans and limited PAHs. Based on the Phase 1 results the DMMP agencies required additional analyses to further elucidate the extent of the dioxin/furan concentrations in surface composited samples, subsurface samples, and Z-samples to complete the data necessary to make the suitability determination (**Table 2**).

## Chemical Testing Results:

8. The analyses were conducted in two phases, initially focusing on the surface sediments (**Table 2**). **Table 3** contains a summary of the sediment conventional results for the samples collected for dioxin analyses[1] and **Table 5** provides conventional data for the samples collected for PAH analyses. The Phase 1 analyses consisted of a subset of composited analyses from the federally maintained harbor area and uncomposited analyses at all other locations including the Port's berthing area, which was sampled at a moderate/high rank (see **Attachment 1**). After reviewing Phase I results, the DMMP agencies determined that additional analyses would be required on archived samples to complete the data analysis requirements for the DMMP Suitability Determination. The Phase 2 analyses focused on breaking apart the composited samples from the Harbor Channel area into uncomposited archived surface samples; analyzing subsurface samples from the berthing area and Turning Basin widening area, not analyzed during Phase I, and analyzing all Z-samples with contaminated overlying sediments, as noted in **Table 2**.

9. **Tables 4a** and **4b** provides summaries of the validated dioxin/furan congener specific testing results for both testing phases, with TEQ (Toxicity Equivalence) concentrations ranging from a low of 0.14 pptr (SZ-12 at core location 12) to a high of 52.6 pptr (Port Berthing area S4, core location 4). The limited PAH analyses at Port Berthing area (Station 4: surface and subsurface) and at Olympia Harbor surface Stations 9 and 10 (composited surface Sample ID = C3; and at Z Stations SZ-9 and SZ-10) showed low concentrations well below DMMP screening level guidelines (**Table 5a**) and SMS Guidelines (**Table 5b**).

10. The dioxin data underwent an independent QA/QC review (by D.M.D., Inc.) to validate the data. The quality assurance/quality control guidelines specified by the EPA method, EPA Function guidelines, and the DMMP Users Manual were generally complied with. The data gathered were deemed sufficient and acceptable for decision-making by the DMMP agencies based on best-professional-judgment (BPJ).

11. Biological testing would only be necessary for samples undergoing PAH analyses if screening levels were exceeded for this chemical, and were not deemed appropriate by the DMMP for dioxin testing results because there are no established screening levels for this chemical (see **Attachment 2**, dioxin white paper). Based on the low levels of PAH observed in the limited retesting conducted (**Table 5**), no biological testing was deemed necessary by the DMMP agencies using BPJ.

12. The DMMP agencies acknowledge the complexity of setting interpretative guidelines for PCDD/F. Currently there is no agreed upon approach for regulating PCDD/F in Puget Sound, and the DMMP has not established programmatic SLs, BTs, or MLs for this complex chemical. In the recent past the DMMP agencies have applied the Grays Harbor dioxin risk framework, developed in 1991, to the four Puget Sound projects that underwent PCDD/F testing between 1991 and 2005. After revisiting the basis for the Grays Harbor guidelines, the DMMP agencies concluded that the process used in Grays Harbor is deficient because the approach used to estimate exposure and risk is outdated and non specific to Puget Sound.

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[1] Sediment Conventionals were performed on composited Phase 1 samples (C1 –C4), and not analyzed on the uncomposited samples (S18, S19, S20, S21, S22, S23, S28, S29) that were subsequently analyzed during Phase 2 testing. Sediment conventionals were not analyzed on subsurface samples from the Turning Basin Expansion (S16, S17) and subsurface samples from the Port berthing area (S24, S25, S26, S27) using BPJ.

## Dioxin Interpretation Summary:

13. The DMMP agencies have developed an interim interpretative approach for PCDD/F based on maintaining “background” concentrations currently existing at and in the vicinity of the Anderson-Ketron site. The use of this approach was supported by the results of a risk-screening exercise that considered the best available information for the proposed disposal site, as well as updated modeling approaches and exposure information for highly exposed human populations. **Attachment 2** provides the White Paper entitled: “Analysis to Support Suitability Determination of Dredged Material with Polychlorinated Dibenzo-p-dioxins and Furans for Disposal at the Anderson/Ketron Island Dredged Material Disposal Site”. The purpose of the exercise was to evaluate the plausibility of setting risk-based guidelines while meeting the needs of the applicant’s time constraints. While this screening exercise and the resulting interim approach received internal and some external review, it has not been thoroughly vetted with the stakeholder community. Such a review will be necessary and will be pursued before the DMMP develops a broader approach for establishing interpretative guidelines for Puget Sound on a programmatic basis. The culmination of this effort should be the presentation of an agreed-on approach to setting limits for dioxin at both dispersive and non-dispersive sites at the 2007 Sediment Management Annual Review Meeting.

14. The following abbreviated summary explains the interim approach that the DMMP has developed to interpret polychlorinated dibenzodioxins and furans (PCDD/F) testing results for the Olympia Harbor joint Federal/Port Project. We reiterate that this interpretative framework was developed specifically for the Olympia Harbor Project and is only applicable to dredged material proposed for disposal at the Anderson/Ketron Island Disposal Site.

15. The goal of the interpretive approach is to insure that disposal of project sediments does not increase “background” concentrations of dioxin at the Anderson/Ketron site. The “background” dioxin concentration at the site is defined using a set of recently-collected sediment data from both onsite and the immediate vicinity. This case-specific approach is based on a two-tiered process. Tier 1 focuses on evaluating the project PCDD/F data relative to the Anderson/Ketron Island disposal site maximum observed sediment value 7.3 pptr TEQ. This concentration is used as a site specific ceiling value not to be exceeded. Every DMMU above this value would be unsuitable for unconfined open-water disposal, whereas, all DMMUs with PCDD/F concentrations below this value would then proceed to the second tier of interpretive framework. Tier 2 focuses on comparing the volume-weighted mean concentration of all project sediments within a given DMMU at or below 7.3 pptr TEQ maximum, to the disposal site mean concentration (3.8 pptr TEQ). If the volume-weighted mean concentration exceeds the disposal site mean concentration, the project proponent could eliminate DMMUs contributing to the volume-weighted mean exceedance until the volume-weighted mean is at or below the disposal site mean concentration.

16. **Table 6** provides a summary of the Tier 1 evaluation for all 29 DMMUs. It shows that 13 DMMUs (S2, S3, S4, S23, S22, S21, S20, S19, S18, S29, S5, S6, S10) exceeded the bright line Anderson/Ketron Island Disposal site maximum concentration of 7.3 pptr, and are unsuitable for unconfined-open water disposal at the Anderson/Ketron Island Disposal site. The remaining 16 DMMUs (S1, S27, S26, S25, S24, SZ5, SZ6, S28, S16, S17, S14, S7, S8, S15, S9, S11) were below the site maximum concentration and proceeded to the Tier 2 analysis.

17. **Table 7** provides a summary of the **Tier 2** weighted mean loading calculations for the 16 remaining DMMUs. The total volume of material below the Tier 1 bright line standard of 7.3 pptr is 220,500 cy, and the calculated weighted mean concentration for this material is 2.2 pptr TEQ, which is below the Anderson/Ketron Island Mean concentration of 3.8 pptr TEQ. Therefore, all 220,500 cy of material meeting the **Tier 1** standard is suitable for unconfined-open-water disposal at the Anderson/Ketron Island non-dispersive disposal site. A second iteration of the **Tier 2** analysis was conducted to evaluate the weighted mean concentration of material that would be likely to be dredged and disposed at the Anderson/Ketron Island disposal site after approximately 60,000 cy of material (DMMU S8, S15, and a portion: 6,645 cy of DMMU S7) is removed for use in a potential beneficial uses placement site located in Olympia Harbor (see **Figure 2**). The weighted mean concentration for PCDD/F for the revised 160,500 cy project is 2.8 pptr TEQ, which is below the Mean disposal site concentration of 3.8 pptr TEQ. The weighted mean concentration for the 60,000 cy of material likely to be used for the beneficial uses project is 0.47 pptr TEQ PCDD/F.

## Suitability Determination:

18. The results of these analyses in summary indicate that all 220,500 cy of material below the **Tier 1** standard (7.3 pptr TEQ) were subsequently evaluated below the **Tier 2** Anderson/Ketron Island disposal site mean concentration (<3.8 pptr TEQ) and are suitable for unconfined open-water disposal at this site. The revised suitable volume, after removing material for a potential beneficial uses project also meets the **Tier 2** guideline of < 3.8 pptr TEQ and is suitable for unconfined-open-water disposal at the Anderson/Ketron Island site.

19. The results indicate that 238,234 cy of material exceed the DMMP dioxin interpretation framework Tier 1 maximum level of 7.3 pptr TEQ and are unsuitable for unconfined-open-water disposal, and must be disposed at an Ecology-approved upland disposal site or in-water confined disposal site.

20. The proposed dredged material evaluated for beneficial uses is suitable for an appropriate BU project based on BPJ. This determination does not make any DMMP judgments about the suitability of the BU location or BU project. There will be a separate process to determine if and where material will be used beneficially.

21. Evaluation of the Z-samples (**Table 6**) demonstrated that all the exposed surfaces represented by these analyses were significantly lower that the overlying surfaces, and would meet the Washington State anti-degradation policy. However, the Z-sample represented by SZ10 (**Table 6**) at Core location 10 exhibited a concentration of PCDD//F of 9.3 pptr TEQ, above the disposal site maximum concentration, but below the overlying surface concentration of 25.6 pptr TEQ.

22. This memorandum documents the suitability of material proposed for dredging from the Joint Federal/Port of Olympia Olympia Harbor Dredging Project, for open-water disposal at the Anderson/Ketron Island disposal site and for beneficial use. However, this suitability determination does not constitute final agency approval of the project. A dredging plan for this project must be completed as part of the final project approval process. A final decision will be made after full consideration of agency input, and after an alternatives analysis is done under Section 404(b)(1) of the Clean Water Act.

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Concur:

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**Figure 1. Coring Locations in the Turning Basin and the Port of Olympia's Berthing Area (Figure prepared by the USACE Seattle District, Navigation Section)**

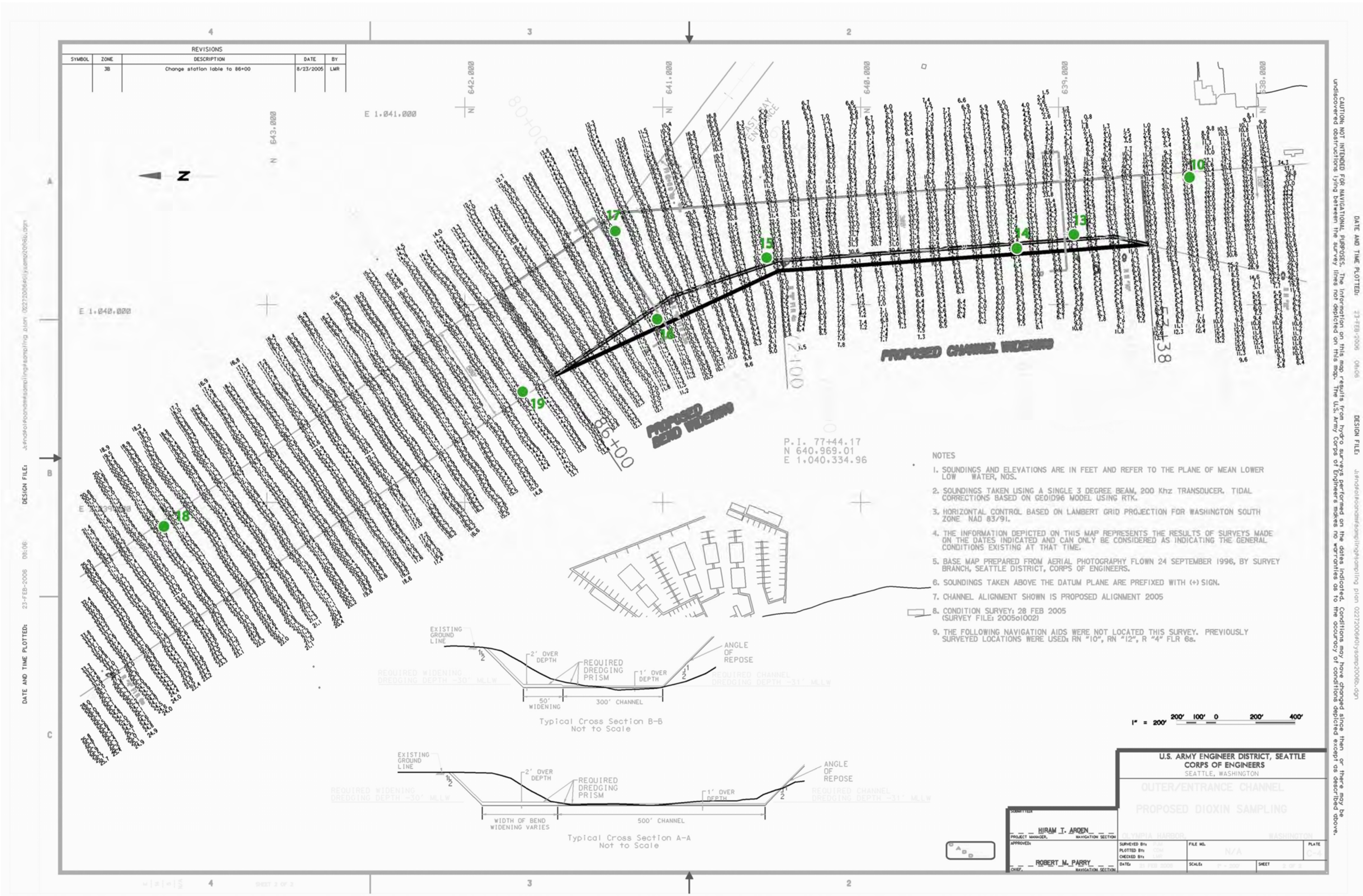

**Figure 2. Coring Locations in the Olympia Navigation Channel (Figure prepared by the USACE Seattle District, Navigation Section)**

Figure 3: DMMU Boundaries for Olympia Harbor Project with Core Sampling Locations noted.

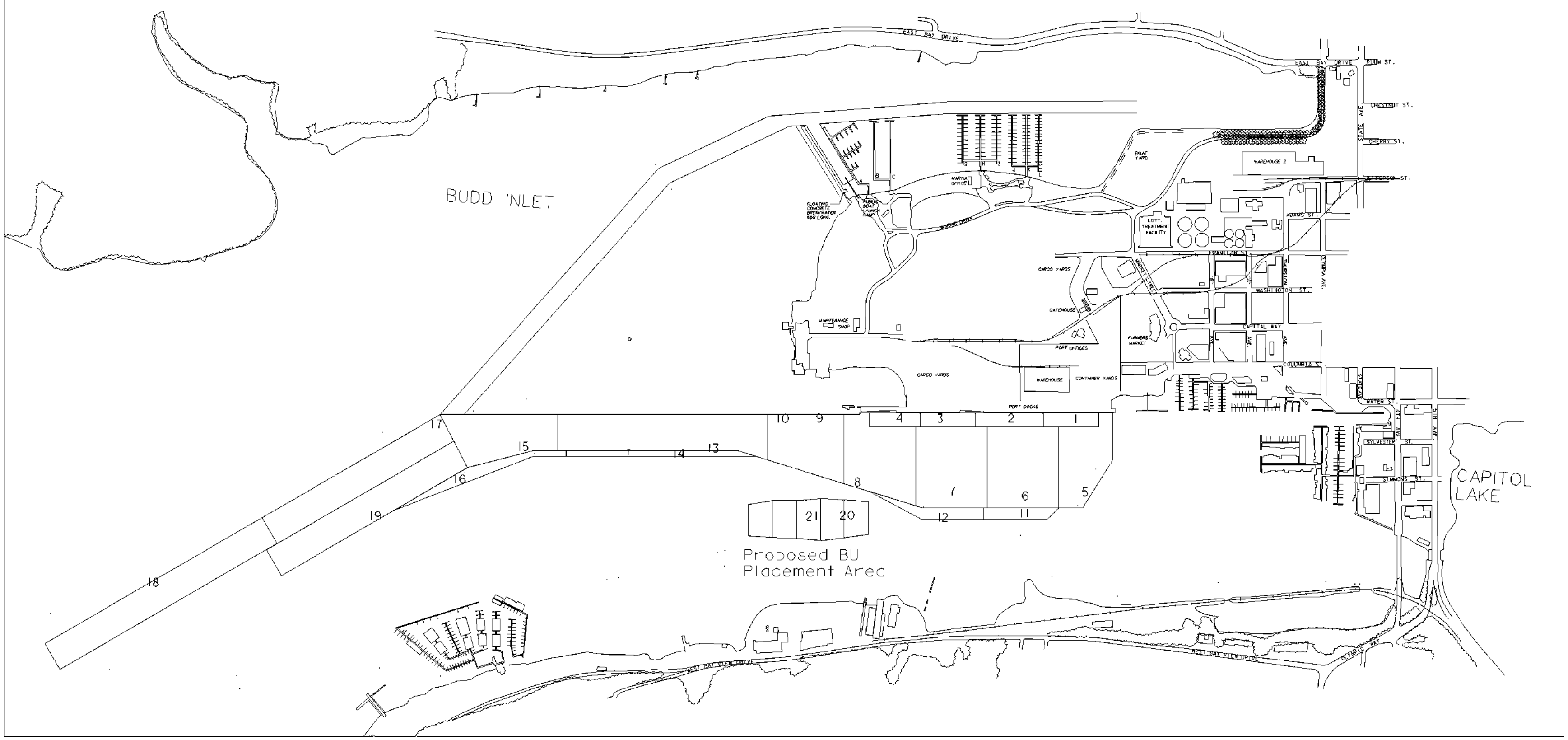

**Table 2. DMMP Sampling Strategy for the Olympia Harbor Federal/Port of Olympia Project for Dioxin/Furans and PAHs[1] (Shaded = Analyzed).**

| DMMU Subarea | Station ID[1] | Depth | Analysis ID | Analytes | Disposition |
|---|---|---|---|---|---|
| Port's Berthing Area | 1a | 0-4 ft | S1 (P1) | Dioxin | Analyze |
| Port's Berthing Area | 1b | 4-9 ft | S27 (A)[2] | Dioxin | Archived |
| Port's Berthing Area | 1c | 9-10 ft | Z-sample (A) | Dioxin | Archived |
| Port's Berthing Area | 2a | 0-4 ft | S2 (P1) | Dioxin | Analyze |
| Port's Berthing Area | 2b | 4-10 ft | S26 (P2) | Dioxin | Analyze |
| Port's Berthing Area | 2c | 10-11 ft | Z-sample (A) | Dioxin | Archived |
| Port's Berthing Area | 3a | 0-4 ft | S3 (P1) | Dioxin | Analyze |
| Port's Berthing Area | 3b | 4-10 ft | S25 (P2) | Dioxin | Analyze |
| Port's Berthing Area | 3c | 10-11 ft | Z-sample (A) | Dioxin | Archived |
| Port's Berthing Area | 4a | 0-4 ft | S4 (P1) | Dioxin, PAHs | Analyze |
| Port's Berthing Area | 4b | 4-13 ft | S24 (P2) | Dioxin, PAHs | Analyze |
| Port's Berthing Area | 4c | 13-14 ft | Z-sample (A) | Dioxin | Archived |
| Turning Basin | 5a | 0-4 ft | C1 (P1)<br>S23 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin | 5b | 4-5 ft | Z-Sample: SZ5 (P2) | Dioxin | Analyze |
| Turning Basin | 6a | 0-4 ft | C1 (P1)<br>S22 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin | 6b | 4-5 ft | Z-Sample: SZ6 (P2) | Dioxin | Analyze |
| Turning Basin | 7a | 0-2 ft | C2 (P1)<br>S21 (P2) | Dioxin | Analyze<br>Analyze |
| Turning Basin | 7b | 2-3 ft | Z-Sample: SZ7 (P2) | Dioxin | Analyze |
| Turning Basin | 8a | 0-2 ft | C2 (P1)<br>S20 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin | 8b | 2-3 ft | Z-Sample: SZ8 (P2) | Dioxin | Analyze |
| Main Channel | 9a | 0-2 ft | C3 (P1)<br>S19 (P2) | Dioxin, PAHs<br>Dioxin | Analyze<br>Analyze |
| Main Channel | 9b | 2-3 ft | Z-Sample: SZ9 (P2) | Dioxin, PAH's | Analyze |
| Main Channel | 10a | 0-2 ft | C3 (P1)<br>S18 (P2) | Dioxin, PAHs<br>Dioxin | Analyze<br>Analyze |
| Main Channel | 10b | 2-3 ft | Z-Sample: SZ10 (P2) | Dioxin | Analyze |
| Turning Basin Widening | 11a | 0-4 ft | C4 (P1)<br>S29 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin Widening | 11b | 4-8 ft | S16 (P2) | Dioxin | Analyze |
| Turning Basin Widening | 11c | 8-9 ft | Z-sample: SZ11 (P2) | Dioxin | Analyze |
| Turning Basin Widening | 12a | 0-4 ft | C4 (P1)<br>S28 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin Widening | 12b | 4-17 ft | S17 (P2) | Dioxin | Analyze |
| Turning Basin Widening | 12c | 17-18 ft | Z-sample: SZ12 (P2) | Dioxin | Analyze |
| Main Channel | 13a | 0-4 ft | S5 (P1) | Dioxin | Analyze |
| Main Channel | 13b | 4-5 ft | Z-Sample: SZ13 (P2) | Dioxin | Analyze |
| Main Channel Widening | 14a | 0-4 ft | S6 (P1) | Dioxin | Analyze |
| Main Channel Widening | 14b | 4-9 ft | S14 (P1) | Dioxin | Analyze |
| Main Channel Widening | 14c | 9-10 ft | Z-sample (A) | Dioxin | Archived |
| Main Channel | 15a | 0-3 ft | S7 (P1) | Dioxin | Analyze |
| Main Channel | 15b | 3-4 ft | Z-sample (A) | Dioxin | Archived |
| Channel Bend Widening | 16a | 0-4 ft | S8 (P1) | Dioxin | Analyze |
| Channel Bend Widening | 16b | 4-19 ft | S15 (P1) | Dioxin | Analyze |
| Channel Bend Widening | 16c | 19-20 ft | Z-sample (A) | Dioxin | Archived |
| Outer Channel | 17a | 0-3 ft | S9 (P1) | Dioxin | Analyze |
| Outer Channel | 17b | 3-4 ft | Z-sample (A) | Dioxin | Archived |
| Outer Channel | 18a | 0-3 ft | S10 (P1) | Dioxin | Analyze |
| Outer Channel | 18b | 3-4 ft | Z-Sample: SZ18 (P2) | Dioxin | Analyze |
| Outer Channel | 19 | 0-4 ft | S11 (P1) | Dioxin | Analyze |
| Outer Channel | 19 | 4-5 ft | Z-sample (A) | Dioxin | Archived |
| BU Placement Area. | 20 | 0-10 cm | S12 (P1) | Dioxin | Analyze |
| BU Placement Area | 21 | 0-10 cm | S13 (P1) | Dioxin | Analyze |

**Legend:** S = uncomposited samples; C = composited for initial analysis during P1 (analyzed as uncomposited samples in P2); P1 = Initial Phase of analyses; P2 = Second Phase of analyses; A = Archived sample

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[1] Z-samples were collected and archived at each Core location

[2] The surface sample (S1) overlying S27 met the Tier 1 guideline (see Table 6), and the DMMP agencies using BPJ determined that analysis of this sample was not required.

# Table 3. Olympia Harbor Project Sediment Chemistry Results - Conventionals

| DMMU Core Location Number: | | | 5a + 6a (0-4 ft) | 7a + 8a (0-4 ft) | 9a + 10a (0-4 ft) | 11a + 12a (0-4 ft) | 1a (0-4 ft) |
|---|---|---|---|---|---|---|---|
| Analysis ID | | | C1 | C2 | C3 | C4 | S1 |
| Collection Date | DMMP SL | DMMP ML | 03/09/2006 | 03/09/2006 | 03/08/2006 | 03/07/2006 | 03/08/2006 |
| **Conventionals** | | | | | | | |
| Total Organic Carbon (% DW) | – | – | 3.09 | 2.54 | 3.09 | 2.28 | 0.25 |
| Total Sulfides (mg/kg DW) | – | – | – | – | 626 | – | – |
| Ammonia (mg-N/kg DW) | – | – | – | – | 89.5 | – | – |
| TVS (%) | – | – | 8.29 | 7.21 | 9.76 | 6.23 | 1.23 |
| Total Solids (%) | – | – | 41.8 | 44.9 | 37.1 | 51.7 | 83.1 |
| Grain Size | | | | | | | |
| Percent Gravel (>2.0 mm) | – | – | 6.34 | 2.31 | 0 | 2.1 | 54.8 |
| Percent Sand (<2.0 mm - 0.06 mm) | – | – | 21.57 | 24.45 | 10.9 | 27.85 | 45.68 |
| Percent Silt (0.06 mm - 0.004 mm) | – | – | 42.84 | 46.4 | 50.4 | 43.93 | 1.68 |
| Percent Fines (<0.06 mm) | – | – | 74.57 | 77.66 | 89.95 | 68.67 | 3.12 |
| Percent Clay (<0.004 mm) | – | – | 31.73 | 31.26 | 39.55 | 24.74 | 1.44 |

| DMMU Core Location Number: | | | 2a (0-4ft) | 3a (0-4 ft) | 4a (0-4 ft) | 13a (0-4 ft) | 14a (0-4 ft) |
|---|---|---|---|---|---|---|---|
| Analysis ID: | | | S2 | S3 | S4 | S5 | S6 |
| Collection Date | DMMP SL | DMMP ML | 03/08/2006 | 03/08/2006 | 03/08/2006 | 03/07/2006 | 03/07/2006 |
| **Conventionals** | | | | | | | |
| Total Organic Carbon (% DW) | – | – | 2.94 | 3.15 | 2.67 | 4.18 | 3.31 |
| Total Sulfides (mg/kg DW) | – | – | – | – | 575 | – | – |
| Ammonia (mg-N/kg DW) | – | – | – | – | 195 | – | – |
| TVS (%) | – | – | 8.86 | 9.54 | 7.75 | 9.31 | 9.36 |
| Total Solids (%) | – | – | 40.4 | 39.8 | 46.9 | 36.7 | 38.7 |
| Grain Size | | | | | | | |
| Percent Gravel (>2.0 mm) | – | – | 0.14 | 6.11 | 4.26 | 0 | 0.02 |
| Percent Sand (<2.0 mm - 0.06 mm) | – | – | 11.1 | 20.33 | 31.63 | 7.66 | 12.04 |
| Percent Silt (0.06 mm - 0.004 mm) | – | – | 51.57 | 41.67 | 36.33 | 50.89 | 47.61 |
| Percent Fines (<0.06 mm) | – | – | 89.42 | 74.18 | 66.18 | 94.49 | 89.21 |
| Percent Clay (<0.004 mm) | – | – | 37.85 | 32.51 | 29.85 | 43.6 | 41.6 |

| DMMU Core Location Number: | | | 15a (0-3 ft) | 16a (0-4 ft) | 17a (0-3 ft) | 18a (0-3 ft) | 19a (0-4 ft) |
|---|---|---|---|---|---|---|---|
| Analysis ID: | | | S7 | S8 | S9 | S10 | S11 |
| Collection Date | DMMP SL | DMMP ML | 03/07/2006 | 03/07/2006 | 03/07/2006 | 03/07/2006 | 03/07/2006 |
| **Conventionals** | | | | | | | |
| Total Organic Carbon (% DW) | – | – | 0.66 | 0.6 | 1.3 | 3.33 | 1.39 |
| Total Sulfides (mg/kg DW) | – | – | – | – | – | – | – |
| Ammonia (mg-N/kg DW) | – | – | – | – | – | – | – |
| TVS (%) | – | – | 2.26 | 2.44 | 5 | 9.99 | 4.52 |
| Total Solids (%) | – | – | 69.6 | 71.1 | 50.7 | 28.1 | 53.5 |
| Grain Size | | | | | | | |
| Percent Gravel (>2.0 mm) | – | – | 2.68 | 3.19 | 0.97 | 0 | 2.41 |
| Percent Sand (<2.0 mm - 0.06 mm) | – | – | 74.63 | 73.34 | 50.26 | 1.93 | 41.38 |
| Percent Silt (0.06 mm - 0.004 mm) | – | – | 13.89 | 17.88 | 25.91 | 50.67 | 29.25 |
| Percent Fines (<0.06 mm) | – | – | 22 | 25.76 | 48.99 | 102.67 | 52.35 |
| Percent Clay (<0.004 mm) | – | – | 8.11 | 7.88 | 23.08 | 52 | 23.1 |

| DMMU Core Location Number: | | | 20 (0-10 cm) | 21 (0-10 cm) | 14b (4-9 ft) | 16b (4-19 ft) | 4b (4-13 ft) |
|---|---|---|---|---|---|---|---|
| Analysis ID: | | | S12 | S13 | S14 | S15 | S24 |
| Collection Date | DMMP SL | DMMP ML | 03/10/2006 | 03/10/2006 | 03/07/2006 | 03/07/2006 | 03/08/2006 |
| **Conventionals** | | | | | | | |
| Total Organic Carbon (% DW) | – | – | 3.92 | 4.25 | 0.64 | 0.75 | 0.35 |
| Total Sulfides (mg/kg DW) | – | – | 652 | 537 | – | – | 16.9 |
| Ammonia (mg-N/kg DW) | – | – | 14.3 | 14.6 | – | – | 19.2 |
| TVS (%) | – | – | 12.1 | 12.4 | 2.28 | 2.96 | 1.5 |
| Total Solids (%) | – | – | 32.7 | 33.1 | 75 | 70.8 | 84.5 |
| Grain Size | | | | | | | |
| Percent Gravel (>2.0 mm) | – | – | 0 | 0 | 5.76 | 6.3 | 51 |
| Percent Sand (<2.0 mm - 0.06 mm) | – | – | 5.51 | 5.25 | 74.72 | 58.17 | 43.57 |
| Percent Silt (0.06 mm - 0.004 mm) | – | – | 65.53 | 69.6 | 12.69 | 23.08 | 4.98 |
| Percent Fines (<0.06 mm) | – | – | 96.34 | 97.54 | 19.3 | 34.83 | 8.13 |
| Percent Clay (<0.004 mm) | – | – | 30.81 | 27.94 | 6.61 | 11.75 | 3.15 |

| DMMU Core Location Number: | | | 9b (2-3 ft) | 10b (2-3 ft) |
|---|---|---|---|---|
| Analysis ID: | | | Z9 | Z10 |
| Collection Date | DMMP SL | DMMP ML | 03/08/2006 | 03/08/2006 |
| **Conventionals** | | | | |
| Total Organic Carbon (% DW) | – | – | 2.4 | 1.7 |
| Total Sulfides (mg/kg DW) | – | – | 172 | 45.1 |
| Ammonia (mg-N/kg DW) | – | – | 147 | 113 |
| TVS (%) | – | – | 7.48 | 5.49 |
| Total Solids (%) | – | – | 45.3 | 51.9 |
| Grain Size | | | | |
| Percent Gravel (>2.0 mm) | – | – | 0.38 | 2.04 |
| Percent Sand (<2.0 mm - 0.06 mm) | – | – | 11.31 | 30.61 |
| Percent Silt (0.06 mm - 0.004 mm) | – | – | 57.1 | 44.17 |
| Percent Fines (<0.06 mm) | – | – | 90.72 | 65.98 |
| Percent Clay (<0.004 mm) | – | – | 33.62 | 21.81 |

**Table 4a. Validated Dioxin/Furan Phase I Testing Results for the Olympia Harbor Project.**

| | | S1 | | | S2 | | | S3 | | | S4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | TEF | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.125 | U | 0.0625 | 2.08 | | 2.08 | 1.05 | | 1.05 | 1.15 | | 1.15 |
| 1,2,3,7,8-PeCDD | 1 | 0.232 | U | 0.116 | 4.49 | | 4.49 | 3.9 | | 3.9 | 3.98 | | 3.98 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 0.416 | J | 0.0416 | 8.4 | | 0.84 | 6.33 | | 0.633 | 5.35 | | 0.535 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 2.11 | J | 0.211 | 53.9 | | 5.39 | 42.5 | | 4.25 | 48 | | 4.8 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 0.745 | J | 0.0745 | 20.4 | | 2.04 | 14.7 | | 1.47 | 13.3 | | 1.33 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 46.2 | | 0.462 | 1820 | | 18.2 | 918 | | 9.18 | 1080 | | 10.8 |
| OCDD | 0.0001 | 326 | | 0.0326 | 19700 | JE | 1.97 | 5890 | | 0.589 | 6700 | | 0.67 |
| 2.3.7.8-TCDF | 0.1 | 0.149 | J | 0.0149 | 3.58 | | 0.358 | 3.7 | | 0.37 | 3.96 | | 0.396 |
| 1,2,3,7,8-PeCDF | 0.05 | 0.227 | J | 0.01135 | 4.83 | | 0.2415 | 4.79 | | 0.2395 | 6.37 | | 0.3185 |
| 2,3,4,7,8-PeCDF | 0.5 | 0.479 | J | 0.2395 | 11.1 | | 5.55 | 13.2 | | 6.6 | 25.8 | | 12.9 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 2.15 | J | 0.215 | 32.9 | | 3.29 | 31 | | 3.1 | 61 | | 6.1 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 1.38 | J | 0.138 | 14 | | 1.4 | 10.2 | | 1.02 | 15.1 | | 1.51 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 0.757 | J | 0.0757 | 15.3 | | 1.53 | 13.9 | | 1.39 | 21.5 | | 2.15 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 0.291 | J | 0.0291 | 5.75 | | 0.575 | 1.81 | J | 0.181 | 13.1 | | 1.31 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 15.9 | | 0.159 | 399 | | 3.99 | 324 | | 3.24 | 431 | | 4.31 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 0.75 | | 0.0075 | 22.3 | | 0.223 | 14.2 | | 0.142 | 25.9 | | 0.259 |
| OCDF | 0.0001 | 29.5 | | 0.00295 | 1390 | | 0.139 | 639 | | 0.0639 | 1160 | | 0.116 |
| Total TEQ (u = 1/2): | | | | 1.8932 | | | 52.307 | | | 37.418 | | | 52.635 |
| Total TEQ (u = 0): | | | | 1.7147 | | | 52.307 | | | 37.418 | | | 52.635 |
| Total TOC, %: | | | | 0.25 | | | 2.94 | | | 3.15 | | | 2.67 |

| | | S5 | | | S6 | | | S7 | | | S8 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | TEF | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.949 | | 0.949 | 0.902 | | 0.902 | 0.144 | UE | 0.072 | 0.035 | U | 0.0175 |
| 1,2,3,7,8-PeCDD | 1 | 4.11 | | 4.11 | 3.5 | | 3.5 | 0.495 | J | 0.495 | 0.059 | U | 0.0295 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 6.97 | | 0.697 | 4.51 | | 0.451 | 0.633 | J | 0.0633 | 0.069 | U | 0.00345 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 37.5 | | 3.75 | 22 | | 2.2 | 2.99 | | 0.299 | 0.077 | U | 0.00385 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 14.9 | | 1.49 | 8.99 | | 0.899 | 1.23 | J | 0.123 | 0.069 | U | 0.00345 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 792 | | 7.92 | 390 | | 3.9 | 55.6 | | 0.556 | 1.14 | J | 0.0114 |
| OCDD | 0.0001 | 4880 | | 0.488 | 2060 | | 0.206 | 330 | | 0.033 | 8.54 | | 0.000854 |
| 2.3.7.8-TCDF | 0.1 | 3.32 | | 0.332 | 3.5 | | 0.35 | 0.585 | | 0.0585 | 0.056 | U | 0.0028 |
| 1,2,3,7,8-PeCDF | 0.05 | 3.54 | | 0.177 | 2.91 | | 0.1455 | 0.483 | J | 0.02415 | 0.081 | U | 0.002025 |
| 2,3,4,7,8-PeCDF | 0.5 | 8.04 | | 4.02 | 8.08 | | 4.04 | 1.15 | J | 0.575 | 0.08 | U | 0.02 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 20.9 | | 2.09 | 15.3 | | 1.53 | 2.06 | J | 0.206 | 0.034 | U | 0.0017 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 8.8 | | 0.88 | 5.76 | | 0.576 | 0.859 | J | 0.0859 | 0.31 | U | 0.0155 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 11.9 | | 1.19 | 8.98 | | 0.898 | 1.3 | J | 0.13 | 0.033 | U | 0.00165 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 4.13 | | 0.413 | 0.925 | J | 0.0925 | 0.416 | J | 0.0416 | 0.044 | U | 0.0022 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 254 | | 2.54 | 143 | | 1.43 | 41.5 | | 0.415 | 0.228 | | 0.00228 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 9.65 | | 0.0965 | 6.78 | | 0.0678 | 0.928 | J | 0.00928 | 0.04 | U | 0.0002 |
| OCDF | 0.0001 | 440 | | 0.044 | 280 | | 0.028 | 45.3 | | 0.00453 | 0.394 | J | 0.0000394 |
| Total TEQ (u = 1/2): | | | | 31.187 | | | 21.216 | | | 3.1913 | | | 0.118 |
| Total TEQ (u = 0): | | | | 31.187 | | | 21.216 | | | 3.1913 | | | 0.015 |
| Total TOC, %: | | | | 4.18 | | | 3.31 | | | 0.66 | | | 0.60 |

| | | S9 | | | S10 | | | S11 | | | S12 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | TEF | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.271 | J | 0.271 | 0.825 | | 0.825 | 0.229 | UE | 0.1145 | 0.657 | | 0.657 |
| 1,2,3,7,8-PeCDD | 1 | 1.01 | J | 1.01 | 4.18 | | 4.18 | 0.985 | J | 0.985 | 3.01 | | 3.01 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 1.5 | J | 0.15 | 6.95 | | 0.695 | 1.46 | J | 0.146 | 4.44 | | 0.444 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 7.44 | | 0.744 | 43.6 | | 4.36 | 7.45 | | 0.745 | 29.2 | | 2.92 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 3.27 | | 0.327 | 18.9 | | 1.89 | 2.95 | | 0.295 | 9.99 | | 0.999 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 160 | | 1.6 | 892 | | 8.92 | 136 | | 1.36 | 448 | | 4.48 |
| OCDD | 0.0001 | 1000 | | 0.1 | 5710 | | 0.571 | 796 | | 0.0796 | 2560 | | 0.256 |
| 2.3.7.8-TCDF | 0.1 | 1.07 | | 0.107 | 4.2 | | 0.42 | 1.06 | | 0.106 | 2.57 | | 0.257 |
| 1,2,3,7,8-PeCDF | 0.05 | 0.873 | J | 0.04365 | 3.72 | | 0.186 | 0.862 | J | 0.0431 | 2.56 | | 0.128 |
| 2,3,4,7,8-PeCDF | 0.5 | 2.11 | J | 1.055 | 7.52 | | 3.76 | 1.96 | J | 0.98 | 5.3 | | 2.65 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 4.05 | | 0.405 | 18.6 | | 1.86 | 3.99 | | 0.399 | 9.71 | | 0.971 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 1.67 | J | 0.167 | 7.88 | | 0.788 | 1.75 | J | 0.175 | 5.56 | | 0.556 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 2.55 | | 0.255 | 10.8 | | 1.08 | 2.65 | | 0.265 | 8.4 | | 0.84 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 0.931 | J | 0.0931 | 3.65 | | 0.365 | 0.886 | J | 0.0886 | 2.46 | J | 0.246 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 56.8 | | 0.568 | 230 | | 2.3 | 59.1 | | 0.591 | 147 | | 1.47 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 1.85 | J | 0.0185 | 8.61 | | 0.0861 | 1.95 | J | 0.0195 | 5.36 | | 0.0536 |
| OCDF | 0.0001 | 77.4 | | 0.00774 | 375 | | 0.0375 | 76.1 | | 0.00761 | 193 | | 0.0193 |
| Total TEQ (u = 1/2): | | | | 6.9220 | | | 32.3 | | | 6.4 | | | 19.957 |
| Total TEQ (u = 0): | | | | 6.9220 | | | 32.3 | | | 6.3 | | | 19.957 |
| Total TOC, %: | | | | 1.30 | | | 3.33 | | | 1.39 | | | 3.92 |

**Table 4a. Validated Dioxin/Furan Phase I Testing Results for the Olympia Harbor Project.**

| Analyte | TEF | S13 | | | S13 (duplicate) | | | S14 | | | S15 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | **0.699** | | **0.699** | **0.744** | | **0.744** | 0.136 | U | 0.068 | 0.066 | U | 0.033 |
| 1,2,3,7,8-PeCDD | 1 | **3.47** | | **3.47** | **3.11** | | **3.11** | 0.117 | UE | 0.0585 | 0.088 | U | 0.044 |
| 1,2,3,4,7,8-HxCDD | 0.1 | **5.43** | | **0.543** | **4.8** | | **0.48** | 0.126 | U | 0.0063 | 0.099 | U | 0.00495 |
| 1,2,3,6,7,8-HxCDD | 0.1 | **37.2** | | **3.72** | **33.3** | | **3.33** | **0.416** | J | **0.0416** | 0.109 | U | 0.00545 |
| 1,2,3,7,8,9-HxCDD | 0.1 | **12.9** | | **1.29** | **11.2** | | **1.12** | **0.233** | J | **0.0233** | 0.099 | U | 0.00495 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | **619** | | **6.19** | **593** | | **5.93** | **7.49** | | **0.0749** | **0.729** | J | **0.00729** |
| OCDD | 0.0001 | **3600** | | **0.36** | **3310** | | **0.331** | **48.3** | | **0.00483** | **10.4** | | 0.00104 |
| 2.3.7.8-TCDF | 0.1 | **2.76** | | **0.276** | **2.73** | | **0.273** | 0.15 | UE | 0.0075 | 0.068 | U | 0.0034 |
| 1,2,3,7,8-PeCDF | 0.05 | **2.77** | | **0.1385** | **2.64** | | **0.132** | 0.161 | U | 0.004025 | 0.083 | U | 0.002075 |
| 2,3,4,7,8-PeCDF | 0.5 | **5.75** | | **2.875** | **5.49** | | **2.745** | **0.323** | J | **0.1615** | 0.075 | U | 0.01875 |
| 1,2,3,4,7,8-HxCDF | 0.1 | **11.5** | | **1.15** | **10** | | **1** | **0.468** | J | **0.0468** | 0.079 | U | 0.00395 |
| 1,2,3,6,7,8-HxCDF | 0.1 | **6.64** | | **0.664** | **5.83** | | **0.583** | **0.304** | J | **0.0304** | 0.038 | U | 0.0019 |
| 2,3,4,6,7,8-HxCDF | 0.1 | **10.2** | | **1.02** | **9.33** | | **0.933** | **0.299** | J | **0.0299** | 0.036 | U | 0.0018 |
| 1,2,3,7,8,9-HxCDF | 0.1 | **2.71** | | **0.271** | **2.56** | | **0.256** | 0.081 | U | 0.00405 | 0.04 | U | 0.002 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | **192** | | **1.92** | **158** | | **1.58** | **17.2** | | **0.172** | **0.057** | J | **0.00057** |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | **6.85** | | **0.0685** | **6.15** | | **0.0615** | 0.147 | U | 0.000735 | 0.043 | U | 0.000215 |
| OCDF | 0.0001 | **252** | | **0.0252** | **235** | | **0.0235** | **10.4** | | **0.00104** | 0.158 | UE | 0.0000079 |
| **Total TEQ (u = 1/2):** | | | | **24.6802** | | | **22.632** | | | **0.7354** | | | **0.1353** |
| **Total TEQ (u = 0):** | | | | **24.6802** | | | **22.632** | | | **0.5863** | | | **0.0089** |
| **Total TOC, %:** | | | | **4.25** | | | | | | **0.64** | | | **0.75** |

| Analyte | TEF | C1 | | | C2 | | | C3 | | | C4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | **TEQ** |
| 2,3,7,8-TCDD | 1 | **0.806** | | **0.806** | **0.543** | | **0.543** | **0.717** | | **0.717** | **0.558** | | **0.558** |
| 1,2,3,7,8-PeCDD | 1 | **2.51** | | **2.51** | **1.71** | J | **1.71** | **2.64** | | **2.64** | **1.97** | J | **1.97** |
| 1,2,3,4,7,8-HxCDD | 0.1 | **3.22** | | **0.322** | **2.13** | J | **0.213** | **3.8** | | **0.38** | **3.42** | | **0.342** |
| 1,2,3,6,7,8-HxCDD | 0.1 | **18.6** | | **1.86** | **11.2** | | **1.12** | **21.7** | | **2.17** | **17.9** | J | **1.79** |
| 1,2,3,7,8,9-HxCDD | 0.1 | **7.11** | | **0.711** | **3.8** | | **0.38** | **8.27** | | **0.827** | **7.25** | | **0.725** |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | **323** | | **3.23** | **170** | | **1.7** | **401** | | **4.01** | **365** | | **3.65** |
| OCDD | 0.0001 | **1830** | | **0.183** | **886** | | **0.0886** | **2390** | | **0.239** | **2320** | | **0.232** |
| 2.3.7.8-TCDF | 0.1 | **3.01** | | **0.301** | **2.02** | | **0.202** | **2.58** | | **0.258** | **1.75** | | **0.175** |
| 1,2,3,7,8-PeCDF | 0.05 | **2.61** | | **0.1305** | **1.7** | J | **0.085** | **2.57** | | **0.1285** | **2** | J | **0.1** |
| 2,3,4,7,8-PeCDF | 0.5 | **7.15** | | **3.575** | **4.61** | | **2.305** | **6.28** | | **3.14** | **4.29** | | **2.145** |
| 1,2,3,4,7,8-HxCDF | 0.1 | **12.3** | | **1.23** | **7.59** | | **0.759** | **12.2** | | **1.22** | **9.05** | | **0.905** |
| 1,2,3,6,7,8-HxCDF | 0.1 | **4.87** | | **0.487** | **5.27** | | **0.527** | **4.83** | | **0.483** | **4.17** | | **0.417** |
| 2,3,4,6,7,8-HxCDF | 0.1 | **7.51** | | **0.751** | **4.17** | | **0.417** | **7.22** | | **0.722** | **5.65** | | **0.565** |
| 1,2,3,7,8,9-HxCDF | 0.1 | **0.769** | J | **0.0769** | **0.313** | J | **0.0313** | **2.95** | | **0.295** | **1.87** | J | **0.187** |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | **146** | | **1.46** | **67.8** | | **0.678** | **150** | | **1.5** | **131** | | **1.31** |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | **5.45** | | **0.0545** | **2.76** | | **0.0276** | **5.78** | | **0.0578** | **4.64** | | **0.0464** |
| OCDF | 0.0001 | **223** | | **0.0223** | **96.4** | | **0.00964** | **215** | | **0.0215** | **199** | | **0.0199** |
| **Total TEQ (u = 1/2):** | | | | **17.710** | | | **10.796** | | | **18.809** | | | **15.137** |
| **Total TEQ (u = 0):** | | | | **17.710** | | | **10.796** | | | **18.809** | | | **15.137** |
| **Total TOC, %:** | | | | **3.09** | | | **2.54** | | | **3.09** | | | **2.28** |

**LQ = lab qualifier code**
U = undetected at the specified method detection limit
UE = Nondetected at the associated value due to possible chemical interference
J = Associated value is considered an estimate due to concentration less than verifiable linear concentration range
JE = Associated value is considered an estimate due to concentration greater than verifiable linear concentration range
Analytical Method = U.S. EPA Method 1613B
* Undetected Congeners were summed in TEQ by dividing the DL by 2 and multiplying by TEF

**Table 4b. Validated Dioxin/Furan Results for Phase II Archived Samples for the Olympia Harbor Project.**

| Analyte | TEF | S24 | | | S25 | | | S26 | | | S26 (dup) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.175 | J | 0.175 | 0.15 | U | 0.075 | 0.153 | U | 0.0765 | 1.85 | U | 0.925 |
| 1,2,3,7,8-PeCDD | 1 | 0.256 | J | 0.256 | 0.117 | U | 0.0585 | 0.165 | U | 0.0825 | 1.31 | U | 0.655 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 0.347 | U | 0.0347 | 0.456 | U | 0.0228 | 0.206 | U | 0.0103 | 2.36 | U | 0.118 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 3.04 | | 0.304 | 1.58 | J | 0.158 | 0.218 | U | 0.0109 | 2.51 | U | 0.1255 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 0.901 | J | 0.0901 | 0.431 | U | 0.02155 | 0.222 | J | 0.0222 | 3.19 | U | 0.1595 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 77.4 | | 0.774 | 40.8 | | 0.408 | 2.32 | J | 0.0232 | 46.3 | | 0.463 |
| OCDD | 0.0001 | 585 | | 0.0585 | 313 | | 0.0313 | 31.1 | | 0.00311 | 714 | | 0.0714 |
| 2.3.7.8-TCDF | 0.1 | 0.309 | JN | 0.0309 | 0.124 | U | 0.0062 | 0.103 | U | 0.00515 | 0.78 | U | 0.039 |
| 1,2,3,7,8-PeCDF | 0.05 | 0.432 | J | 0.0216 | 0.207 | U | 0.005175 | 0.106 | U | 0.00265 | 1.3 | U | 0.0325 |
| 2,3,4,7,8-PeCDF | 0.5 | 2.08 | J | 1.04 | 0.816 | J | 0.408 | 0.1 | U | 0.025 | 1.21 | U | 0.3025 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 4.92 | | 0.492 | 2.03 | J | 0.203 | 0.039 | U | 0.00195 | 0.58 | U | 0.029 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 1.28 | J | 0.128 | 0.548 | J | 0.0548 | 0.037 | U | 0.00185 | 0.524 | U | 0.0262 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 1.88 | J | 0.188 | 0.8 | J | 0.08 | 0.039 | U | 0.00195 | 0.565 | U | 0.02825 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 0.946 | J | 0.0946 | 0.386 | J | 0.0386 | 0.058 | U | 0.0029 | 0.817 | U | 0.04085 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 84.9 | | 0.849 | 43 | | 0.43 | 0.093 | U | 0.000465 | 1.06 | U | 0.0053 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 2.45 | J | 0.0245 | 1.08 | J | 0.0108 | 0.114 | U | 0.00057 | 0.63 | U | 0.00315 |
| OCDF | 0.0001 | 132 | | 0.0132 | 67.1 | | 0.00671 | 0.237 | U | 0.00001185 | 1.74 | U | 0.000087 |
| Total TEQ (u = 1/2): | | | | 4.5741 | | | 2.018 | | | 0.271 | | | 3.024 |
| Total TEQ (u = 0): | | | | 4.5741 | | | 2.018 | | | 0.049 | | | 0.534 |
| Total TOC, %: | | | | 0.35 | | | NA | | | NA | | | NA |

| Analyte | TEF | S23 | | | S22 | | | S21 | | | S20 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.934 | | 0.934 | 0.809 | | 0.809 | 0.681 | | 0.681 | 0.636 | U | 0.318 |
| 1,2,3,7,8-PeCDD | 1 | 3.26 | | 3.26 | 2.59 | | 2.59 | 2.44 | J | 2.44 | 3 | | 3 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 4.9 | | 0.49 | 2.9 | | 0.29 | 2.78 | | 0.278 | 4.19 | | 0.419 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 24.7 | | 2.47 | 19.1 | | 1.91 | 14.8 | | 1.48 | 20.7 | | 2.07 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 9.51 | | 0.951 | 6.31 | | 0.631 | 6.1 | | 0.61 | 8.89 | | 0.889 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 406 | | 4.06 | 289 | | 2.89 | 264 | | 2.64 | 365 | | 3.65 |
| OCDD | 0.0001 | 1940 | | 0.194 | 1590 | | 0.159 | 1530 | | 0.153 | 2000 | | 0.2 |
| 2.3.7.8-TCDF | 0.1 | 3.32 | | 0.332 | 3.22 | | 0.322 | 2.48 | | 0.248 | 2.95 | | 0.295 |
| 1,2,3,7,8-PeCDF | 0.05 | 3.21 | | 0.1605 | 2.59 | | 0.1295 | 2.14 | J | 0.107 | 2.92 | | 0.146 |
| 2,3,4,7,8-PeCDF | 0.5 | 8.42 | | 4.21 | 6.98 | | 3.49 | 5.94 | | 2.97 | 7.46 | | 3.73 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 16.4 | | 1.64 | 9.93 | | 0.993 | 9.85 | | 0.985 | 13.6 | | 1.36 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 6.3 | | 0.63 | 4.45 | | 0.445 | 3.92 | | 0.392 | 5.38 | | 0.538 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 9.38 | | 0.938 | 6.72 | | 0.672 | 5.92 | | 0.592 | 7.2 | | 0.72 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 3.56 | | 0.356 | 2.59 | | 0.259 | 2.03 | J | 0.203 | 2.8 | | 0.28 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 142 | JD | 1.42 | 127 | | 1.27 | 144 | | 1.44 | 149 | | 1.49 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 7.99 | | 0.0799 | 4.63 | | 0.0463 | 4.45 | | 0.0445 | 6.13 | | 0.0613 |
| OCDF | 0.0001 | 298 | | 0.0298 | 169 | | 0.0169 | 200 | | 0.02 | 244 | | 0.0244 |
| Total TEQ (u = 1/2): | | | | 22.155 | | | 16.923 | | | 15.284 | | | 19.191 |
| Total TEQ (u = 0): | | | | 22.155 | | | 16.923 | | | 15.284 | | | 18.873 |
| Total TOC, %: | | | | 3.09 | | | 3.09 | | | 2.54 | | | 2.54 |

| Analyte | TEF | S19 | | | S18 | | | S29 | | | S28 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.841 | | 0.841 | 0.75 | | 0.75 | 1.1 | | 1.1 | 0.238 | U | 0.119 |
| 1,2,3,7,8-PeCDD | 1 | 3.68 | | 3.68 | 3.29 | | 3.29 | 4.78 | | 4.78 | 0.884 | J | 0.884 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 6.19 | | 0.619 | 5.43 | | 0.543 | 7.92 | | 0.792 | 1.24 | J | 0.124 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 39 | | 3.9 | 32.1 | | 3.21 | 41 | | 4.1 | 6.27 | | 0.627 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 15.8 | | 1.58 | 12.6 | | 1.26 | 16.7 | | 1.67 | 2.35 | J | 0.235 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 806 | | 8.06 | 647 | | 6.47 | 833 | | 8.33 | 103 | | 1.03 |
| OCDD | 0.0001 | 5170 | | 0.517 | 4080 | | 0.408 | 5180 | | 0.518 | 556 | | 0.0556 |
| 2.3.7.8-TCDF | 0.1 | 3.36 | | 0.336 | 2.65 | | 0.265 | 4.37 | | 0.437 | 0.949 | | 0.0949 |
| 1,2,3,7,8-PeCDF | 0.05 | 3.66 | | 0.183 | 3.14 | | 0.157 | 4.35 | | 0.2175 | 0.805 | J | 0.04025 |
| 2,3,4,7,8-PeCDF | 0.5 | 8.16 | | 4.08 | 7.11 | | 3.555 | 10.8 | | 5.4 | 1.86 | J | 0.93 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 18.1 | | 1.81 | 16.2 | | 1.62 | 25.2 | | 2.52 | 3.39 | | 0.339 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 7.69 | | 0.769 | 6.18 | | 0.618 | 9.99 | | 0.999 | 1.41 | J | 0.141 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 10.5 | | 1.05 | 9.21 | | 0.921 | 14.1 | | 1.41 | 2.17 | J | 0.217 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 3.86 | | 0.386 | 3.56 | | 0.356 | 4.58 | | 0.458 | 0.811 | J | 0.0811 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 280 | | 2.8 | 209 | | 2.09 | 330 | | 3.3 | 38.4 | | 0.384 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 9.01 | | 0.0901 | 8.38 | | 0.0838 | 12 | | 0.12 | 1.45 | J | 0.0145 |
| OCDF | 0.0001 | 413 | | 0.0413 | 357 | | 0.0357 | 647 | | 0.0647 | 61.2 | | 0.00612 |
| Total TEQ (u = 1/2): | | | | 30.742 | | | 25.6 | | | 36.2 | | | 5.322 |
| Total TEQ (u = 0): | | | | 30.742 | | | 25.6 | | | 36.2 | | | 5.203 |
| Total TOC, %: | | | | 3.09 | | | 3.09 | | | 2.28 | | | 2.28 |

**Table 4b. Validated Dioxin/Furan Results for Phase II Archived Samples for the Olympia Harbor Project.**

| Analyte | TEF | S16 | | | S17 | | | S17 dup | | | SZ5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.215 | J | 0.215 | 0.091 | U | 0.0455 | 0.074 | U | 0.037 | 0.08 | U | 0.04 |
| 1,2,3,7,8-PeCDD | 1 | 0.44 | J | 0.44 | 0.117 | U | 0.0585 | 0.092 | U | 0.046 | 0.115 | U | 0.0575 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 0.248 | J | 0.0248 | 0.102 | U | 0.0051 | 0.066 | U | 0.0033 | 0.16 | J | 0.016 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 0.739 | J | 0.0739 | 0.106 | U | 0.0053 | 0.132 | J | 0.0132 | 0.709 | J | 0.0709 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 0.458 | J | 0.0458 | 0.099 | U | 0.00495 | 0.109 | J | 0.0109 | 0.411 | J | 0.0411 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 6.04 | | 0.0604 | 1.33 | J | 0.0133 | 1.43 | J | 0.0143 | 15.9 | | 0.159 |
| OCDD | 0.0001 | 23.2 | | 0.00232 | 8.34 | | 0.000834 | 11.3 | | 0.00113 | 115 | | 0.0115 |
| 2.3.7.8-TCDF | 0.1 | 0.749 | JN | 0.0749 | 0.043 | U | 0.00215 | 0.052 | U | 0.0026 | 0.09 | U | 0.0045 |
| 1,2,3,7,8-PeCDF | 0.05 | 0.419 | J | 0.02095 | 0.084 | U | 0.0021 | 0.082 | U | 0.00205 | 0.113 | U | 0.002825 |
| 2,3,4,7,8-PeCDF | 0.5 | 0.869 | J | 0.4345 | 0.078 | U | 0.0195 | 0.073 | U | 0.01825 | 0.253 | J | 0.1265 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 0.407 | J | 0.0407 | 0.03 | U | 0.0015 | 0.022 | U | 0.0011 | 0.582 | J | 0.0582 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 0.4 | J | 0.04 | 0.029 | U | 0.00145 | 0.019 | U | 0.00095 | 0.216 | J | 0.0216 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 0.512 | J | 0.0512 | 0.033 | U | 0.00165 | 0.022 | U | 0.0011 | 0.302 | J | 0.0302 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 0.096 | U | 0.0048 | 0.047 | U | 0.00235 | 0.034 | U | 0.0017 | 0.116 | J | 0.0116 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 8.73 | | 0.0873 | 0.392 | J | 0.00392 | 0.463 | J | 0.00463 | 7.56 | | 0.0756 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 0.181 | J | 0.00181 | 0.042 | U | 0.00021 | 0.043 | U | 0.000215 | 0.291 | J | 0.00291 |
| OCDF | 0.0001 | 4.92 | | 0.000492 | 0.566 | J | 5.7E-05 | 0.586 | J | 0.0000586 | 14.9 | | 0.00149 |
| Total TEQ (u = 1/2): | | | | 1.619 | | | 0.1684 | | | 0.1585 | | | 0.7314 |
| Total TEQ (u = 0): | | | | 1.614 | | | 0.0181 | | | 0.0442 | | | 0.6266 |
| Total TOC, %: | | | | NA | | | NA | | | NA | | | NA |

| Analyte | TEF | SZ6 | | | SZ7 | | | SZ8 | | | SZ9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.222 | J | 0.418 | 0.075 | U | 0.0375 | 0.079 | U | 0.0395 | 0.055 | U | 0.0275 |
| 1,2,3,7,8-PeCDD | 1 | 0.418 | J | 0.263 | 0.084 | U | 0.042 | 0.094 | U | 0.047 | 0.19 | J | 0.19 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 0.263 | U | 0.01315 | 0.083 | U | 0.00415 | 0.166 | U | 0.0083 | 0.314 | J | 0.0314 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 0.816 | J | 0.0466 | 0.192 | U | 0.0096 | 0.423 | J | 0.0423 | 1.62 | J | 0.162 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 0.466 | J | 0.776 | 0.152 | J | 0.0152 | 0.216 | J | 0.0216 | 0.594 | J | 0.0594 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 7.76 | | 0.368 | 3.03 | | 0.0303 | 6.51 | | 0.0651 | 32.6 | | 0.326 |
| OCDD | 0.0001 | 36.8 | | 0.000079 | 23.1 | | 0.00231 | 42.6 | | 0.00426 | 235 | | 0.0235 |
| 2.3.7.8-TCDF | 0.1 | 0.79 | JN | 0.0474 | 0.048 | U | 0.0024 | 0.069 | U | 0.00345 | 0.174 | JN | 0.0174 |
| 1,2,3,7,8-PeCDF | 0.05 | 0.474 | J | 0.056 | 0.078 | U | 0.00195 | 0.0751 | U | 0.0018775 | 0.196 | J | 0.0098 |
| 2,3,4,7,8-PeCDF | 0.5 | 1.12 | J | 0.2775 | 0.071 | U | 0.01775 | 0.125 | J | 0.0625 | 0.502 | J | 0.251 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 0.555 | J | 0.0505 | 0.068 | U | 0.0034 | 0.181 | J | 0.0181 | 0.944 | J | 0.0944 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 0.505 | J | 0.0721 | 0.029 | U | 0.00145 | 0.113 | J | 0.0113 | 0.411 | J | 0.0411 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 0.721 | J | 0.0142 | 0.033 | U | 0.00165 | 0.15 | J | 0.015 | 0.61 | J | 0.061 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 0.142 | J | 3.46 | 0.046 | U | 0.0023 | 0.04 | U | 0.002 | 0.221 | J | 0.0221 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 34.6 | | 0.00195 | 0.891 | J | 0.00891 | 2.47 | J | 0.0247 | 17.4 | | 0.174 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 0.195 | J | 0.134 | 0.041 | U | 0.000205 | 0.104 | J | 0.00104 | 0.42 | J | 0.0042 |
| OCDF | 0.0001 | 13.4 | | 0.0013 | 1.11 | J | 0.000111 | 3.05 | J | 0.000305 | 21.9 | | 0.00219 |
| Total TEQ (u = 1/2): | | | | 6.000 | | | 0.1812 | | | 0.3683 | | | 1.497 |
| Total TEQ (u = 0): | | | | 5.987 | | | 0.0416 | | | 0.2011 | | | 1.469 |
| Total TOC, %: | | | | 0.041631 | | | NA | | | NA | | | 2.4 |

| Analyte | TEF | SZ10 | | | SZ11B | | | SZ12B | | | Z13B | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ | ng/kg-dw | LQ | TEQ |
| 2,3,7,8-TCDD | 1 | 0.289 | J | 0.289 | 0.17 | J | 0.17 | 0.079 | U | 0.0395 | 0.065 | U | 0.0325 |
| 1,2,3,7,8-PeCDD | 1 | 1.06 | J | 1.06 | 2.27 | J | 2.27 | 0.103 | U | 0.0515 | 0.086 | U | 0.043 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 1.5 | J | 0.15 | 0.391 | J | 0.0391 | 0.06 | U | 0.003 | 0.103 | U | 0.00515 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 7.39 | | 0.739 | 0.944 | J | 0.0944 | 0.075 | U | 0.00375 | 0.114 | U | 0.0057 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 2.99 | | 0.299 | 2.51 | | 0.251 | 0.066 | U | 0.0033 | 0.11 | U | 0.0055 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | 165 | | 1.65 | 8.86 | | 0.0886 | 0.373 | J | 0.00373 | 1.1 | J | 0.011 |
| OCDD | 0.0001 | 985 | | 0.0985 | 60.8 | | 0.00608 | 3.08 | J | 0.000308 | 7.85 | | 0.000785 |
| 2.3.7.8-TCDF | 0.1 | 0.988 | JN | 0.0988 | 0.819 | JN | 0.0819 | 0.052 | U | 0.0026 | 0.086 | U | 0.0043 |
| 1,2,3,7,8-PeCDF | 0.05 | 1.21 | J | 0.0605 | 0.237 | U | 0.005925 | 0.086 | U | 0.00215 | 0.059 | U | 0.001475 |
| 2,3,4,7,8-PeCDF | 0.5 | 3.88 | | 1.94 | 0.274 | J | 0.137 | 0.075 | U | 0.01875 | 0.055 | U | 0.01375 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 9.34 | | 0.934 | 0.303 | J | 0.0303 | 0.101 | U | 0.00505 | 0.039 | U | 0.00195 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 2.65 | | 0.265 | 0.146 | J | 0.0146 | 0.093 | U | 0.00465 | 0.037 | U | 0.00185 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 4.05 | | 0.405 | 0.147 | J | 0.0147 | 0.03 | U | 0.0015 | 0.043 | U | 0.00215 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 1.63 | J | 0.163 | 0.072 | U | 0.0036 | 0.043 | U | 0.00215 | 0.059 | U | 0.00295 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | 105 | | 1.05 | 2.26 | J | 0.0226 | 0.039 | U | 0.000195 | 0.305 | J | 0.00305 |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 4.01 | | 0.0401 | 0.131 | J | 0.00131 | 0.045 | U | 0.000225 | 0.075 | U | 0.000375 |
| OCDF | 0.0001 | 201 | | 0.0201 | 5.43 | | 0.000543 | 0.124 | U | 0.0000062 | 0.499 | J | 0.0000499 |
| Total TEQ (u = 1/2): | | | | 9.262 | | | 3.232 | | | 0.1424 | | | 0.1355 |
| Total TEQ (u = 0): | | | | 9.262 | | | 3.222 | | | 0.0040 | | | 0.0173 |
| Total TOC, %: | | | | 1.7 | | | NA | | | NA | | | NA |

**Table 4b. Validated Dioxin/Furan Results for Phase II Archived Samples for the Olympia Harbor Project.**

| Analyte | TEF | SZ18B | | |
|---|---|---|---|---|
| | | **ng/kg-dw** | **LQ** | **TEQ** |
| 2,3,7,8-TCDD | 1 | 0.054 | U | 0.027 |
| 1,2,3,7,8-PeCDD | 1 | 0.088 | U | 0.044 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 0.049 | U | 0.00245 |
| 1,2,3,6,7,8-HxCDD | 0.1 | **0.147** | J | **0.0147** |
| 1,2,3,7,8,9-HxCDD | 0.1 | **0.163** | J | **0.0163** |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | **2.94** | | **0.0294** |
| OCDD | 0.0001 | **24.2** | | **0.00242** |
| 2.3.7.8-TCDF | 0.1 | 0.075 | U | 0.00375 |
| 1,2,3,7,8-PeCDF | 0.05 | 0.045 | U | 0.001125 |
| 2,3,4,7,8-PeCDF | 0.5 | 0.043 | U | 0.01075 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 0.039 | U | 0.00195 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 0.041 | U | 0.00205 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 0.044 | U | 0.0022 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 0.059 | U | 0.00295 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | **0.756** | J | **0.00756** |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | 0.049 | U | 0.000245 |
| OCDF | 0.0001 | **1.16** | **J** | **0.000116** |
| **Total TEQ (u = 1/2):** | | | | **0.1690** |
| **Total TEQ (u = 0):** | | | | **0.0705** |
| **Total TOC, %:** | | | | **NA** |

**NA = Not Analyzed**
**B = This Compound detected in the method blank;**
**U = undetected at the detection limit**
**J = The amount detected is below the lower claibration limit of the instrument;**
**JN =Associated value is considered an estimate due to concentration not verified confirmatory/second column**
*** Undetected Congeners were summed in TEQ by dividing the DL by 2 and multiplying by TEF**

# Table 5a. Olympia Harbor Navigation Project Phase 1 Sediment non-Dioxin Chemistry Results

| DMMU Location Number | | | 4a (0-4 ft) | | 4b (4-13 ft) | | 9a + 10a (0-4 ft) | | 9b (2-3 ft) | | 10b (2-3 ft) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station Number | | | S4 | | S24 | | C3 | | Z9 | | Z10 | | | |
| Lab Number | DMMP | DMMP | | | | | | | | | | | | |
| Collection Date | SL | ML | 03/08/2006 | LQ VQ | 03/08/2006 | LQ VQ | 03/08/2006 | LQ VQ | 03/08/2006 | LV VQ | 03/08/2006 | LQ VQ | Mean | %RSD |
| **Conventionals** | | | | | | | | | | | | | | |
| Total Organic Carbon (% DW) | – | – | 2.67 | | 0.35 | | 3.09 | | 2.4 | | 1.7 | | 2.0 | 52.5% |
| Total Sulfides (mg/kg DW) | – | – | 575 | | 16.9 | | 650 | | 172 | | 45.1 | | 291.8 | 102.7% |
| Ammonia (mg-N/kg DW) | – | – | 195 | | 19.2 | | 90 | | 147 | | 113 | | 112.8 | 58.1% |
| TVS (%) | – | – | 7.75 | | 1.5 | | 9.76 | | 7.48 | | 5.49 | | 6.4 | 48.9% |
| Total Solids (%) | – | – | 46.9 | | 84.5 | | 37.1 | | 45.3 | | 51.9 | | 53.1 | 34.5% |
| Grain Size | | | | | | | | | | | | | | |
| Percent Gravel (>2.0 mm) | – | – | 4.26 | | 51 | | 0 | | 0.38 | | 2.04 | | 11.5 | 191.8% |
| Percent Sand (<2.0 mm - 0.06 mm) | – | – | 31.63 | | 43.97 | | 10.9 | | 11.31 | | 30.61 | | 25.7 | 55.7% |
| Percent Silt (0.06 mm - 0.004 mm) | – | – | 36.33 | | 4.98 | | 50.4 | | 57.1 | | 44.17 | | 38.6 | 52.6% |
| Percent Fines (<0.06 mm) | – | – | 66.18 | | 8.13 | | 89.95 | | 90.72 | | 65.98 | | 64.2 | 52.4% |
| Percent Clay (<0.004 mm) | – | – | 29.85 | | 3.15 | | 39.55 | | 33.62 | | 21.81 | | 25.6 | 55.1% |
| **LPAH in ug/kg DW** | | | | | | | | | | | | | | |
| Naphthalene | 2100 | 2400 | 91 | | 35 | | 16 | | 37 | | 23 | | 40.4 | 73.2% |
| Acenaphthylene | 560 | 1300 | 15 | | 4.5 | J | 16 | | 11 | | 6.4 | | 10.6 | 48.1% |
| Acenaphthene | 500 | 2000 | 94 | | 39 | | 16 | | 8.4 | | **3.3** | J | 32.1 | 115.7% |
| Fluorene | 540 | 3600 | 93 | | 38 | | 24 | | 16 | | 5.3 | | 35.3 | 97.6% |
| Phenanthrene | 1500 | 21000 | 310 | | 120 | | 320 | | 58 | | 23 | | 166.2 | 84.4% |
| Anthracene | 960 | 13000 | 100 | | 35 | | 36 | | 23 | | 11 | | 41.0 | 84.2% |
| 2-Methylnaphthalene | 670 | 1900 | 21 | | 10 | | 4.8 | J | 11 | | 4.3 | J | 10.2 | 65.9% |
| Total LPAH* | 5200 | 29000 | 724 | | 281.5 | | 432.8 | | 164.4 | | 76.3 | | 335.8 | 75.9% |
| **HPAH in ug/kg DW** | | | | | | | | | | | | | | |
| Fluoranthene | 1700 | 30000 | 540 | | 200 | | 450 | | 62 | | 31 | | 256.6 | 89.2% |
| Pyrene | 2600 | 16000 | 470 | | 170 | | 370 | | 90 | | 42 | | 228.4 | 80.7% |
| Benzo(a)anthracene | 1300 | 5100 | 170 | | 56 | | 73 | | 28 | | 15 | | 68.4 | 89.5% |
| Chrysene | 1400 | 21000 | 260 | | 82 | | 170 | | 36 | | 24 | | 114.4 | 87.0% |
| Benzofluoranthenes* | 3200 | 9900 | 260 | | 70 | | 160 | | 63 | | 22 | | 115.0 | 83.0% |
| Benzo(a)pyrene | 1600 | 3600 | 120 | | 31 | | 63 | | 30 | | 10 | | 50.8 | 84.8% |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 64 | | 17 | | 41 | | 21 | | 6.7 | | 29.9 | 76.0% |
| Dibenz(a,h)anthracene | 230 | 1900 | 16 | | 3.2 | J | 9.2 | | 4.0 | J | 1.3 | J | 6.7 | 88.2% |
| Benzo(g,h,i)perylene | 670 | 3200 | 63 | | 17 | | 41 | | 21 | | 9.6 | | 30.3 | 71.4% |
| Total HPAH* | 12000 | 69000 | 1963 | | 646.2 | | 1377.2 | | 355 | | 161.6 | | 900.6 | 83.5% |

## Table 5b. TOC Normalized - Olympia Harbor Navigation Project Phase 1 Sediment non-Dioxin Chemistry Results

| DMMU Location Number | | | 4a (0-4 ft) | | | 4b (4-13 ft) | | | 9a + 10a (0-4 ft) | | | 9b (2-3 ft) | | | 10b (2-3 ft) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station Number | WA SMS | WA SMS | S4 | | | S24 | | | C3 | | | Z9 | | | Z10 | | |
| Lab Number | Chem | Max Chm | | | | | | | | | | | | | | | |
| Collection Date | Criteria | Criteria | 03/08/2006 | LQ | VQ | 03/08/2006 | LQ | VQ | 03/08/2006 | LQ | VQ | 03/08/2006 | LQ | VQ | 03/08/2006 | LQ | VQ |
| **Conventionals** | | | | | | | | | | | | | | | | | |
| Total Organic Carbon (% DW) | – | – | 2.67 | | | 0.35 | | | 3.09 | | | 2.67 | | | 0.35 | | |
| Total Sulfides (mg/kg DW) | – | – | 575 | | | 16.9 | | | 650 | | | 575 | | | 16.9 | | |
| Ammonia (mg-N/kg DW) | – | – | 195 | | | 19.2 | | | 90 | | | 195 | | | 19.2 | | |
| TVS (%) | – | – | 7.75 | | | 1.5 | | | 9.76 | | | 7.75 | | | 1.5 | | |
| Total Solids (%) | – | – | 46.9 | | | 84.5 | | | 37.1 | | | 46.9 | | | 84.5 | | |
| Grain Size | | | | | | | | | | | | | | | | | |
| Percent Gravel (>2.0 mm) | – | – | 4.26 | | | 51 | | | 0 | | | 4.26 | | | 51 | | |
| Percent Sand (<2.0 mm - 0.06 mm) | – | – | 31.63 | | | 43.97 | | | 10.9 | | | 31.63 | | | 43.97 | | |
| Percent Silt (0.06 mm - 0.004 mm) | – | – | 36.33 | | | 4.98 | | | 50.4 | | | 36.33 | | | 4.98 | | |
| Percent Fines (<0.06 mm) | – | – | 66.18 | | | 8.13 | | | 89.95 | | | 66.18 | | | 8.13 | | |
| Percent Clay (<0.004 mm) | – | – | 29.85 | | | 3.15 | | | 39.55 | | | 29.85 | | | 3.15 | | |
| **LPAH in mg/kg TOC** | | | | | | | | | | | | | | | | | |
| Naphthalene | 99 | 170 | 3.41 | | | 10.00 | | | 0.52 | | | 1.54 | | | 1.35 | | |
| Acenaphthylene | 66 | 66 | 0.56 | J | | 1.29 | | | 0.52 | | | 0.46 | | | 0.38 | | |
| Acenaphthene | 16 | 57 | 3.52 | | | 11.14 | | | 0.52 | | | 0.35 | | | 0.19 | J | |
| Fluorene | 23 | 79 | 3.48 | | | 10.86 | | | 0.78 | | | 0.67 | | | 0.31 | | |
| Phenanthrene | 100 | 480 | 11.61 | | | 34.29 | | | 10.36 | | | 2.42 | | | 1.35 | | |
| Anthracene | 220 | 1200 | 3.75 | | | 10.00 | | | 1.17 | | | 0.96 | | | 0.65 | | |
| 2-Methylnaphthalene | 38 | 64 | 0.79 | | | 2.86 | J | | 0.16 | | | 0.46 | | | 0.25 | J | |
| Total LPAH* | 370 | 780 | 27.12 | | | 80.43 | | | 14.01 | | | 6.85 | | | 4.49 | | |
| **HPAH in mg/kg TOC** | | | | | | | | | | | | | | | | | |
| Fluoranthene | 160 | 1200 | 20.22 | | | 57.14 | | | 14.56 | | | 2.58 | | | 1.82 | | |
| Pyrene | 1000 | 1400 | 17.60 | | | 48.57 | | | 11.97 | | | 3.75 | | | 2.47 | | |
| Benzo(a)anthracene | 110 | 270 | 6.37 | | | 16.00 | | | 2.36 | | | 1.17 | | | 0.88 | | |
| Chrysene | 110 | 460 | 9.74 | | | 23.43 | | | 5.50 | | | 1.50 | | | 1.41 | | |
| Benzofluoranthenes* | 230 | 450 | 9.74 | | | 20.00 | | | 5.18 | | | 2.63 | | | 1.29 | | |
| Benzo(a)pyrene | 99 | 210 | 4.49 | | | 8.86 | | | 2.04 | | | 1.25 | | | 0.59 | | |
| Indeno(1,2,3-cd)pyrene | 34 | 88 | 2.40 | | | 4.86 | | | 1.33 | | | 0.88 | | | 0.39 | | |
| Dibenz(a,h)anthracene | 12 | 33 | 0.60 | J | | 0.91 | | | 0.30 | | | 0.17 | | | 0.08 | J | |
| Benzo(g,h,i)perylene | 31 | 78 | 2.36 | | | 4.86 | | | 1.33 | | | 0.88 | | | 0.56 | | |
| Total HPAH* | 960 | 5300 | 73.52 | | | 184.63 | | | 44.57 | | | 14.79 | | | 9.51 | | |

**Table 6. Tier 1 Dioxin Analysis Summary for the Olympia Harbor Project***

| 2006 Location ID | 2006 DMMU ID | 1999 DMMU ID | Depth (ft) | Volume (cy) | Phase 1: Initial Dioxin/Furan pptr, TEQ | Phase 2: Supplemental Dioxin/Furan pptr, TEQ | Phase 2: Z-Sample Dioxin/Furan pptr, TEQ |
|---|---|---|---|---|---|---|---|
| 1a | S1 | B1 | 0-4 | 7,547 | S1 =1.89 | | |
| 1b | S27 | B2 | 4-9 | 3,674 | Archive | Not analyzed (BPJ) | Not Analyzed (BPJ) |
| 2a | S2 | B1 | 0-4 | 11,643 | S2 = 52.3 | | |
| 2b | S26 | B2 | 4-10 | 6,752 | Archive | S26 = 0.271, 3.024 | Not Analyzed (BPJ) |
| 3a | S3 | B1 | 0-4 | 8,310 | S3 = 37.4 | | |
| 3b | S25 | B2 | 4-10 | 5,898 | Archive | S25 = 2.018 | Not Analyzed (BPJ) |
| 4a | S4 | B1 | 0-4 | 8,403 | S4 = 52.6 | | |
| 4b | S24 | B2 | 4-13 | 9,264 | Archive | S24 = 4.574 | Not Analyzed (BPJ) |
| 5a | C1 / S23 | MC1 | 0-4 | 26,079 | C1 = 17.7 | S23 = 22.2 | |
| 6a | C1 / S22 | MC2 | 0-4 | 29,434 | | S22 = 16.9 | |
| 5b | SZ5 | MC8 | Z: 4-5 | 4,144 | | | SZ5 =0.73 |
| 6b | SZ6 | MC8 | Z: 4-5 | 2,599 | | | SZ6 = 6.0 |
| 7 | C2 / S21 | MC3 | 0-2; Z: 2-3 | 25,277 | C2 = 10.8 | S21 = 15.3 | SZ7 = 0.18 |
| 8 | C2 / S20 | MC4 | 0-2; Z: 2-3 | 21,716 | | S20 = 19.2 | SZ8 = 0.37 |
| 9 | C3 / S19 | MC5 | 0-2; Z: 2-3 | 18,422 | C3 = 18.8 | S19 = 30.7 | SZ9 = 1.5 |
| 10 | C3 / S18 | MC5 | 0-2; Z: 2-3 | 29,062 | | S18 = 25.6 | SZ10 = 9.3 |
| 11a | C4 / S29 | TBW1 | 0-4 | 9,952 | C4 = 15.1 | S29 = 36.2 | SZ11 = 3.2 |
| 12a | C4 / S28 | TBW1 | 0-4 | 13,827 | | S28 = 5.32 | SZ12 = 0.14 |
| 11b | S16 | TBW2 | 4-8; Z: 8-9 | 13,926 | Archive | S16 = 1.62 | Not Analyzed (BPJ) |
| 12b | S17 | TBW2 | 4-17; Z: 17-18 | 27,864 | Archive | S17 = 0.17, 0.16 | Not Analyzed (BPJ) |
| 13 | S5 | MC6 | 0-4; Z: 4-5 | 20,774 | S5 = 31.2 | | SZ13 = 0.14 |
| 14a | S6 | MCW1 | 0-4 | 20,148 | S6 = 21.2 | | |
| 14b | S14 | MCW2 | 4-9; Z: 9-10 | 24,056 | S14 = 0.735 | | Not Analyzed (BPJ) |
| 15 | S7 | MC7 | 0-3; Z: 3-4 | 21,283 | S7 = 3.19 | | Not Analyzed (BPJ) |
| 16a | S8 | MCW1 | 0-4 | 21,584 | S8 = 0.118 | | |
| 16b | S15 | MCW2 | 4-19; Z: 19-20 | 31,771 | S15 = 0.135 | | Not Analyzed (BPJ) |
| 17 | S9 | OC1 | 0-3; Z: 3-4 | 18,359 | S9 = 6.92 | | Not Analyzed (BPJ) |
| 18 | S10 | OC2 | 0-3; Z: 3-4 | 9,014 | S10 = 32.3 | | SZ18 = 0.17 |
| 19 | S11 | OC3 | 0-4; Z: 4-5 | 7,952 | S11 = 6.4 | | Not Analyzed (BPJ) |
| 20 (BUP) | | | 0-10 cm | | S12 = 20 | | Not Collected |
| 21 (BUP) | | | 0-10 cm | | S13 = 24.7, 22.6 | | Not Collected |
| Total: | | | | 458,734 | | | |

BUP = potential beneficial use placement area; TEQ concentrations, ppt (u = 1/2 detection limit)

| | | |
|---|---|---|
| Volume Passing Tier 1: | 220,500 | 48.1% |
| Volume Failing Tier 1: | 238,234 | 51.9% |

* Regulatory Limit = 7.3 pptr TEQ

## Table 7. Tier 2 Weighted Mean Loading Calculations for Suitable Olympia Harbor Dredged Material

| DMMU Core ID | Depth, ft | Analysis ID* | 1999 DMMU ID | Volume (CY) | TCDD/F TEQ | ng/kg-dw | Product (Vol x TEQ) | ng x cy/kg x DMMU | Product/total | Loading contribution/Suitable DMMU |
|---|---|---|---|---|---|---|---|---|---|---|
| 1a | 0-4 | S1 | B1 | 7,547 | 1.89 | ng/kg-dw | 14,263.83 | ng x cy/kg | 0.0647 | ng/kg-dw/DMMU |
| 1b | 4-9 | S27 | B2 | 3,674 | NA[+] | ng/kg-dw | 6,943.86 | ng x cy/kg | 0.0315 | ng/kg-dw/DMMU |
| 2a | 0-4 | S2 | B1 | 11,643 | 52.3 | | 608,928.90 | | | |
| 2b | 4-10 | S26 | B2 | 6,752 | 0.271, 3.024 | ng/kg-dw | 11,123.92 | ng x cy/kg | 0.050 | ng/kg-dw/DMMU |
| 3a | 0-4 | S3 | B1 | 8,310 | 37.4 | | 310,794.00 | | | |
| 3b | 4-10 | S25 | B2 | 5,898 | 2.018 | ng/kg-dw | 11,902.16 | ng x cy/kg | 0.0540 | ng/kg-dw/DMMU |
| 4a | 0-4 | S4 | B1 | 8,403 | 52.6 | | 441,997.80 | | | |
| 4b | 4-13 | S24 | B2 | 9,264 | 4.574 | ng/kg-dw | 42,373.54 | ng x cy/kg | 0.1922 | ng/kg-dw/DMMU |
| 5a | 0-4 | C1 /S23 | MC1 | 26,079 | 22.2 (17.7) | | 578,953.80 | | | |
| 5b | Z: 4-5 | Z5 | MC8 | 4,144 | 0.73 | ng/kg-dw | 3,025.12 | ng x cy/kg | 0.0137 | ng/kg-dw/DMMU |
| 6a | 0-4 | C1 / S22 | MC2 | 29,434 | 16.9 (17.7) | | 653,434.80 | | | |
| 6b | Z: 4-5 | Z6 | MC8 | 2,599 | 6 | ng/kg-dw | 15,594.00 | ng x cy/kg | 0.0707 | ng/kg-dw/DMMU |
| 7 | 0-2 | C2 / S21 | MC3 | 25,277 | 15.3 (10.8) | | 386,738.10 | | | |
| 8 | 0-2 | C2 / S20 | MC4 | 21,716 | 19.2 (10.8) | | 416,947.20 | | | |
| 9 | 0-2 | C3 / S19 | MC5 | 18,422 | 30.7 (18.8) | | 565,555.40 | | | |
| 10 | 0-2 | C3 / S18 | MC5 | 29,062 | 25.6 (18.8) | | 743,987.20 | | | |
| 11a | 0-4 | C4 / S29 | TBW1 | 9,952 | 36.2 (15.1) | | 360,262.40 | | | |
| 12a | 0-4 | C4 / S28 | TBW1 | 13,827 | 5.32 (15.1) | ng/kg-dw | 73,559.64 | ng x cy/kg | 0.3336 | ng/kg-dw/DMMU |
| 11b | 4-8 | S16 | TBW2 | 13,926 | 1.62 | ng/kg-dw | 22,560.12 | ng x cy/kg | 0.1023 | ng/kg-dw/DMMU |
| 12b | 4-17 | S17 | TBW2 | 27,864 | 0.17, 0.16 | ng/kg-dw | 4,597.56 | ng x cy/kg | 0.0209 | ng/kg-dw/DMMU |
| 13 | 0-4 | S5 | MC6 | 20,774 | 31.2 | | 648,148.80 | | | |
| 14a | 0-4 | S6 | MCW1 | 20,148 | 21.2 | | 427,137.60 | | | |
| 14b | 4-9 | S14 | MCW2 | 24,056 | 0.735 | ng/kg-dw | 17,681.16 | ng x cy/kg | 0.0802 | ng/kg-dw/DMMU |
| 15 | 0-3 | S7 | MC7 (BU-partial*) | 21,283 | 3.19 | ng/kg-dw | 67,892.77 | ng x cy/kg | 0.3079 | ng/kg-dw/DMMU |
| 16a | 0-4 | S8 | MCW1 (BU) | 21,584 | 0.118 | ng/kg-dw | 2,546.91 | ng x cy/kg | 0.01155 | ng/kg-dw/DMMU |
| 16b | 4-19 | S15 | MCW2 (BU) | 31,771 | 0.135 | ng/kg-dw | 4,289.09 | ng x cy/kg | 0.0195 | ng/kg-dw/DMMU |
| 17 | 0-3 | S9 | OC1 | 18,359 | 6.92 | ng/kg-dw | 127,044.28 | ng x cy/kg | 0.5762 | ng/kg-dw/DMMU |
| 18 | 0-3 | S10 | OC2 | 9,014 | 32.3 | | 291,152.20 | | | |
| 19 | 0-4 | S11 | OC3 | 7,952 | 6.4 | ng/kg-dw | 50,892.80 | ng x cy/kg | 0.2308 | ng/kg-dw/DMMU |
| 20 (BUP) | 0-10 cm | S12 | | | 20 | | | | | |
| 21 (BUP) | 0-10 cm | S13 | | | 24.7 / 22.6 | | | | | |
| Totals (Suitable + Unsuitable): | | | | 458,734 | cy | | 6,910,328.96 | ng x cy/kg | 15.06 | ng/kg-dw/Project (Total Loading: S + U) |
| Total (Suitable): | | | | 220,500 | cy | | 476,290.76 | ng x cy/kg | 2.16 | ng/kg-dw/Project (Total Loading S only) |
| Total (Suitable - BU volume): | | | | 160,500 | cy | | 447,987.07 | ng x cy/kg | 2.79 | ng/kg-dw/Project (Loading S - BU) |
| Total BU Project: | | | | 60,000 | cy | | 28,032.12 | ng x cy/kg | 0.47 | ng/kg-dw/BU Project Material (Loading) |

**Tier 2 Comparison to Disposal Site Mean Concentration = 3.8 pptr TEQ**

*** Only uncomposited analysis results used in loading calculations; Green = Suitable; Red = Unsuitable**

BUP = potential beneficial use placement area

**+ not analyzed, surface concentration (1.89 ng/kg) used in loading calculation**

*** 6,645cy/21,283 cy = 0.3122 (proportion of total for BU)**

| | | | | |
|---|---|---|---|---|
| Suitable: | Port of Olympia | 33,135 | cy | 7.2% |
| Unsuitable: | Port of Olympia | 28,356 | cy | 6.2% |
| Suitable: | USACE | 187,365 | cy | 40.8% |
| Unsuitable: | USACE | 209,878 | cy | 45.8% |
| Totals: | | 458,734 | cy | 100% |

CENWS-OD-TS-DM

MEMORANDUM FOR RECORD 31 January 2006
(updated 11 July 2006)

**ATTACHMENT 1. SUBJECT: WHITE PAPER SUMMARY OF THE PREVIOUS PSDDA/DMMP TESTING FOR THE OLYMPIA HARBOR FEDERAL/PORT NAVIGATION PROJECT, EXISTING DATA GAPS AND DMMP CONSENSUS ON SUPLEMENTAL TESTING REQUIREMENTS.**

1. The purpose of this memorandum is to review the previous testing conducted for the Olympia Harbor Project, discuss the data gaps that have been recently identified by the Dredged Material Management Program (DMMP), and present the agencies' consensus determination on what testing will be required to complete the suitability determination for this joint Federal/Port dredging action.

2. The Olympia Harbor Navigation project underwent two rounds of testing in 1988, a Partial Characterization, for purposes of considering a down-ranking, followed by a Full Characterization for the 535,185 cy project. In 1999, the Olympia Harbor Navigation project was expanded to 624,000 cy with the inclusion of the Port of Olympia's berthing area and underwent another round of testing. The results of the 1988 and 1999 testing are described in more detail in Sections 3 and 4 below. The results of the 1999 characterization were subject to a DMMP review and Recency Extension during 2005. That review included a tier-1 review of all activities and sources in the project area that might affect sediment quality since the 1999 characterization. Based on available sediment quality data and information on circulation patterns in lower Budd Inlet, the DMMP agencies did not believe that was sufficient likelihood of dioxins/furans being present in the project area at levels of concern to warrant new sampling and testing. Subsequent to the Recency Extension the DMMP agencies were notified about dioxin concerns in the Olympia Harbor/Budd Inlet area and dioxin data resulting from the post-cleanup monitoring investigation at the Cascade Pole MTCA site. After reviewing these data the DMMP agencies determined that additional testing for dioxin would be required to evaluate this concern throughout the proposed project area. The concerns raised and the proposed sampling/testing approach recommended by the DMMP agencies are discussed below in Section 5.

3. <u>**Background/Summary: 1988 Testing Summary .**</u> The Olympia Harbor Navigation Project initially underwent Puget Sound Dredged Disposal Analysis (PSDDA) testing in 1988. Because the ranking for the Olympia Harbor in the Phase II Management Plan Report (**Table A.1,** page A-11) ranked this area High for testing purposes, the federal project manager elected to undergo a Partial Characterization (PC) (see Evaluation Procedures Technical Appendix, pages II-63 to II-65) to evaluate the potential for down-ranking the project to a lower rank. Nine samples were collected /analyzed during the PC, five within the Turning Basin, and four within the Navigation channel (**Figure 1, Table 1**). The data from the PC resulted in a re-ranking of the proposed project area into 4 subareas ranked high, low-moderate, moderate, and low-moderate (see **Table 2**, **Figure 2**) for the full characterization. Analysis of the full characterization (FC) data for the 23 Dredged Material Management Units (DMMU) interpreted with the more conservative 1988 SL guidelines indicated that 12 of 23 DMMUs had SL exceedances[1] (nickel, cadmium, mercury, copper, naphthalene, pyrene, and 2-methylphenol), and were subject to bioassay testing (**Figure 2, Table 3**). The results of the bioassay testing confirmed that one DMMU (DMMU-Z: 9,000 cubic yards) subsequently failed the non-dispersive interpretation guidelines and was unsuitable for unconfined open-water disposal. The bioassays were problematic and, due to QA/QC performance problems with the negative controls and reference samples, the Geoduck bioassay[2] and Sea Urchin larval bioassay results were unusable for decision-making. The data for the amphipod bioassay and saline Microtox test were suitable for decision-making and were the basis for

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[1] It should be noted that reinterpreting these data with the 1999 DMMP chemical guidelines results in no chemicals exceeding the screening levels (SLs).

[2] The Geoduck bioassay was abandoned by the PSDDA agencies after 2 years of trying to get it to work in the PSDDA program. It was subsequently replaced by the Neanthes acute bioassay, and later the Neanthes (biomass) Growth bioassay in 1992.

the suitability determination with both showing a hit response for DMMU Z. Thus, the 1988 FC indicated that 526,185 cy were suitable and 9,000 cy were unsuitable for unconfined open-water disposal.

4. **Background/Summary: 1999 Testing Summary.** The 1999 SAP referenced the 1988 PC/FC in the Tier I review of previous testing conducted. The March 23, 1999 SAP submitted to the DMMP for review stated (page 2, second paragraph, last sentence) "The area received a low-moderate ranking for future dredging projects (Kendall 1989)". However, the SAP misquoted the context of this quote[3], which was not an actual re-ranking of the project, but an indication that the FC data suggested that future testing of the Olympia harbor area might consider a lower rank, but these data should be used with extreme caution, due to previous test results during the PC showing elevated 4-methylphenol. The SAP then discussed the comparison of the 1988 FC data using 1998 SLs, which indicated that there were no SL exceedances. The SAP went on to conclude that the project would fit a Low Rank based on these data, and the lack of historic sources in the project area.

At the time of review, the DMMP agencies did not challenge or question the ranking proposed in the 1999 SAP and the 624,000 cy project was ranked Low for the full characterization with 17 DMMUs being tested (**Figures 3, 4, 5, 6**, **Tables 4** for **DMMP** and **5 for SMS**). However, based on a reanalysis of the existing information, the DMMP has now identified the following omissions/misinterpretations in the 1999 SAP:

- No discussion of the bioassay hit in one DMMU at the head of the Turning Basin (DMMU-Z, see **Figure 2**), which would indicate a high ranking for future testing in this area.
- There had been no testing performed in the Port's berthing area portion of the project to corroborate the re-rank from high (PSDDA Management Plan Report, Phase II: Page A-11) to low for the subsequent testing. This portion of the project should have been tested at either a moderate or high rank.

The results of the 1999 analysis are summarized in the DMMP suitability determination dated 17 May 2000 (**Attachment 1**). The results of the testing of the 17 DMMUs ( e.g., 13 surface DMMUs and 4 subsurface DMMUs) indicated that all Chemicals-of-Concern (COC) were detected or reported below the detection limits Screening Levels (SLs), except TBT. TBT exceeded the SL in surface DMMU's in the Port's berthing area (B1) and in the Turning Basin Widening area (TBW1). These two DMMU's subsequently underwent 45 day bioaccumulation testing, and the tissue levels of TBT were quantitated well below the risk based Target Tissue Levels (TTL's) used by the DMMP for interpretation (TTL = 3.0 ug/g-dry weight; 0.6 ug/g-wet weight).

The data collected in 1999 had a seven year recency for DMMP. The Port of Olympia subsequently requested a data extension consideration by the DMMP. The DMMP reviewed the previous testing data that were readily available and other factors that could have resulted in changed conditions in the Olympia Harbor navigation channel and Port berthing areas, including localized spills and other actions The agencies determined in a 24 May 2005 recency extension memorandum (**Attachment 2**) that the recency of the data could be extended to May 2008. However, subsequent to this recency extension, the DMMP learned of post-construction dioxin monitoring data from the Cascade Pole MTCA cleanup effort. Based on our review of the Cascade Pole Dioxin monitoring data and

[3] Quote from Kendall, D., 1989 (page 8-9 of the "Dredged Material Sampling, Testing, and Disposal Guidelines Application Report") states as follows: "Lastly, results from the FC for the Olympia harbor Navigation Improvement Feasibility Study generally supported a Low-Moderate area ranking for future dredged material testing. However, some elevated chemicals were noted during the PC within the uncomposited samples collected within the surface sediment layer. The highest chemical noted was 4-methylphenol, where a single analysis in the PC exceeded the ML (117 percent) and approached it in another sample (92 percent) from the south end of the turning basin (this area subsequently ranked "high" for FC); but, subsequent analyses of project sediments during FC failed to document a problem with this chemical in uncomposited samples. The differences noted in analyses conducted during PC and FC from the south end of the turning basin surface sediment layer **suggest caution in reranking at this time.**" (Emphasis added in bold and underline)

recognizing that there has been no dioxin testing performed during the 1988 and 1999 sediment testing events conducted by the Port of Olympia, the DMMP decided that dioxin testing was a data gap for the proposed project.

5. **Background/Summary: Data Gaps and Proposed Sampling/Testing Strategy.** This section reviews the adequacy of past sampling and analyses efforts for the Olympia Harbor Project and Port of Olympia berthing area, as well as the conceptual design for additional testing for dioxins and PAHs within the project area to address data gaps for the DMMP. Re-evaluating the data collected in 1988 and 1999 for the Olympia Harbor Project, generally indicate that the outer harbor and main channel and most of the Turning Basin (except the Turning Basin Widening area) did support a low rank for testing, given that all chemicals tested were detected/undetected below the SL. The Turning Basin widening section (DMMU TBW1) and the Port of Olympia's berthing area (B1) exhibited generally similar chemistry to the rest of the characterized area except a TBT exceedance within the surface DMMU's at both these locations (these areas were subsequently found suitable for unconfined-open-water disposal after conducting 45-day bioaccumulation testing) and these two areas would generally fit within the general ranking guidelines for a low-moderate rank (i.e., one or more chemicals of concern > SL but less than (SL + ML)/2; EPTA, 1988, pages II-64). The data in hand for the Inner Harbor and Port berthing area for the 1999 characterization did not show any significant sediment quality problems, and all material was found suitable for unconfined-open water disposal. Admittedly, these areas of the project should have been ranked higher for the 1999 FC testing. Given the biological response during the 1988 FC, the inner harbor area should have been ranked either moderate or high for testing purposes. Similarly, the berthing area (because of the lack of previous testing) should have been ranked either moderate or high for FC.

6. Concerns over the lack of dioxin/furan testing at the Port of Olympia and in the navigation channel were raised during the January 5, 2006 DMMP monthly meeting. The DMMP agencies have since reviewed the available dioxin data for the Budd Inlet area (**Attachment 3**) contained within the report entitled: Post-Remedial Dioxin Testing and Fish Tissue Monitoring, Cascade Pole Sediment Remediation Site, Olympia, Washington (report date, January 2003, prepared by Landau Associates for the Port of Olympia). These data showed elevated sediment dioxin levels in the Olympia Harbor and Budd Inlet area, indicating that dioxin is a chemical that must be evaluated before the DMMP agencies can finalize their suitability determination for this project. Also, data from a 1991/1992 Cascade Pole Remedial Investigation (Remedial Investigation Report, Sediments Operable Unit, Cascade Pole Site, Port of Olympia, Washington Volume 1, Feb 28, 1992. Prepared by Landau Associates, Inc. for the Port of Olympia) showed a background station adjacent to the Turning Basin, across from the Port of Olympia berthing area with a TEQ (Toxicity Equivalent Quotient) of 22 pptr Dioxins/Furans. This same station was reoccupied during the 2003 monitoring effort and found to have dropped to 3.99 pptr TEQ (e.g., Station CP-27-S' see **Figure 3** of **Attachment 3**). The apparent drop in dioxin/furan concentrations may be due to burial through sedimentation after source control measures were implemented.

7. The DMMP agencies have determined that dioxin/furans[4] must be analyzed within each of the federal Navigation Channel/Turning Basin and Port of Olympia berthing area DMMUs to evaluate the dioxin/furan concentrations relative to human health and ecological health concern levels. **Figures 7 and 8** show the proposed core sampling locations that will be occupied for dioxin/furan testing, based on potential dredging depth depicted in **Table 6,** and **Table 7** summarizes the sampling, analysis, and archival requirements to accomplish the analyses. The DMMP agencies have determined that a more intensive sampling/analysis effort at the Port of Olympia's berthing area will be required to address dioxin/furans to provide the requisite data based on a moderate-high rank, rather than the low rank

[4]Definitive analysis for dioxin/furans, should use EPA Method 1613 rather than 8290. The main difference between the two methods is that EPA Method 1613 has additional labeled internal standards so that each 2,3,7,8-substituted PCDD/PCDF isomer can be related to an internal standard for identification and quantification purposes.

assigned during the 1999 characterization. The DMMP agencies also required PAH analyses at three core locations to further assess PAH concerns[5].

8. **Postscript** (7/11/2006): The sampling and analysis strategy initially involved a tiered Phase I testing strategy that focused on the analysis of surface (0-4 ft) samples. The results of Phase I testing led to a Phase II second tier of analyses to analyze individual uncomposited samples (archived) comprising composited Phase I analyses from the Federal Project Turning Basin, analyses of subset of selected subsurface archived samples, and analyses of archived Z-samples underlying contaminated sediments for dioxins/furans and PAHs (see Table 7). After all the testing and data quality control/assurances have been completed, the DMMP agencies will prepare a supplemental suitability determination. The supplemental suitability determination will document the DMMP determination on the testing outcome, and conclude whether or not the material is suitable for unconfined open-water disposal and/or beneficial use.

9. The proposed sampling and testing strategy was fully coordinated with DMMP agency staff, and all concurred with these recommendations to complete the required sampling/testing for this project.

David R. Kendall, Ph.D.
Chief, Dredged Material Management Office

Copies Furnished:
Port of Olympia
Hiram Arden, Corps Navigation Project Manager
George Hart, Corps
Erika Hoffman, EPA
Jonathan Freedman, EPA
Ted Benson, Ecology
Loree Randall, Ecology
Russ McMillan, Ecology
Peter Leon, DNR
DMMO File

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[5] Lower Budd Inlet, and especially the industrial peninsula, has been the site of past industrial activity that is known to have caused contaminant releases to the inlet. The industrial activities include a wood treating operation and bulk petroleum storage and transfer area. The general effects of these potential sources on the sediments proposed for dredging appear to be below existing DMMP standards based on 1988 and 1999 testing. However, to ensure appropriate protection of Budd Inlet and the Anderson/Ketron disposal site, additional sampling will be performed to further target PAHs and dioxin/furans within selected portions of the dredging prism in closest proximity to these potential source areas.

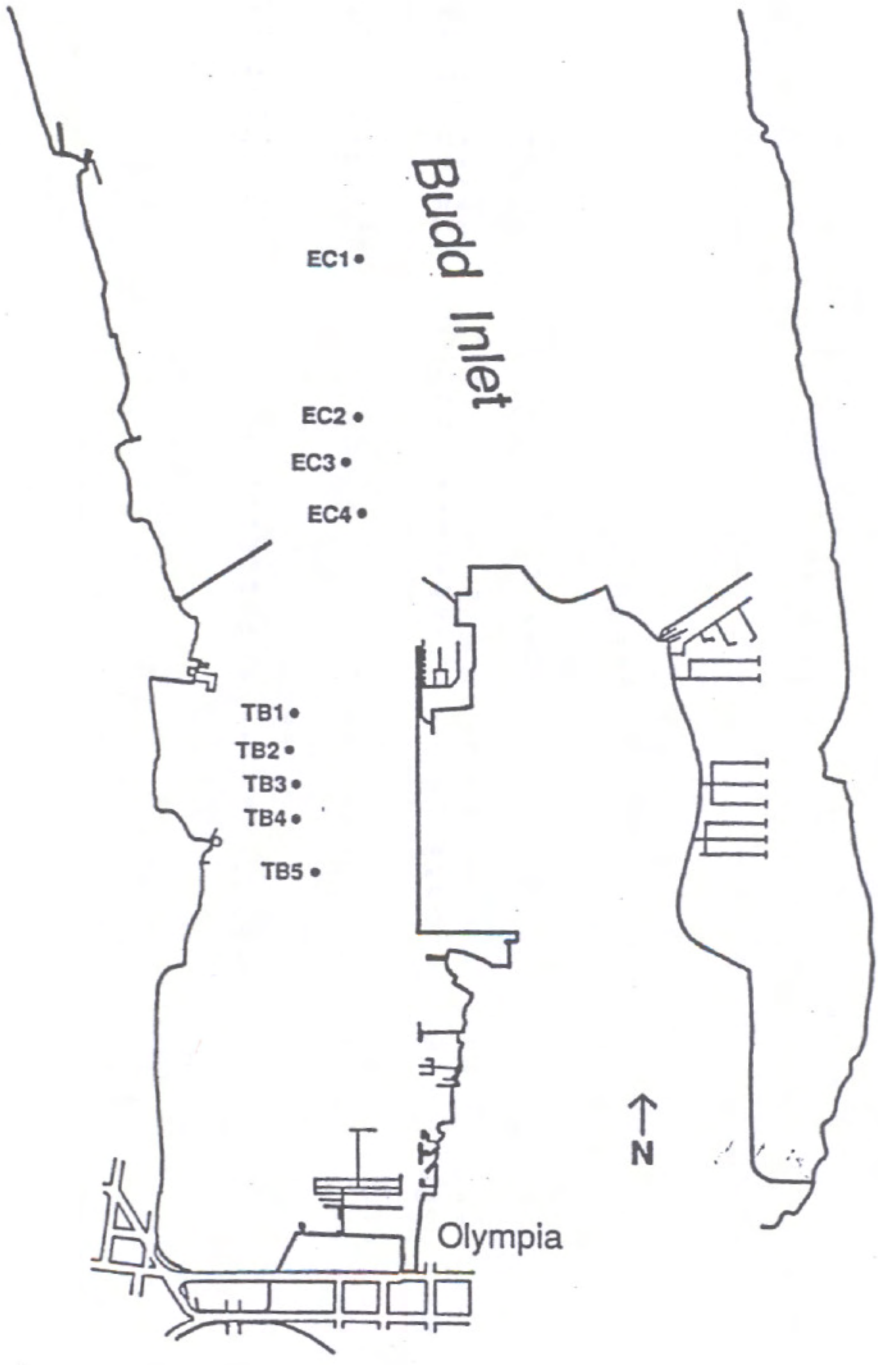



Figure 1. Sampling stations for the Partial Characterization of Olympia Harbor Navigation Improvement Project, August. 1988

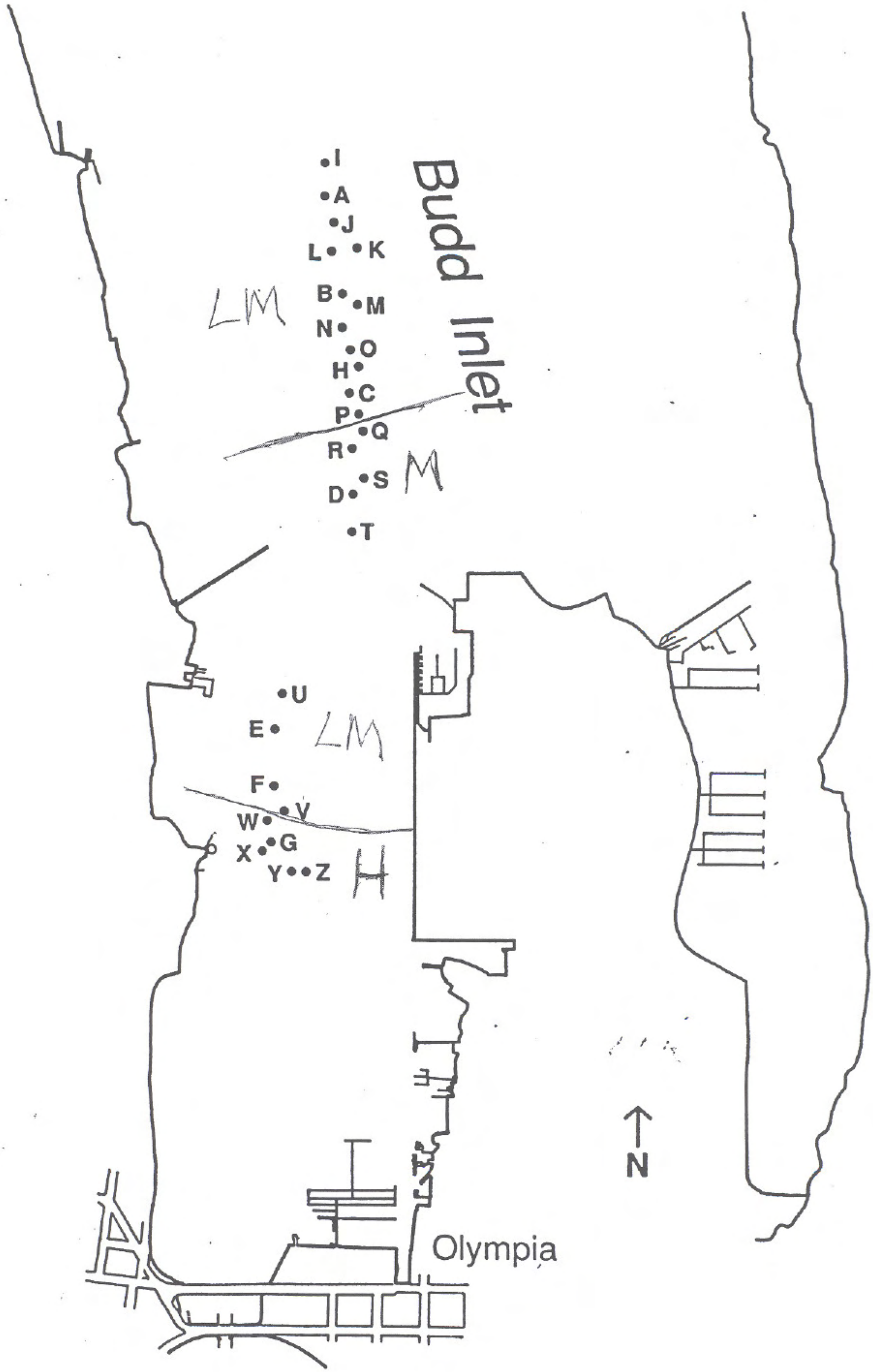



FIGURE 2

Sampling stations for the Olympia Harbor Navigation Improvement Project, November 1988.

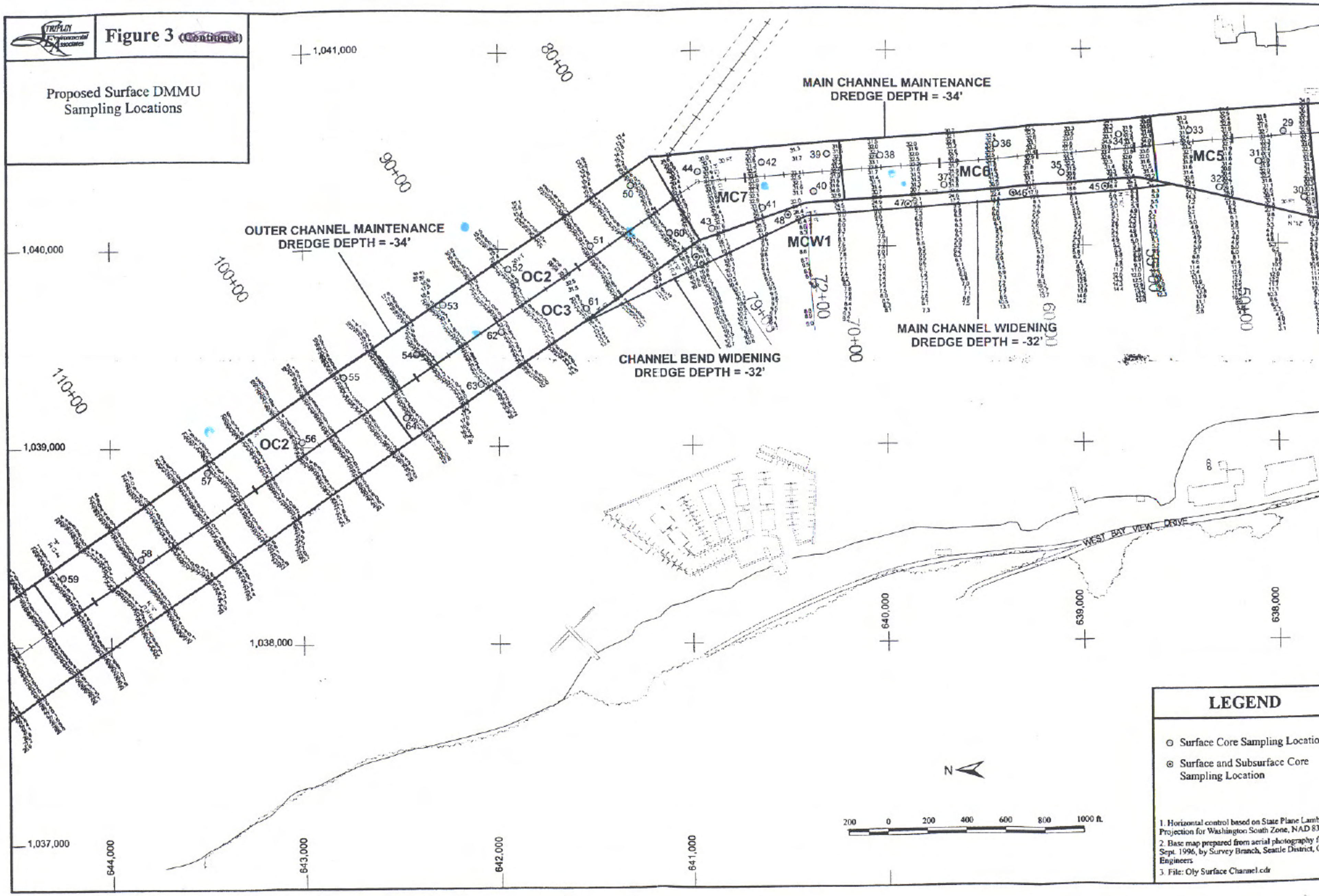


Figure 3 (Continued)
Proposed Surface DMMU Sampling Locations
MAIN CHANNEL MAINTENANCE DREDGE DEPTH = -34'
OUTER CHANNEL MAINTENANCE DREDGE DEPTH = -34'
CHANNEL BEND WIDENING DREDGE DEPTH = -32'
MAIN CHANNEL WIDENING DREDGE DEPTH = -32'
MC5
MC6
MC7
MCW1
OC2
OC3
80+00
90+00
100+00
110+00
70+00
60+00
50+00
1,041,000
1,040,000
1,039,000
1,038,000
1,037,000
644,000
643,000
642,000
641,000
640,000
639,000
638,000
WEST BAY VIEW DRIVE
N
200 0 200 400 600 800 1000 ft.
LEGEND
Surface Core Sampling Location
Surface and Subsurface Core Sampling Location
1. Horizontal control based on State Plane Lamber Projection for Washington South Zone, NAD 83/9
2. Base map prepared from aerial photography flo Sept. 1996, by Survey Branch, Seattle District, Co Engineers
3. File: Oly Surface Channel.cdr

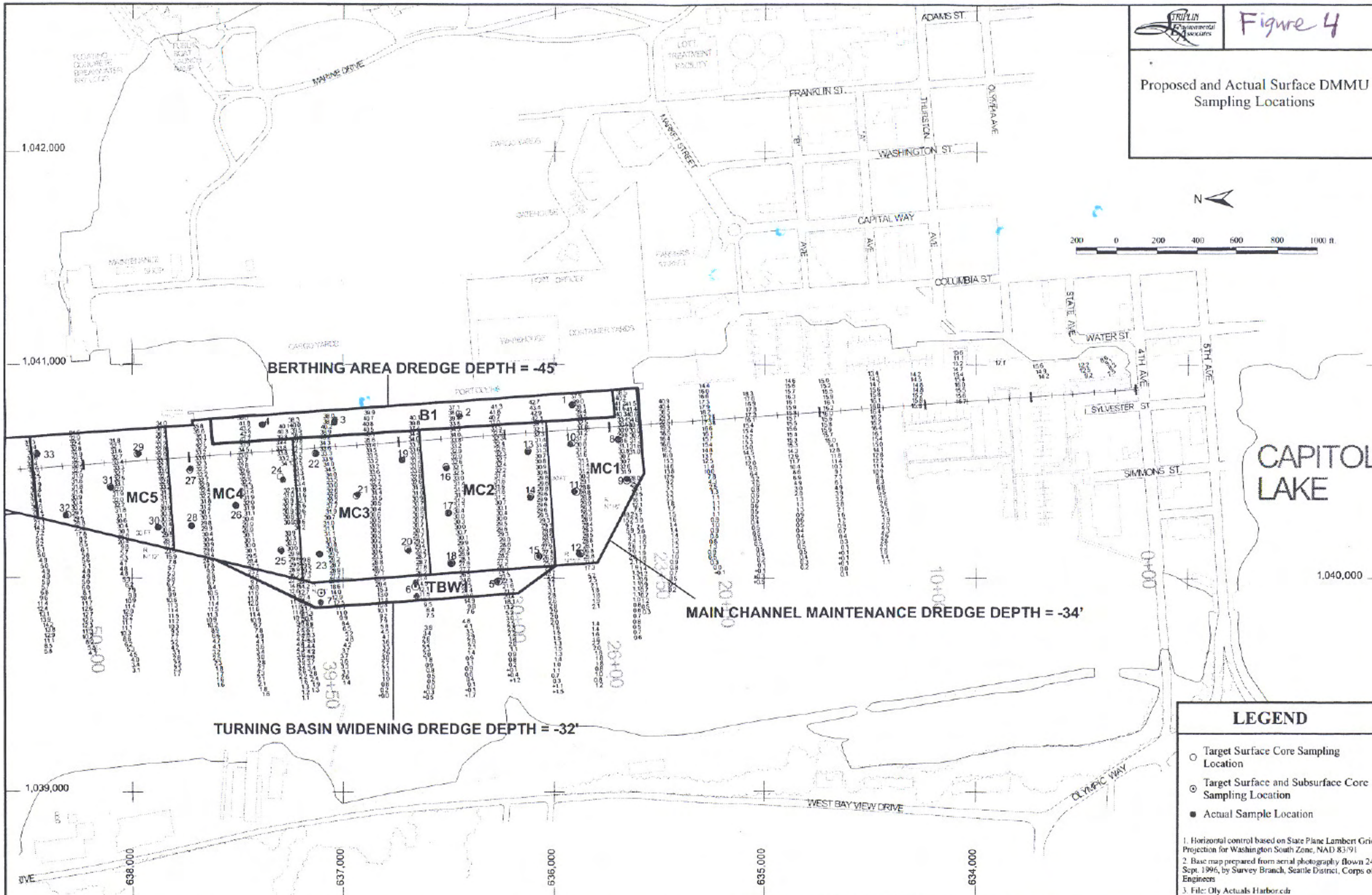


Figure 4
Proposed and Actual Surface DMMU Sampling Locations
BERTHING AREA DREDGE DEPTH = -45'
MAIN CHANNEL MAINTENANCE DREDGE DEPTH = -34'
TURNING BASIN WIDENING DREDGE DEPTH = -32'
B1
MC1
MC2
MC3
MC4
MC5
TBW1
CAPITOL LAKE
ADAMS ST.
FRANKLIN ST.
WASHINGTON ST.
CAPITAL WAY
COLUMBIA ST.
STATE AVE
WATER ST.
4TH AVE
5TH AVE
SYLVESTER ST.
SIMMONS ST.
MARINE DRIVE
MARKET STREET
OLYMPIA AVE
THURSTON
OLYMPIC WAY
WEST BAY VIEW DRIVE
N
200 0 200 400 600 800 1000 ft
1,042,000
1,041,000
1,040,000
1,039,000
638,000
637,000
636,000
635,000
634,000
LEGEND
Target Surface Core Sampling Location
Target Surface and Subsurface Core Sampling Location
Actual Sample Location
1. Horizontal control based on State Plane Lambert Grid Projection for Washington South Zone, NAD 83/91
2. Base map prepared from aerial photography flown 24 Sept. 1996, by Survey Branch, Seattle District, Corps of Engineers
3. File: Oly Actuals Harbor.cdr

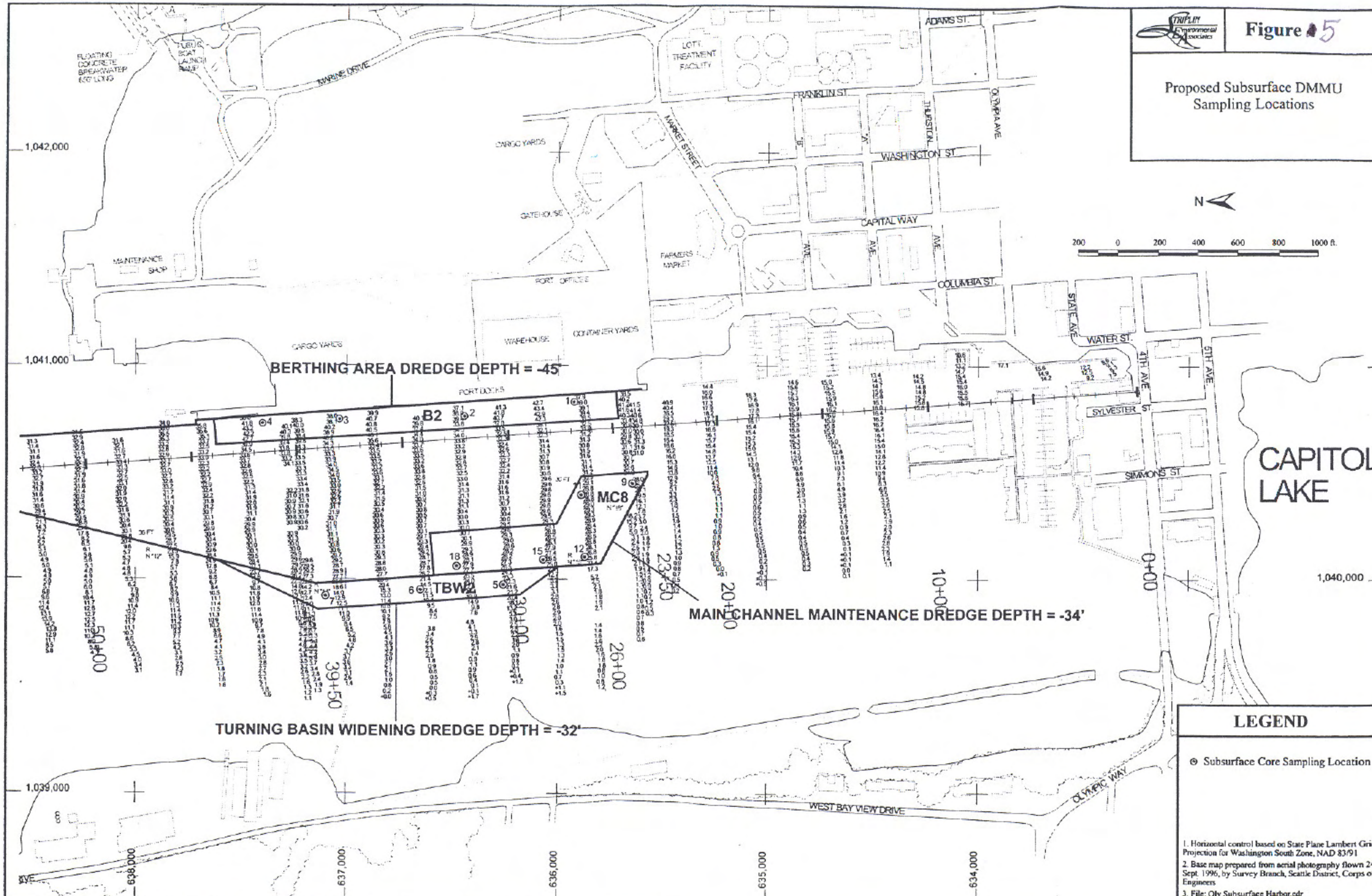


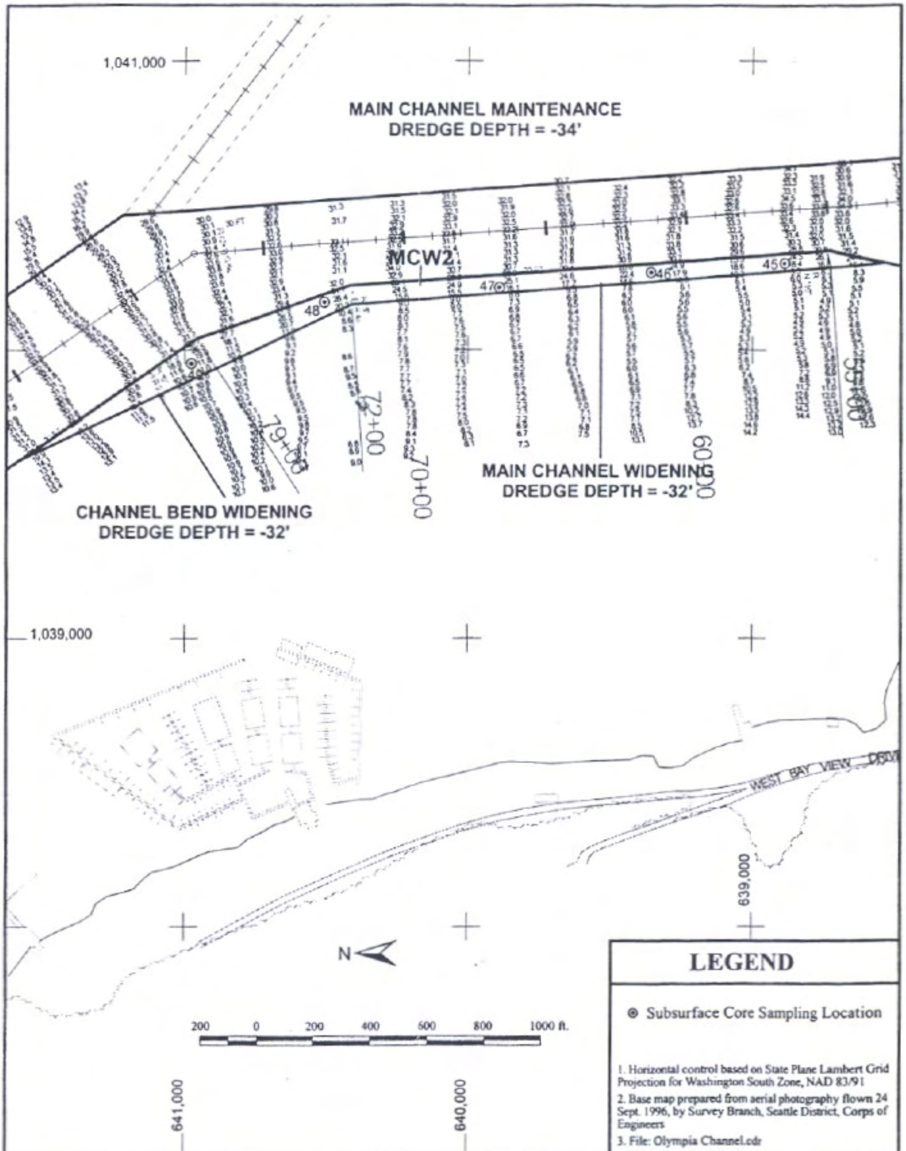

Figure 5

Proposed Subsurface DMMU Sampling Locations

**LEGEND**

⊙ Subsurface Core Sampling Location

1. Horizontal control based on State Plane Lambert Grid Projection for Washington South Zone, NAD 83/91
2. Base map prepared from aerial photography flown 24 Sept. 1996, by Survey Branch, Seattle District, Corps of Engineers
3. File: Oly Subsurface Harbor.cdr



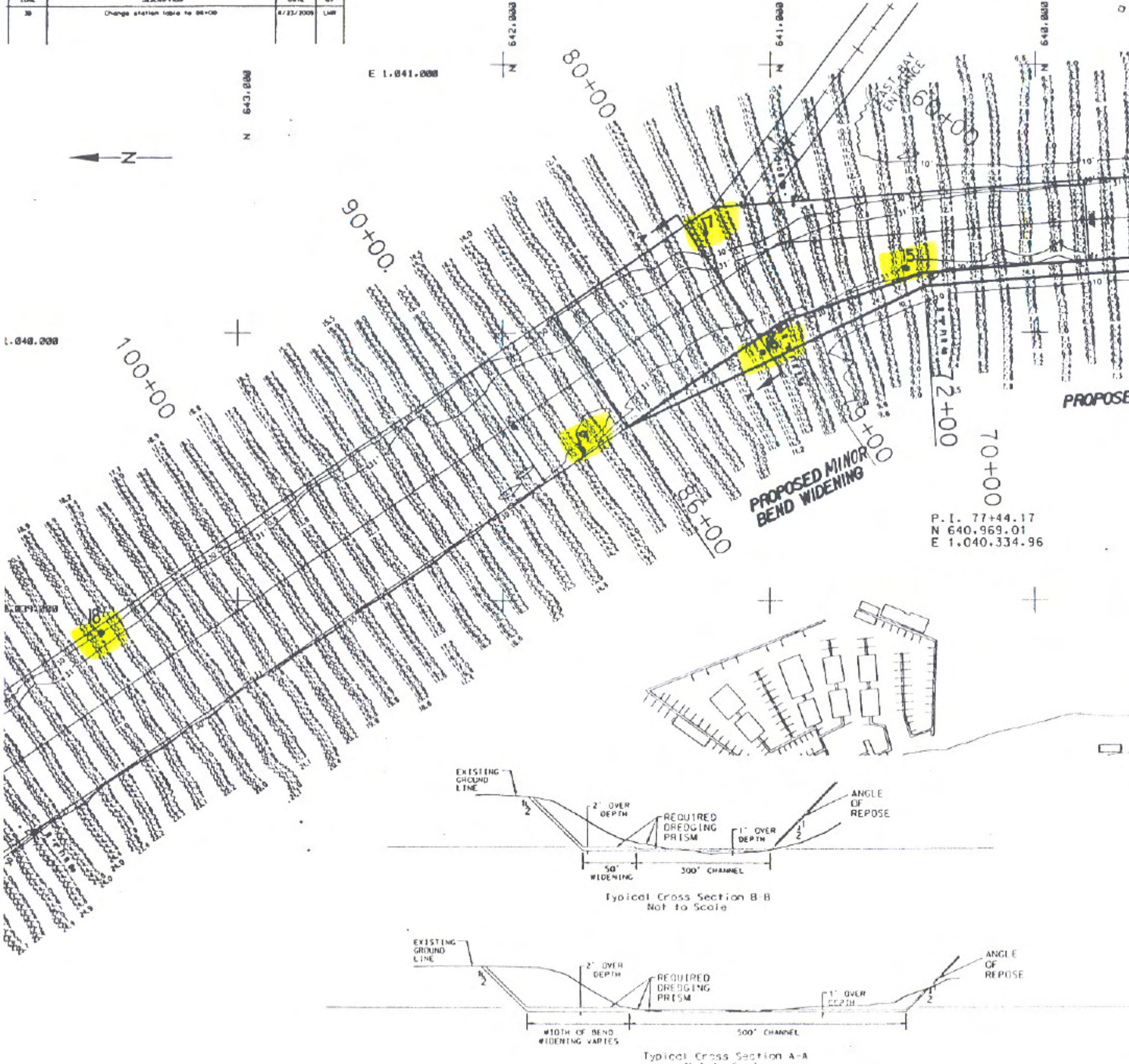

STRIPLIN Environmental Associates

**Figure 6 (Continued)**

Proposed Subsurface DMMU Sampling Locations

| |
|---|
| Olympia Harbor |
| 3/23/99 |
| Oly Subsurface Channel.cdr |

| ZONE | DESCRIPTION | DATE | BY |
|---|---|---|---|
| 3B | Change station table to 98+00 | 4/23/2005 | LMR |




NOTES

1. SOUNDINGS AND ELEVATIONS ARE IN FEET AND REFER TO THE PLANE OF MEAN LOWER LOW WATER, NOS.
2. SOUNDINGS TAKEN USING A SINGLE 3 DEGREE BEAM, 200 Khz TRANSDUCER. TIDAL CORRECTIONS BASED ON GEOID96 MODEL USING RTK.
3. HORIZONTAL CONTROL BASED ON LAMBERT GRID PROJECTION FOR WASHINGTON SOUTH ZONE NAD 83/91.
4. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.
5. BASE MAP PREPARED FROM AERIAL PHOTOGRAPHY FLOWN 24 SEPTEMBER 1996, BY SURVEY BRANCH, SEATTLE DISTRICT, CORPS OF ENGINEERS.
6. SOUNDINGS TAKEN ABOVE THE DATUM PLANE ARE PREFIXED WITH (+) SIGN.
7. CHANNEL ALIGNMENT SHOWN IS PROPOSED ALIGNMENT 2005
8. CONDITION SURVEY: 28 FEB 2005 (SURVEY FILE: 2005o1002)
9. THE FOLLOWING NAVIGATION AIDS WERE NOT LOCATED THIS SURVEY. PREVIOUSLY SURVEYED LOCATIONS WERE USED: RN "10", RN "12", R "4" FLR 6s.

DRAFT

1" = 200'   200' 100' 0 200' 400'

Figure 7.

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

OUTER/ENTRANCE CHANNEL

PROPOSED MINOR WIDENING

HIRAM T. ARDEN

ROBERT M. PARRY

OLYMPIA HARBOR, WASHINGTON

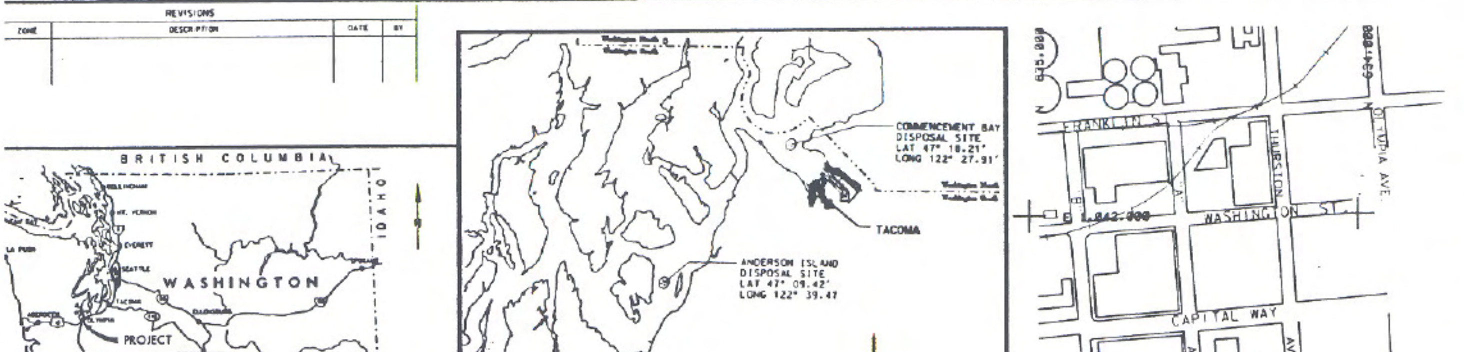
SURVEYED BY: PJM
PLOTTED BY: LMR
CHECKED BY: FOG
DATE: 25 APR 2005

E-14-5-148

SCALE: 1" = 200'

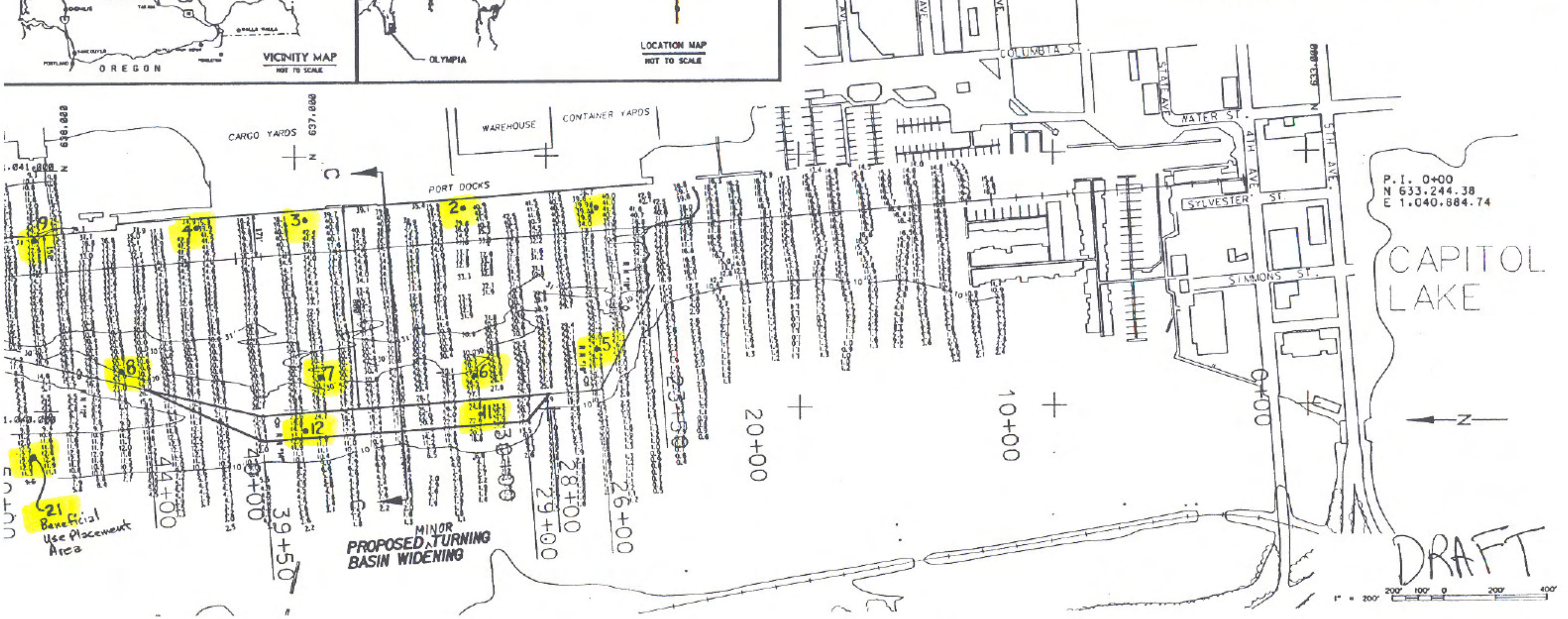
SHEET 2 OF 2

PLATE C-4




NOTES

1. SOUNDINGS AND ELEVATIONS ARE IN FEET AND REFER TO THE PLANE OF MEAN LOWER LOW WATER, NOS.
2. SOUNDINGS TAKEN USING A SINGLE 3 DEGREE BEAM, 200 KHz TRANSDUCER. TIDAL CORRECTIONS BASED ON GEOID96 MODEL USING RTK.
3. HORIZONTAL CONTROL BASED ON LAMBERT GRID PROJECTION FOR WASHINGTON SOUTH ZONE, NAD 83/91.
4. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.
5. BASE MAP PREPARED FROM AERIAL PHOTOGRAPHY FLOWN 24 SEPTEMBER 1996, BY SURVEY BRANCH, SEATTLE DISTRICT, CORPS OF ENGINEERS.
6. SOUNDINGS TAKEN ABOVE THE DATUM PLANE ARE PREFIXED WITH (+) SIGN.
7. CHANNEL ALIGNMENT SHOWN IS PROPOSED ALIGNMENT 2005
8. CONDITION SURVEY: 28 FEB 2005 (SURVEY FILE: 2005o1002)
9. THE FOLLOWING NAVIGATION AIDS WERE NOT LOCATED THIS SURVEY. PREVIOUSLY SURVEYED LOCATIONS WERE USED: RN "12", RN "14", RN "16", RN "18".





Typical Cross Section C-C
Not to Scale

Figure 8.

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

TURNING BASIN

PROPOSED MINOR WIDENING

| | | |
|---|---|---|
| HIRAM T. ARDEN | OLYMPIA HARBOR, WASHINGTON | |
| ROBERT M. PARRY | E-14-5-14B | C-2 |
| | DATE 25 APR 2005 SCALE 1" = 200 | SHEET 1 OF 2 |

DAIS Value Table - Dry Weight Basis

**Table 1. Olympia Harbor 1988 PC Characterization**

| | EC1 | EC2 | EC3 | EC4 | TB1 | TB2 | TB3 | TB4 | TB5 |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
| SEDIMENT CONVENTIONALS | | | | | | | | | |
| Total Solids | 61.1 | 55.5 | 54.1 | 68.9 | 42.9 | 21.6 | 41.6 | 39.8 | 39.9 |
| Total Volatile Solids | 2.22 | 2.92 | 2.89 | 2.82 | 2.95 | 2.89 | 2.76 | 2.81 | 2.93 |
| Total Organic Carbon | 2.19 | 4.74 | 3.86 | 2.07 | 3.8 | 3.83 | 3.78 | 4.03 | 4 |
| Ammonia | 28.8 | 40.2 | 39.5 | 15.7 | 73.9 | 112 | 53.8 | 47.7 | 35.6 |
| Total Sulfides | 130 | 170 | 150 | 96 | 410 | 560 | 360 | 430 | 570 |
| METALS | | | | | | | | | |
| Antimony | 0.45 | 0.49 | 0.45 | 0.32 | 0.56 | 0.59 | 0.54 | 0.55 | 0.55 |
| Arsenic | 11 | 14 | 12 | 10 | 11 | 11 | 11 | 11 | 11 |
| Cadmium (1) | 1.1 | 1.7 | 2.1 | 1.2 | 2.3 | 2.2 | 2.3 | 2.3 | 2.1 |
| Copper (1) | 25.3 | 39.1 | 42.9 | 42.6 | 13.9 | 68.8 | 86.4 | 91.7 | 98.3 |
| Lead (1) | 10.9 | 15.5 | 18.8 | 12.9 | 22.1 | 23.9 | 20.5 | 19.6 | 20.1 |
| Mercury | 0.03 | 0.1 | 0.11 | 0.07 | 0.11 | 0.11 | 0.21 | 0.21 | 0.23 |
| Nickel | 27.8 | 33.3 | 37.4 | 34.1 | 34.6 | 36.7 | 36.3 | 38.9 | 38.2 |
| Silver | 0.18 | 0.37 | 0.42 | 0.23 | 0.82 | 0.82 | 0.94 | 0.81 | 0.86 |
| Zinc (1) | 57 | 78 | 82 | 60 | 124 | 121 | 124 | 128 | 130 |
| LPAH | | | | | | | | | |
| 2-Methylnaphthalene (1) | 0.7 u | 0.6 u | 1 | 2 | 16 | 7 | 14 | 0.6 u | 17 |
| Acenaphthene (1) | 0.7 u | 0.6 u | 2 | 0.6 | 8 | 2 | 17 | 0.7 u | 10 |
| Acenaphthylene (1) | 0.4 u | 2 | 0.3 u | 1 | 9 | 2 | 11 | 0.5 u | 11 |
| Anthracene (1) | 0.3 u | 0.5 u | 1 | 3 | 22 | 8 | 29 | 5 | 35 |
| Fluorene (1) | 0.5 u | 0.5 u | 0.4 u | 0.7 | 11 | 0.9 u | 20 | 1 u | 16 |
| Naphthalene (1) | 3 | 17 | 19 | 18 | 67 | 44 | 76 | 11 | 69 |
| Phenanthrene (1) | 3 | 24 | 12 | 16 | 110 | 37 | 120 | 31 | 93 |
| Total LPAH (1) | 6 | 43 | 35 | 41.3 | 243 | 100 | 287 | 47 | 251 |
| HPAH | | | | | | | | | |
| Benzo(a)anthracene (1) | 0.4 u | 9 | 4 | 10 | 61 | 38 | 62 | 54 | 93 |
| Benzo(a)pyrene | 0.4 u | 6 | 4 | 9 | 58 | 39 | 61 | 37 | 86 |
| Benzo(g,h,i)perylene (1) | 0.6 u | 5 | 2 | 7 | 55 | 29 | 58 | 13 | 64 |
| Benzofluoranthenes (1) | 0.6 u | 16 | 10 | 26 | 160 | 100 | 160 | 88 | 230 |
| Chrysene (1) | 0.9 u | 22 | 9 | 13 | 82 | 56 | 85 | 56 | 150 |
| Dibenzo(a,h)anthracene (1) | 0.6 u | 0.5 u | 0.3 u | 0.3 u | 6 | 0.6 u | 4 | 0.5 u | 6 |
| Fluoranthene | 1 u | 59 | 20 | 28 | 210 | 86 | 140 | 100 | 260 |
| Indeno(1,2,3-c,d)pyrene (1) | 0.6 u | 3 | 1 | 5 | 46 | 26 | 43 | 16 | 64 |
| Pyrene (1) | 3 | 57 | 22 | 41 | 250 | 110 | 220 | 97 | 310 |
| Total HPAH (1) | 3 | 177 | 72 | 139 | 928 | 484 | 833 | 461 | 1263 |
| CHLORINATED HYDROCARBONS | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | 1 u | 1 u | 1 u | 1 u | 1 u | 2 u | 1 u | 1 u | 1 u |
| 1,2-Dichlorobenzene | 2 u | 2 u | 2 u | 2 u | 3 u | 3 u | 2 u | 3 u | 3 u |
| 1,3-Dichlorobenzene (2) | 2 u | 2 u | 2 u | 2 u | 3 u | 3 u | 2 u | 3 u | 3 u |
| 1,4-Dichlorobenzene | 2 u | 2 u | 2 u | 2 u | 3 u | 3 u | 2 u | 3 u | 3 u |
| Hexachlorobenzene | 0.9 u | 0.1 u | 0.1 u | 0.4 | 2 | 0.2 u | 1 | 0.8 | 1 |
| PHTHALATES | | | | | | | | | |
| Bis(2-ethylhexyl)phthalate (2) | 170 | 180 | 280 | 180 | 660 | 770 | 820 | 840 | 1100 |
| Butyl benzyl phthalate (3) | 47 | 84 | 87 | 68 | 130 | 190 | 220 | 180 | 320 |
| Di-n-butyl phthalate (2) | 37 | 21 | 27 | 32 | 74 | 85 | 69 | 90 | 110 |
| Di-n-octyl phthalate (3) | 20 | 4 | 12 | 9 | 59 | 60 | 94 | 86 | 37 |
| Diethyl phthalate (3) | 46 | 4 | 13 | 31 | 34 | 55 | 27 | 45 | 36 |
| Dimethyl phthalate (2) | 2 u | 2 u | 2 u | 2 | 3 u | 5 u | 4 u | 12 | 3 u |
| PHENOLS | | | | | | | | | |
| 2 Methylphenol (1) | 1 u | 1 u | 1 u | 1 u | 1 u | 2 u | 3 u | 1 u | 1 u |
| 2,4-Dimethylphenol (1) | 2 u | 3 | 1 u | 4 u | 1 u | 2 u | 2 u | 5 u | 1 u |
| 4 Methylphenol (1) | 390 | 500 | 1100 | 450 | 340 | 83 | 420 | 760 | 1400 |
| Pentachlorophenol | 1 u | 1 u | 1 u | 1 u | 3 u | 4 u | 2 u | 2 u | 2 u |
| Phenol | 160 | 110 | 230 | 72 | 330 | 71 | 48 | 100 | 75 |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | |
| Benzoic acid (1) | 22 | 32 | 6 | 22 | 70 | 71 | 86 | 70 | 84 |
| Benzyl alcohol (1) | 6 | 8 | 6 u | 6 | 16 | 10 | 16 | 27 | 21 |
| Dibenzofuran (1) | 11 | 27 | 10 | 4 | 15 | 11 | 20 | 24 | 24 |
| Hexachlorobutadiene | 0.3 u | 0.2 u | 0.2 u | 0.2 u | 0.4 u | 0.6 u | 0.4 u | 0.3 u | 0.3 u |
| Hexachloroethane | 8 u | 8 u | 10 u | 8 u | 13 u | 15 u | 12 u | 14 u | 14 u |
| N-Nitrosodiphenylamine | 1 u | 3 u | 1 u | 1 u | 4 u | 9 u | 2 u | 2 u | 4 u |
| VOLATILE ORGANICS | | | | | | | | | |
| Ethylbenzene | 2 u | 1 u | 2 u | 1 u | 2 u | 2 u | 2 u | 2 u | 2 u |
| Tetrachloroethene | 4 u | 0.9 u | 1 u | 0.8 u | 1 u | 2 u | 1 u | 1 u | 1 u |
| Total Xylene (1) | 3 u | 3 u | 3 u | 3 u | 5 u | 5 u | 4 u | 5 u | 5 u |
| Trichloroethene | 1 u | 1 u | 1 u | 1 u | 2 u | 2 u | 2 u | 2 u | 2 u |
| PESTICIDES AND PCBs | | | | | | | | | |
| Aldrin (2) | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u |
| Chlordane (2) | 0.1 u | 0.1 u | 0.1 u | 0.3 u | 0.8 | 0.6 | 0.9 | 0.1 u | 1 |
| Dieldrin (2) | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u |
| Heptachlor (2) | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u |
| Lindane (2) | 0.1 | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u |
| Total DDT | 0.1 u | 0.3 | 0.1 u | 0.7 | 1.7 | 1.4 | 2 | 0.2 u | 2 |
| Total PCBs | 4 | 27 | 23 | 30 | 72 | 58 | 130 | 22 | 140 |
| ORGANOMETALLICS | | | | | | | | | |
| Tributyltin (2) | - | - | - | - | - | - | - | - | - |

END OF REPORT

**Table-2. Dredged Material Ranking Guidelines.**

| RANK | GUIDELINES |
|---|---|
| **Low** | Few or no sources of chemicals of concern. Data are available to verify low chemical concentrations (below DMMP screening levels) and no significant response in biological tests. |
| **Low-Moderate** | Available information indicates a "low" rank, but there are insufficient data to confirm the ranking. |
| **Moderate** | Sources exist in the vicinity of the project, or there are present or historical uses of the project site, with the potential for producing chemical concentrations within a range associated historically with some potential for causing adverse biological impacts. |
| **High** | Many known chemical sources, high concentrations of chemicals of concern, and/or biological testing failures in one or both of the two most recent cycles of testing. |

## Table 3. Olympia Harbor 1988 - FC Characterization

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEDIMENT CONVENTIONALS | | | | | | | | | | | | | | | |
| Total Solids | 54.5 | 63.4 | 74.5 | 77.3 | 58 | 62.9 | 62.8 | 71.6 | 71.2 | 72.8 | 75.5 | 70.9 | 60.2 | 72.8 | 49 |
| Total Volatile Solids | 5.08 | 3.06 | 1.72 | 1.74 | 4.06 | 3.83 | 3.6 | 2.18 | 2.64 | 1.91 | 1.57 | 2.59 | 4.9 | 2.2 | 7.09 |
| Total Organic Carbon | 1.63 | 1.53 | 1.55 | 0.44 | 1.21 | 1.23 | 1.02 | 0.63 | 0.87 | 0.62 | 0.34 | 1.33 | 1.67 | 0.51 | 0.97 |
| Ammonia | 168 | 907 | 95.2 | 106 | 4060 | 101 | 1290 | 95.2 | 146 | 140 | 67.2 | 118 | 146 | 84 | 263 |
| Total Sulfides | 66.9 | 30.6 | 5 u | 5 u | 45.6 | 23.8 | 11.9 | 5 u | 5 u | 5 u | 5 u | 11.3 | 48.3 | 10.7 | 81.5 |
| METALS | | | | | | | | | | | | | | | |
| Antimony | 0.29 | 0.27 | 0.01 u | 0.01 u | 0.23 | 0.13 | 0.12 | 0.14 | 0.25 | 0.04 | 0.01 u | 0.16 | 0.15 | 0.32 | 0.01 |
| Arsenic | 3.99 | 3.85 | 5.95 | 3.92 | 6.93 | 6.01 | 4.89 | 1.96 | 4.02 | 4.02 | 3.18 | 3.37 | 8.48 | 4.42 | 6.91 |
| Cadmium (1) | 1.29 | 1.28 | 0.71 | 0.19 | 1.22 | 1.31 | 1.28 | 0.76 | 1.08 | 0.81 | 0.53 | 0.82 | 0.95 | 0.48 | 1.75 |
| Copper (1) | 33.9 | 17.5 | 0.05 u | 0.05 u | 30.1 | 17.1 | 18.6 | 15.2 | 2.87 | 0.05 u | 0.05 u | 7.05 | 23.3 | 12.5 | 51.6 |
| Lead (1) | 6.9 | 2.9 | 0.07 u | 0.46 | 6.1 | 2.3 | 2.8 | 5.1 | 3.1 | 2.1 | 0.37 | 0.07 u | 5.7 | 1.2 | 18.6 |
| Mercury | 0.12 | 0.1 | 0.26 | 0.16 | 0.02 u | 0.02 u | 0.02 u | 0.05 | 0.04 | 0.02 | 0.05 | 0.15 | 0.37 | 0.19 | 0.1 |
| Nickel | 29 | 21.9 | 23.8 | 26.7 | 24.5 | 22.8 | 23 | 28.4 | 23.8 | 20.8 | 21.5 | 24.5 | 45 | 25.7 | 38.9 |
| Silver | 0.22 | 0.12 | 0.05 | 0.03 | 0.17 | 0.17 | 0.13 | 0.03 | 0.49 | 0.1 | 0.1 | 0.03 | 0.08 | 0.07 | 0.24 |
| Zinc (1) | 62 | 44 | 39 | 41 | 57 | 50 | 50 | 47 | 41 | 39 | 35 | 35 | 59 | 48 | 85 |
| LPAH | | | | | | | | | | | | | | | |
| 2-Methylnaphthalene (1) | 9 | 4 | 2 u | 2 u | 7 | 5 | 2 | 2 u | 2 u | 2 u | 2 u | 2 u | 9 | 2 u | 14 |
| Acenaphthene (1) | 5 | 2 | 2 u | 2 u | 3 | 2 u | 2 u | 2 u | 2 u | 2 u | 2 u | 2 u | 6 | 2 u | 8 |
| Acenaphthylene (1) | 10 | 5 | 1 u | 1 u | 6 | 8 | 7 | 1 u | 2 u | 1 u | 1 u | 1 u | 24 | 1 u | 26 |
| Anthracene (1) | 11 | 3 | 0.9 u | 0.7 u | 6 | 3 | 3 | 0.9 u | 1 u | 0.7 u | 0.9 u | 0.8 u | 14 | 0.7 u | 24 |
| Fluorene (1) | 6 | 2 | 2 u | 1 u | 4 | 1 u | 1 u | 2 u | 2 u | 1 u | 2 u | 1 u | 8 | 1 u | 9 |
| Naphthalene (1) | 63 | 32 | 2 u | 1 u | 40 | 62 | 18 | 2 | 2 u | 1 u | 2 u | 3 | 120 | 1 u | 180 |
| Phenanthrene (1) | 43 | 17 | 0.9 u | 2 | 26 | 21 | 25 | 2 | 2 | 1 | 2 | 3 | 76 | 1 | 120 |
| Total LPAH (1) | 147 | 65 | 2 u | 2 | 92 | 99 | 55 | 4 | 2 | 1 | 2 | 6 | 257 | 1 | 381 |
| HPAH | | | | | | | | | | | | | | | |
| Benzo(a)anthracene (1) | 13 | 4 | 0.6 u | 0.5 u | 8 | 3 | 1 | 0.6 u | 0.7 u | 0.6 u | 0.6 u | 0.6 u | 18 | 1 | 35 |
| Benzo(a)pyrene | 15 | 5 | 2 | 0.4 u | 10 | 6 | 4 | 1 | 1 | 0.4 u | 3 | 0.5 u | 20 | 6 | 37 |
| Benzo(g,h,i)perylene (1) | 26 | 8 | 0.8 | 0.5 u | 11 | 7 | 2 | 0.6 u | 0.7 u | 0.5 u | 0.6 u | 0.6 u | 30 | 5 | 43 |
| Benzofluoranthenes (1) | 29 | 15 | 0.9 | 0.5 u | 22 | 11 | 2 | 0.6 u | 0.6 u | 0.5 u | 2 | 0.5 u | 44 | 6 | 96 |
| Chrysene (1) | 19 | 8 | 0.6 | 0.5 u | 12 | 5 | 3 | 1 | 0.8 | 0.5 u | 2 | 0.9 | 27 | 4 | 47 |
| Dibenzo(a,h)anthracene (1) | 5 | 2 | 0.6 u | 0.5 u | 0.8 u | 0.8 u | 0.9 u | 0.6 u | 0.7 u | 0.5 u | 0.9 | 0.6 u | 0.8 u | 3 | 1 |
| Fluoranthene | 69 | 27 | 0.7 u | 0.6 u | 35 | 23 | 16 | 1 | 0.9 u | 0.6 u | 2 | 0.7 u | 110 | 1 | 170 |
| Indeno(1,2,3-c,d)pyrene (1) | 29 | 10 | 0.7 | 0.5 u | 11 | 5 | 2 u | 0.6 u | 0.6 u | 0.5 u | 0.5 u | 0.5 u | 13 | 5 | 25 |
| Pyrene (1) | 87 | 33 | 0.7 u | 0.6 u | 46 | 31 | 18 | 0.9 | 0.8 u | 0.6 u | 2 | 2 | 130 | 2 | 230 |
| Total HPAH (1) | 292 | 112 | 5 | 0.6 u | 155 | 91 | 36 | 3.9 | 1.8 | 0.6 u | 12.4 | 2.9 | 392 | 33 | 684 |
| CHLORINATED HYDROCARBONS | | | | | | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | 1 u | 1 u | 0.8 u | 0.9 u | 1 u | 1 u | 1 u | 0.8 u | 0.9 u | 0.8 u | 0.8 u | 0.9 u | 1 u | 0.7 u | 1 u |
| 1,2-Dichlorobenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1,3-Dichlorobenzene (2) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1,4-Dichlorobenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hexachlorobenzene | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u |
| PHTHALATES | | | | | | | | | | | | | | | |
| Bis(2-ethylhexyl)phthalate (2) | 120 | 30 | 40 | 34 | 22 | 49 | 13 | 40 | 49 | 35 | 21 | 47 | 76 | 51 | 200 |
| Butyl benzyl phthalate (3) | 16 u | 19 | 0.5 u | 0.4 u | 11 u | 7 u | 9 u | 0.3 | 0.4 | 20 | 0.6 u | 2 | 19 | 0.4 u | 40 |
| Di-n-butyl phthalate (2) | 4 | 3 | 0.4 | 0.3 | 3 u | 2 u | 2 u | 0.8 | 1 | 0.8 | 0.2 | 0.8 | 3 | 0.3 | 9 |
| Di-n-octyl phthalate (3) | 12 | 4 u | 0.2 u | 0.2 u | 5 u | 3 u | 4 u | 0.5 | 0.2 | 0.2 | 0.3 u | 0.4 | 8 | 0.2 u | 85 |
| Diethyl phthalate (3) | 4 u | 3 u | 0.8 | 0.8 | 4 u | 2 u | 3 u | 2 | 1 | 1 | 2 | 1 | 3 | 1 | 3 u |
| Dimethyl phthalate (2) | 5 u | 4 u | 0.3 u | 0.3 u | 4 u | 3 u | 3 u | 0.2 | 0.2 u | 0.2 u | 0.4 u | 0.2 u | 0.3 u | 0.2 u | 4 u |
| PHENOLS | | | | | | | | | | | | | | | |
| 2 Methylphenol (1) | 34 | 4 u | 5 | 2 | 5 u | 3 u | 3 u | 0.6 u | 6 | 3 | 2 | 1 | 7 | 6 u | 4 u |
| 2,4-Dimethylphenol (1) | 3 u | 2 u | 0.5 u | 0.5 u | 2 u | 1 u | 2 u | 0.4 u | 0.5 u | 0.4 u | 0.5 u | 0.5 u | 0.7 u | 0.4 u | 2 u |
| 4 Methylphenol (1) | 76 | 2 u | 2 | 2 | 14 u | 3 | 3 | 5 | 5 | 3 | 2 | 6 | 63 | 1 | 78 |
| Pentachlorophenol | 11 u | 13 u | 0.3 u | 0.3 u | 13 u | 6 u | 8 u | 0.2 u | 0.3 u | 0.2 u | 0.4 u | 0.3 u | 0.4 u | 0.3 u | 10 u |
| Phenol | 2 u | 16 | 42 | 17 | 11 | 15 | 11 | 41 | 20 | 22 | 15 | 32 | 24 | 13 | 20 |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | | | | | | |
| Benzoic acid (1) | 4 u | 0.9 u | 0.1 u | 0.1 u | 1 u | 2 u | 0.8 u | 4 | 4 | 2 | 0.1 u | 2 | 0.2 u | 2 | 6 |
| Benzyl alcohol (1) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dibenzofuran (1) | 2 u | 3 u | 0.1 u | 0.1 u | 3 u | 1 u | 2 u | 0.1 u | 0.09 u | 0.08 u | 0.1 u | 0.09 u | 9 | 0.1 u | 12 |
| Hexachlorobutadiene | 0.2 u | 0.2 u | 0.3 u | 0.3 u | 0.2 u | 0.2 u | 0.2 u | 0.3 u | 0.3 u | 0.3 u | 0.2 u | 0.3 u | 0.4 u | 0.3 u | 0.2 u |
| Hexachloroethane | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| N-Nitrosodiphenylamine | 4 u | 5 u | 0.2 u | 0.1 u | 5 u | 2 u | 3 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.1 u | 0.2 u | 0.1 u | 6 u |
| VOLATILE ORGANICS | | | | | | | | | | | | | | | |
| Ethylbenzene | 1 u | 1 u | 1 u | 0.9 u | 1 u | 1 u | 1 u | 1 u | 1 u | 1 u | 1 u | 1 u | 1 u | 1 u | 2 u |
| Tetrachloroethene | 0.9 u | 0.6 u | 0.5 u | 0.6 u | 0.7 u | 0.8 u | 0.8 u | 0.6 u | 0.6 u | 0.7 u | 0.7 u | 0.7 u | 0.7 u | 0.5 u | 1 u |
| Total Xylene (1) | 3 u | 2 u | 2 u | 2 u | 3 u | 2 u | 3 u | 2 u | 2 u | 2 u | 2 u | 2 u | 3 u | 2 u | 4 u |
| Trichloroethene | 1 u | 0.8 u | 0.7 u | 0.8 u | 0.9 u | 0.8 u | 0.9 u | 0.7 u | 0.7 u | 0.8 u | 0.8 u | 1 u | 0.8 u | 0.7 u | 1 u |
| PESTICIDES AND PCBs | | | | | | | | | | | | | | | |
| Aldrin (2) | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 1 u |
| Chlordane (2) | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.5 |
| Dieldrin (2) | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u |
| Heptachlor (2) | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u |
| Lindane (2) | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.2 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.1 u | 0.2 u |
| Total DDT | 0.5 u | 0.2 u | 0.2 u | 0.2 u | 0.3 u | 0.3 u | 0.3 u | 0.2 u | 0.2 u | 0.2 u | 0.2 u | 0.2 u | 0.2 u | 0.2 u | 1.6 |
| Total PCBs | 27 | 7 | 2 | 2 | 13 | 13 | 9 | 5 | 3 | 2 | 3 | 3 | 9 | 1 | 36 |
| ORGANOMETALLICS | | | | | | | | | | | | | | | |
| Tributyltin (2) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

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**Table 3. Olympia Harbor 1988 -**

| | C16 | C17 | C18 | S1 | S2 | S3 | S4 | S5 |
|---|---|---|---|---|---|---|---|---|
| SEDIMENT CONVENTIONALS | | | | | | | | |
| Total Solids | 53.6 | 74.9 | 77.2 | 52.5 | 41.5 | 57.7 | 37.4 | 37.6 |
| Total Volatile Solids | 7.01 | 1.89 | 1.98 | 9.42 | 11.08 | 4.75 | 10.95 | 10.3 |
| Total Organic Carbon | 2.34 | 0.44 | 0.4 | 3.18 | 3.83 | 3.15 | 3.8 | 3.57 |
| Ammonia | 1930 | 78.4 | 146 | 347 | 263 | 84 | 218 | 151 |
| Total Sulfides | 56.3 | 5 u | 5 u | 77.8 | 101 | 45 | 127 | 141 |
| METALS | | | | | | | | |
| Antimony | 0.15 | 0.15 | 0.19 | 0.15 | 0.15 | 0.1 | 0.29 | 0.32 |
| Arsenic | 5.54 | 3.31 | 1.85 | 5.66 | 8.65 | 3.72 | 8.62 | 10 |
| Cadmium (1) | 1.52 | 0.42 | 0.24 | 1.62 | 2.19 | 1.33 | 2.09 | 2.58 |
| Copper (1) | 40.2 | 5.95 | 13.5 | 28.1 | 63.9 | 17.1 | 83.9 | 103 |
| Lead (1) | 13.2 | 5.6 | 5.2 | 13.7 | 22.9 | 5.2 | 31.5 | 33.5 |
| Mercury | 0.09 | 0.02 u | 0.02 u | 0.02 u | 0.12 | 0.02 u | 0.32 | 0.37 |
| Nickel | 29.1 | 29.8 | 42.6 | 26.3 | 33.3 | 17.5 | 31.7 | 39.9 |
| Silver | 0.15 | 0.06 | 0.05 | 0.09 | 0.24 | 0.08 | 0.58 | 0.68 |
| Zinc (1) | 67 | 43 | 51 | 60 | 97 | 40 | 109 | 129 |
| LPAH | | | | | | | | |
| 2-Methylnaphthalene (1) | 9 | 2 u | 2 u | 19 | 23 | 2 | 14 | 18 |
| Acenaphthene (1) | 2 | 2 u | 2 u | 6 | 15 | 1 u | 6 | 8 |
| Acenaphthylene (1) | 13 | 1 u | 1 u | 24 | 32 | 1 u | 4 | 10 |
| Anthracene (1) | 21 | 0.7 u | 0.8 u | 19 | 48 | 3 | 28 | 36 |
| Fluorene (1) | 8 | 1 u | 1 u | 7 | 17 | 1 u | 10 | 6 |
| Naphthalene (1) | 130 | 3 | 1 u | 230 | 180 | 32 | 73 | 130 |
| Phenanthrene (1) | 100 | 3 | 0.8 u | 110 | 180 | 22 | 110 | 120 |
| Total LPAH (1) | 283 | 6 | 2 u | 415 | 495 | 59 | 245 | 328 |
| HPAH | | | | | | | | |
| Benzo(a)anthracene (1) | 28 | 0.5 u | 0.6 u | 23 | 130 | 9 | 89 | 70 |
| Benzo(a)pyrene | 36 | 2 | 0.5 u | 24 | 110 | 8 | 84 | 91 |
| Benzo(g,h,i)perylene (1) | 27 | 1 | 0.6 u | 22 | 83 | 2 u | 56 | 66 |
| Benzofluoranthenes (1) | 87 | 1 | 0.5 u | 56 | 270 | 16 | 230 | 240 |
| Chrysene (1) | 36 | 1 | 0.6 u | 28 | 140 | 16 | 150 | 94 |
| Dibenzo(a,h)anthracene (1) | 1 u | 0.5 u | 0.6 u | 1 u | 4 | 2 u | 4 u | 1 |
| Fluoranthene | 140 | 2 | 0.7 u | 150 | 410 | 33 | 180 | 200 |
| Indeno(1,2,3-c,d)pyrene (1) | 21 | 0.5 u | 0.5 u | 10 | 55 | 3 u | 64 | 54 |
| Pyrene (1) | 210 | 2 | 0.6 u | 180 | 760 | 38 | 270 | 320 |
| Total HPAH (1) | 585 | 9 | 0.7 u | 493 | 1962 | 120 | 1123 | 1136 |
| CHLORINATED HYDROCARBONS | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | 1 u | 0.7 u | 0.7 u | 1 u | 2 u | 2 u | 4 u | 0.8 u |
| 1,2-Dichlorobenzene | - | - | - | - | - | - | - | - |
| 1,3-Dichlorobenzene (2) | - | - | - | - | - | - | - | - |
| 1,4-Dichlorobenzene | - | - | - | - | - | - | - | - |
| Hexachlorobenzene | 0.2 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.2 u | 0.5 u | 0.2 u |
| PHTHALATES | | | | | | | | |
| Bis(2-ethylhexyl)phthalate (2) | 190 | 22 | 22 | 180 | 400 | 76 | 26 | 490 |
| Butyl benzyl phthalate (3) | 16 | 0.4 u | 0.4 u | 43 | 200 | 8 u | 10 | 100 |
| Di-n-butyl phthalate (2) | 9 | 0.9 | 0.9 | 7 | 22 | 2 u | 1 | 21 |
| Di-n-octyl phthalate (3) | 9 | 0.4 u | 0.4 u | 16 | 98 | 4 u | 9 | 98 |
| Diethyl phthalate (3) | 3 u | 1 | 1 | 3 u | 4 u | 2 | 0.2 u | 5 u |
| Dimethyl phthalate (2) | 3 u | 0.2 u | 0.2 u | 4 u | 5 u | 3 u | 0.3 u | 6 u |
| PHENOLS | | | | | | | | |
| 2 Methylphenol (1) | 4 u | 2 | 10 | 5 u | 6 u | 3 u | 4 u | 6 u |
| 2,4-Dimethylphenol (1) | 2 u | 0.4 u | 0.4 u | 2 u | 3 u | 1 u | 2 u | 3 u |
| 4 Methylphenol (1) | 25 | 2 | 3 | 110 | 71 | 90 | 56 | 46 |
| Pentachlorophenol | 7 u | 0.2 u | 0.3 u | 7 u | 10 u | 5 u | 7 u | 11 u |
| Phenol | 12 | 17 | 18 | 32 | 31 | 28 | 26 | 2 u |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | |
| Benzoic acid (1) | 9 | 0.1 u | 2 | 16 | 31 | 0.6 u | 3 | 1 u |
| Benzyl alcohol (1) | - | - | - | - | - | - | - | - |
| Dibenzofuran (1) | 5 u | 0.09 u | 0.1 u | 14 | 17 | 1 u | 8 | 3 u |
| Hexachlorobutadiene | 0.3 u | 0.2 u | 0.2 u | 0.3 u | 0.3 u | 0.3 u | 0.7 u | 0.4 u |
| Hexachloroethane | - | - | - | - | - | - | - | - |
| N-Nitrosodiphenylamine | 4 u | 0.1 u | 0.1 u | 4 u | 5 u | 2 u | 3 u | 6 u |
| VOLATILE ORGANICS | | | | | | | | |
| Ethylbenzene | 2 u | 0.9 u | 0.9 u | 1 u | 2 u | 1 u | 2 u | 2 u |
| Tetrachloroethene | 0.9 u | 0.5 u | 0.5 u | 1 u | 1 u | 0.8 u | 1 u | 1 u |
| Total Xylene (1) | 3 u | 2 u | 2 u | 3 u | 4 u | 3 u | 4 u | 4 u |
| Trichloroethene | 1 u | 0.7 u | 0.7 u | 1 u | 1 u | 1 u | 1 u | 1 u |
| PESTICIDES AND PCBs | | | | | | | | |
| Aldrin (2) | 2 u | 0.1 u | 0.1 u | 3 u | 1 u | 0.3 u | 0.6 u | 2 u |
| Chlordane (2) | 0.5 | 0.1 u | 0.1 u | 0.2 u | 0.6 | 0.2 u | 0.5 u | 0.3 u |
| Dieldrin (2) | 0.2 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.3 u | 0.5 u | 0.2 u |
| Heptachlor (2) | 0.2 u | 0.1 u | 0.1 u | 0.3 u | 0.3 u | 0.3 u | 0.6 u | 0.3 u |
| Lindane (2) | 0.2 u | 0.1 u | 0.1 u | 0.2 u | 0.2 u | 0.3 u | 0.5 u | 0.2 u |
| Total DDT | 1.6 | 0.2 u | 0.2 u | 0.4 u | 0.4 u | 0.4 u | 5 | 2 |
| Total PCBs | 40 | 3 | 2 | 30 | 38 | 21 | 68 | 75 |
| ORGANOMETALLICS | | | | | | | | |
| Tributyltin (2) | - | - | - | - | - | - | - | - |

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Table 4 Olympia Harbor Sediment Characterization Data Summary Compared to PSDDA Guidelines[a].

| PARAMETER | PSDDA CHEMICAL GUIDELINES | | | OLYMPIA HARBOR | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Screening Level (SL) | Bioaccumulation Level (BT) | Maximum Level (ML) | B1 | B2 | MC1 | MC2 | MC3 | MC4 | MC5 | MC6 | MC7 | MC8 | MCW1 | MCW2 | OC1 | OC2 | OC3 | TBW1 | TBW2 |
| **CONVENTIONALS** | | | | | | | | | | | | | | | | | | | | |
| Total Solids (%) | --- | --- | --- | 49.9 | 72.2 | 40.4 | 40.8 | 45.7 | 42 | 38.6 | 38.2 | 44.1 | 61.6 | 57.7 | 72.0 | 40.6 | 39.8 | 53.3 | 43 | 71.7 |
| Total Volatile Solids (mg/kg) | --- | --- | --- | 69,000 | 33,000 | 87,000 | 88,000 | 74,000 | 84,000 | 98,000 | 86,000 | 69,000 | 42,000 | 42,000 | 23,000 | 79,000 | 77,000 | 49,000 | 100,000 | 27,000 |
| N-Ammonia (mg/L) | --- | --- | --- | 7.8 | 58 | 4.8 | 4.9 | 87 | 9.2 | 78 | 68 | 77 | 69 | 43 | 50 | 92 | 56 | 40 | 94 | 50 |
| Sulfides (mg/L) | --- | --- | --- | 360 | 0.62 U | 460 | 90 | 19 | 430 | 900 | 170 | 960 | 48 | 430 | 1.3U | 950 | 1100 | 46 | 130 | 26 |
| Total Organic Carbon (%) | --- | --- | --- | 2.7 | 1.6 | 2.9 | 2.8 | 2.3 | 2.5 | 2.7 | 2.7 | 2.3 | 1.9 | 1.4 | 0.74 | 2.4 | 2.3 | 1.7 | 3.2 | 1.0 |
| Grain Size | | | | | | | | | | | | | | | | | | | | |
| % gravel | --- | --- | --- | 22.5 | 32.7 | 7.5 | 0.9 | 1.4 | 2.2 | 0.6 | 1.5 | 1.8 | 14.1 | 4 | 6.5 | 2.9 | 5 | 3.8 | 2.8 | 4.5 |
| % sand | --- | --- | --- | 39 | 50.3 | 26.9 | 25 | 27.1 | 20.1 | 19.2 | 28.5 | 30.8 | 52.8 | 52.1 | 65.8 | 28.5 | 22.3 | 49.6 | 18.3 | 71.3 |
| % silt | --- | --- | --- | 20.6 | 10.7 | 36.9 | 42.1 | 43.4 | 45.7 | 46.4 | 38.6 | 38.9 | 21.6 | 27.9 | 18.8 | 39.7 | 42.5 | 28.2 | 49.8 | 16.8 |
| % clay | --- | --- | --- | 18 | 6.3 | 28.6 | 31.8 | 28 | 31.9 | 33.9 | 31.5 | 28.5 | 11.6 | 16.1 | 9 | 29 | 29.9 | 18.4 | 29.2 | 7.5 |
| **METALS (mg/kg dry weight)** | | | | | | | | | | | | | | | | | | | | |
| Antimony | 150 | 150 | 200 | 5 U | 3 U | 6 U | 6 U | 6 U | 6 U | 6 U | 7 U | 6 U | 4 U | 8 U | 7 U | 6 U | 6 U | 5 U | 6 U | 3 U |
| Arsenic | 57 | 507 | 700 | 5 | 6 | 7 | 6 | 9 | 6 | 6 | 7 | 8 | 8 | 9 | 7 U | 8 | 8 | 7 | 9 | 5 |
| Cadmium | 5.1 | --- | 14 | 1.6 | 0.7 | 1.8 | 1.8 | 1.7 | 1.5 | 2 | 1.7 | 1.4 | 0.7 | 0.9 | 0.7 | 1.8 | 1.7 | 1.2 | 2 | 0.6 |
| Chromium | --- | --- | --- | 34.9 | 27.3 | 41.7 | 43.7 | 39.6 | 38.8 | 42.9 | 39.6 | 38.6 | 27.7 | 28.9 | 24.6 | 42 | 43.5 | 31.1 | 40.9 | 22.3 |
| Copper | 390 | --- | 1,300 | 55.8 | 28.4 | 66.5 | 66.5 | 60.4 | 52.4 | 64.6 | 60.6 | 49.9 | 29.1 | 27.6 | 16.6 | 63.2 | 50.7 | 32.2 | 63.9 | 17.3 |
| Lead | 450 | --- | 1,200 | 20 | 14 | 21 | 22 | 2 | 2 | 3 | 3 | 2 | 7 | 5 | 3 U | 20 | 3 | 8 | 20 | 3 |
| Mercury | 0.41 | 1.5 | 2.3 | 0.16 | 0.1 | 0.23 | 0.22 | 0.18 | 0.16 | 0.18 | 0.19 | 0.14 | 0.09 | 0.08 U | 0.06U | 0.24 | 0.13 | 0.09 | 0.21 | 0.02 |
| Nickel | 140 | 370 | 370 | 32 | 25.8 | 35 | 36 | 34 | 32 | 37 | 33 | 32 | 27.2 | 23 | 20 | 35 | 36 | 25 | 34 | 21.2 |
| Silver | 6.1 | 6.1 | 8.4 | 1 | 0.6 | 1.3 | 1.3 | 1 | 0.7 | 1.2 | 1 | 0.8 | 0.5 | 0.5 U | 0.4 U | 1.2 | 0.7 | 0.4 | 1.1 | 0.3 |
| Zinc | 410 | --- | 3,800 | 93.3 | 59.6 | 95.9 | 98.9 | 87.7 | 79.4 | 91.8 | 91.3 | 74.9 | 50.3 | 45.7 | 31.6 | 92 | 80.1 | 52.5 | 92 | 34.9 |
| **ORGANICS (ug/kg dry weight)** | | | | | | | | | | | | | | | | | | | | |
| Naphthalene | 2,100 | --- | 2,400 | 33 | 51 | 19 U | 20 U | 20 U | 20 U | 20 | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 38 | 19 U |
| Acenaphthylene | 560 | --- | 1,300 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Acenaphthene | 500 | --- | 2,000 | 20 | 340 | 19 U | 20 U | 20 U | 20 U | 19 U | 40 | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Fluorene | 540 | --- | 3,600 | 20 | 290 | 19 U | 20 U | 20 U | 20 U | 19 U | 31 | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Phenanthrene | 1,500 | --- | 21,000 | 280 | 880 | 35 | 26 | 23 | 22 | 35 | 380 | 20 | 19 U | 19 U | 20 U | 22 | 35 | 20 U | 49 | 19 U |
| Anthracene | 960 | --- | 13,000 | 20 | 20 | 19 U | 20 U | 20 U | 20 U | 19 U | 87 | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 21 | 19 U |
| 2-Methylnaphthalene | 670 | --- | 1,900 | 20 U | 30 | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Total LPAH | 5,200 | --- | 29,000 | 373 | 1611 | 35 | 26 | 23 | 22 | 55 | 538 | 20 | 19 U | 19 U | 20 U | 22 | 35 | 20 U | 108 | 19 U |
| Fluoranthene | 1,700 | 4,600 | 30,000 | 620 | 20 | 83 | 67 | 57 | 51 | 76 | 20 | 39 | 31 | 19 U | 20 U | 42 | 35 | 22 | 84 | 22 |
| Pyrene | 2,600 | --- | 16,000 | 630 | 860 | 19 | 20 | 84 | 85 | 19 | 250 | 63 | 42 | 33 | 20 U | 76 | 58 | 35 | 20 | 28 |
| Benzo(a)anthracene | 1,300 | --- | 5,100 | 240 | 270 | 41 | 47 | 24 | 23 | 34 | 36 | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 33 | 19 U |
| Chrysene | 1,400 | --- | 21,000 | 310 | 300 | 61 | 76 | 38 | 41 | 53 | 57 | 25 | 19 U | 19 U | 20 U | 25 | 20 | 20 U | 49 | 19 U |
| Benzofluoranthenes | 3,200 | --- | 9,900 | 20 | 20 | 64 | 70 | 40 | 41 | 67 | 37 | 33 | 19 U | 19 U | 20 U | 44 | 36 | 20 U | 54 | 19 U |
| Benzo(a)pyrene | 1,600 | 3,600 | 3,600 | 20 | 20 | 46 | 50 | 27 | 33 | 47 | 30 | 23 | 19 U | 19 U | 20 U | 25 | 20 | 20 U | 38 | 19 U |
| Indeno(1,2,3-cd)pyrene | 600 | --- | 4,400 | 56 | 44 | 25 | 29 | 20 U | 20 | 27 | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 23 | 19 U |
| Dibenz(a,h)anthracene | 230 | --- | 1,900 | 21 | 25 | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Benzo(g,h,i)perylene | 670 | --- | 3,200 | 52 | 44 | 29 | 31 | 20 U | 22 | 31 | 20 U | 22 | 19 U | 19 U | 20 U | 21 | 20 U | 20 U | 29 | 19 U |
| Total HPAH | 12,000 | --- | 69,000 | 1,969 | 1,603 | 368 | 390 | 270 | 316 | 354 | 430 | 205 | 73 | 33 | 20 U | 233 | 169 | 57 | 330 | 50 |
| 1,2-Dichlorobenzene | 35 | 37 | 110 | 1.0 U | 0.8 U | 2.3 U | 2.2 U | 1.2 U | 1.3 U | 2.1 U | 2.8 U | 2.8 U | 1.0 U | 1.7 U | 0.9 U | 2.2 U | 2.5 U | 1.5 U | 2.0 U | 1.0 U |
| 1,3-Dichlorobenzene | 170 | --- | --- | 1.0 U | 0.8 U | 2.3 U | 2.2 U | 1.2 U | 1.3 U | 2.1 U | 2.8 U | 2.8 U | 1.0 U | 1.7 U | 0.9 U | 2.2 U | 2.5 U | 1.5 U | 2.0 U | 1.0 U |
| 1,4-Dichlorobenzene | 110 | 120 | 120 | 1.0 U | 0.8 U | 2.3 U | 2.2 U | 1.2 U | 1.3 U | 2.1 U | 2.8 U | 2.8 U | 1.0 U | 1.7 U | 0.9 U | 2.2 U | 2.5 U | 1.5 U | 2.0 U | 1.0 U |
| 1,2,4-Trichlorobenzene | 31 | --- | 64 | 5.1 U | 4.2 U | 11 U | 11 U | 6.2 U | 6.7 U | 11 U | 14 U | 14 U | 5.0 U | 8.7 U | 4.5 U | 11 U | 12 U | 7.3 U | 9.8 U | 4.8 U |
| Hexachlorobenzene | 22 | 168 | 230 | 1.0 U | 0.8 U | 2.3 U | 2.2 U | 1.2 U | 1.3 U | 2.1 U | 2.8 U | 2.8 U | 1.0 U | 1.7 U | 0.9 U | 2.2 U | 2.5 U | 1.5 U | 2.0 U | 1.0 U |
| Dimethylphthalate | 1,400 | 1,400 | --- | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Diethylphthalate | 1,200 | --- | --- | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |

Table 4 Olympia Harbor Sediment Characterization Data Summary Compared to PSDDA Guidelines[a].

| PARAMETER | PSDDA CHEMICAL GUIDELINES Screening Level (SL) | Bioaccumulation Level (BT) | Maximum Level (ML) | OLYMPIA HARBOR B1 | B2 | MC1 | MC2 | MC3 | MC4 | MC5 | MC6 | MC7 | MC8 | MCW1 | MCW2 | OC1 | OC2 | OC3 | TBW1 | TBW2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Di-n-butylphthalate | 5,100 | 10,220 | --- | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Butylbenzylphthalate | 970 | --- | --- | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Bis(2-ethylhexyl)phthalate | 8,300 | 13,870 | --- | 76 | 55 | 50 | 34 | 30 | 35 | 64 | 28 | 26 | 19 U | 30 | 20 U | 28 | 29 | 20 U | 38 | 19 U |
| Di-n-octyl phthalate | 6,200 | --- | --- | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Phenol | 420 | 876 | 1,200 | 20 U | 20 U | 19 U | 20 U | 20 | 20 U | 19 U | 20 U | 38 | 19 U | 24 | 22 | 20 U | 20 U | 20 U | 20 U | 19 U |
| 2-Methylphenol | 63 | --- | 77 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| 4-Methylphenol | 670 | --- | 3,600 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| 2,4-Dimethylphenol | 29 | --- | 210 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Pentachlorophenol | 400 | 504 | 690 | 98 U | 98 U | 97 U | 100 U | 98 U | 100 U | 97 U | 98 U | 97 U | 94 U | 95 U | 98 U | 99 U | 99 U | 99 U | 98 U | 96 U |
| Benzyl Alcohol | 57 | --- | 870 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Benzoic Acid | 650 | --- | 760 | 200 U | 200 U | 190 U | 200 U | 200 U | 200 U | 190 U | 200 U | 220 | 190 U | 190 U | 200 U | 200 U | 200 U | 200 U | 200 U | 190 U |
| Dibenzofuran | 540 | --- | 1,700 | 27 | 59 | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Hexachloroethane | 1,400 | 10,220 | 14,000 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Hexachlorobutadiene | 540 | 212 | 270 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| N-Nitrosodiphenylamine | 28 | 130 | 130 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Trichloroethene | 160 | 1,168 | 1,600 | 1 U | 0.8 U | 2.3 U | 2.2 U | 1.2 U | 1.3 U | 2.1 U | 2.8 U | 2.8 U | 1 U | 1.7 U | 0.9 U | 2.2 U | 2.5 U | 1.5 U | 2 U | 1 U |
| Tetrachloroethene | 57 | 102 | 210 | 1 U | 0.8 U | 2.3 U | 2.2 U | 1.2 U | 1.3 U | 2.1 U | 2.8 U | 2.8 U | 1 U | 1.7 U | 0.9 U | 2.2 U | 2.5 U | 1.5 U | 2 U | 1 U |
| Ethylbenzene | 10 | 27 | 50 | 1 U | 0.8 U | 2.3 U | 2.2 U | 1.2 U | 1.3 U | 2.1 U | 2.8 U | 2.8 U | 1 U | 1.7 U | 0.9 U | 2.2 U | 2.5 U | 1.5 U | 2 U | 1 U |
| Total Xylene | 40 | --- | 160 | 1 U | 0.8 U | 2.3 U | 2.2 U | 1.2 U | 1.3 U | 2.1 U | 2.8 U | 2.8 U | 1 U | 1.7 U | 0.9 U | 2.2 U | 2.5 U | 1.5 U | 2 U | 1 U |
| Total DDT | 6.9 | 50 | 69 | 3.9 | 1.7 | 2.6 | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.3 U | 1.8 U | 1.9 U | 2.0 U | 1.3 U | 2 U | 1.9 U | 1.9 U | 2 |
| 4,4'-DDE | --- | --- | --- | 1.3 | 1.3 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.3 U | 1.8 U | 1.9 U | 2.0 U | 1.3 U | 2 U | 1.9 U | 1.9 U | 1.8 U |
| 4,4'-DDD | --- | --- | --- | 1.5 UY | 1.5 UY | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.3 U | 1.8 U | 1.9 U | 2.0 U | 1.3 U | 2 U | 1.9 U | 1.9 U | 1.8 U |
| 4,4'-DDT | --- | --- | --- | 2.6 | 1.7 | 2.6 | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.3 U | 1.8 U | 1.9 U | 2.0 U | 1.3 U | 2 U | 1.9 U | 1.9 U | 2 |
| Aldrin | 10 | 37 | --- | 0.65 U | 0.65 U | 0.93 U | 0.94 U | 0.97 U | 0.95 U | 0.92 U | 0.93 U | 0.64 U | 0.88 U | 0.95 U | 0.98 U | 0.63 U | 0.99 U | 0.94 U | 0.97 U | 0.92 U |
| Chlordane | 10 | 37 | --- | 1.2 UY | 1 UY | 0.93 U | 0.94 U | 0.97 U | 0.95 U | 0.92 U | 0.93 U | 0.73 UY | 0.88 U | 0.95 U | 0.98 U | 0.8 UY | 0.99 U | 0.94 U | 0.97 U | 0.92 U |
| Dieldrin | 10 | 37 | --- | 1.3 U | 1.3 U | 1.9 U | 1.9 U | 1.9 U | 1.9 U | 1.8 U | 1.9 U | 1.3 U | 1.8 U | 0.95 U | 0.98 U | 1.3 U | 2 U | 1.9 U | 1.9 U | 1.8 U |
| Heptachlor | 10 | 37 | --- | 0.65 U | 0.65 U | 0.93 U | 0.94 U | 0.97 U | 0.95 U | 0.92 U | 0.93 U | 0.64 U | 0.88 U | 0.95 U | 0.98 U | 0.63 U | 0.99 U | 0.94 U | 0.97 U | 0.92 U |
| gamma-BHC (Lindane) | 10 | --- | --- | 0.65 U | 0.65 U | 0.93 U | 0.94 U | 0.97 U | 0.95 U | 0.92 U | 0.93 U | 0.64 U | 0.88 U | 0.95 U | 0.98 U | 0.63 U | 0.99 U | 0.94 U | 0.97 U | 0.92 U |
| Total PCBs | 130 | 38[b] | 3,100 | 35 | 51 | 37 U | 38 U | 39 U | 38 U | 37 U | 27 | 18 | 18 J | 38 U | 39 U | 20 | 20 J | 19 J | 25 | 24 |
| Aroclor 1016 | --- | --- | --- | 13 U | 13 U | 19 U | 19 U | 19 U | 19 U | 18 U | 19 U | 13 U | 18 U | 19 U | 20 U | 13 U | 20 U | 19 U | 19 U | 18 U |
| Aroclor 1242 | --- | --- | --- | 13 U | 13 U | 19 U | 19 U | 19 U | 19 U | 18 U | 19 U | 13 U | 18 U | 19 U | 20 U | 13 U | 20 U | 19 U | 19 U | 18 U |
| Aroclor 1248 | --- | --- | --- | 13 U | 13 U | 19 U | 19 U | 19 U | 19 U | 18 U | 19 U | 13 U | 18 U | 19 U | 20 U | 13 U | 20 U | 19 U | 19 U | 18 U |
| Aroclor 1254 | --- | --- | --- | 35 | 28 | 27 | 28 | 24 | 25 | 18 U | 27 | 18 | 18 J | 19 U | 20 U | 20 | 20 J | 19 J | 25 | 24 |
| Aroclor 1260 | --- | --- | --- | 13 U | 23 | 19 U | 19 U | 19 U | 19 U | 18 U | 19 U | 13 U | 18 U | 19 U | 20 U | 13 U | 20 U | 19 U | 19 U | 18 U |
| Aroclor 1221 | --- | --- | --- | 26 U | 26 U | 37 U | 38 U | 39 U | 38 U | 37 U | 37 U | 26 U | 35 U | 38 U | 39 U | 25 U | 39 U | 37 U | 39 U | 37 U |
| Aroclor 1232 | --- | --- | --- | 13 U | 13 U | 19 U | 19 U | 19 U | 19 U | 18 U | 19 U | 13 U | 18 U | 19 U | 20 U | 13 U | 20 U | 19 U | 19 U | 18 U |
| Tributyl Tin (ug/L porewater) | --- | 0.15 | --- | 0.28 | 0.13 | 0.04 | 0.02 | 0.03 M | 0.05 | 0.05 M | 0.02 M | 0.04 | 0.05 | 0.02 U | 0.02 U | 0.02 J | 0.02 U | 0.02 | 0.16 | 0.02 MJ |

[a]All units are dry weight based unless otherwise noted.
[b]Total PCBs BT value in ppm carbon-normalized.
M=Indicates an estimated value of analtye found and confirmed by analyst but with low spectral match.
U=Chemical is undetected and is reported at the detection limit.
Y=Indicates raised reporting limit due to background interference. Compound is still not detected at or above the raised level.
J = Indicates an estimated value.

[box] = BT Exceedance

Table 5. Olympia Harbor Sediment Characterization Data Summary Compared to Marine Sediment Quality Standards (WAC 173-204).

| PARAMETER | SEDIMENT QUALITY CRITERIA | | | OLYMPIA HARBOR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 SQS | 1995 MCUL | Draft 1998 SQS | B1 | B2 | MC1 | MC2 | MC3 | MC4 | MC5 | MC6 | MC7 | MC8 |
| **CONVENTIONALS** | | | | | | | | | | | | | |
| Total Solids (%) | --- | --- | --- | 49.9 | 72.2 | 40.4 | 40.8 | 45.7 | 42 | 38.6 | 38.2 | 44.1 | 61.6 |
| Total Volatile Solids (mg/kg) | --- | --- | --- | 69,000 | 33,000 | 87,000 | 88,000 | 74,000 | 84,000 | 98,000 | 86,000 | 69,000 | 42,000 |
| N-Ammonia (mg/L) | --- | --- | --- | 7.8 | 58 | 4.8 | 4.9 | 87 | 9.2 | 78 | 68 | 77 | 69 |
| Sulfides (mg/L) | --- | --- | --- | 360 | 0.62 U | 460 | 90 | 19 | 430 | 900 | 170 | 960 | 48 |
| Total Organic Carbon (%) | --- | --- | --- | 2.7 | 1.6 | 2.9 | 2.8 | 2.3 | 2.5 | 2.7 | 2.7 | 2.3 | 1.9 |
| Grain Size | | | | | | | | | | | | | |
| % gravel | --- | --- | --- | 22.5 | 32.7 | 7.5 | 0.9 | 1.4 | 2.2 | 0.6 | 1.5 | 1.8 | 14.1 |
| % sand | --- | --- | --- | 39 | 50.3 | 26.9 | 25 | 27.1 | 20.1 | 19.2 | 28.5 | 30.8 | 52.8 |
| % silt | --- | --- | --- | 20.6 | 10.7 | 36.9 | 42.1 | 43.4 | 45.7 | 46.4 | 38.6 | 38.9 | 21.6 |
| % clay | --- | --- | --- | 18 | 6.3 | 28.6 | 31.8 | 28 | 31.9 | 33.9 | 31.5 | 28.5 | 11.6 |
| **METALS (mg/kg dry weight)** | | | | | | | | | | | | | |
| Arsenic | 57 | 93 | 57 | 5 | 6 | 7 | 6 | 9 | 6 | 6 | 7 | 8 | 8 |
| Cadmium | 5.1 | 6.7 | 2.7 | 1.6 | 0.7 | 1.8 | 1.8 | 1.7 | 1.5 | 2 | 1.7 | 1.4 | 0.7 |
| Chromium | 260 | 270 | 62 | 34.9 | 27.3 | 41.7 | 43.7 | 39.6 | 38.8 | 42.9 | 39.6 | 38.6 | 27.7 |
| Copper | 390 | 390 | 270 | 55.8 | 28.4 | 66.5 | 66.5 | 60.4 | 52.4 | 64.6 | 60.6 | 49.9 | 29.1 |
| Lead | 450 | 530 | 360 | 20 | 14 | 21 | 22 | 2 | 2 | 3 | 3 | 2 | 7 |
| Mercury | 0.41 | 0.59 | 0.41 | 0.16 | 0.1 | 0.23 | 0.22 | 0.18 | 0.16 | 0.18 | 0.19 | 0.14 | 0.09 |
| Silver | 6.1 | 6.1 | 3.3 | 1 | 0.6 | 1.3 | 1.3 | 1 | 0.7 | 1.2 | 1 | 0.8 | 0.5 |
| Zinc | 410 | 960 | 410 | 93.3 | 59.6 | 95.9 | 98.9 | 87.7 | 79.4 | 91.8 | 91.3 | 74.9 | 50.3 |
| **ORGANICS (mg/kg OC)** | | | | | | | | | | | | | |
| Naphthalene | 99 | 170 | 39 | 1.2 | 3.1 | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.8 | 0.7 U | 0.9 U | 1.0 U |
| Acenaphthylene | 66 | 66 | 5.4 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Acenaphthene | 16 | 57 | 16 | 6.7 | 20 | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 1.5 | 0.9 U | 1.0 U |
| Fluorene | 23 | 79 | 23 | 5.0 | 17 | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 1.1 | 0.9 U | 1.0 U |
| Phenanthrene | 100 | 480 | 100 | 10 | 53 | 1.2 | 0.9 | 1.0 | 0.9 | 1.3 | 14 | 0.9 | 1.0 U |
| Anthracene | 220 | 1,200 | 93 | 4.0 | 10 | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 3.2 | 0.9 U | 1.0 U |
| 2-Methylnaphthalene | 38 | 64 | 13 | 0.7 U | 1.8 | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Total LPAH | 370 | 780 | 22 | 26.9 | 104.9 | 1.2 | 0.9 | 1.0 | 0.9 | 2.1 | 19.8 | 0.9 | 1.0 U |
| Fluoranthene | 160 | 1,200 | 160 | 23 | 62 | 2.8 | 2.3 | 2.5 | 2.0 | 2.8 | 7.1 | 1.7 | 1.6 |
| Pyrene | 1,000 | 1,400 | 520 | 23 | 52 | 4.4 | 3.6 | 3.6 | 3.4 | 5.4 | 9.3 | 2.8 | 2.2 |
| Benzo(a)anthracene | 110 | 270 | 110 | 8.8 | 17 | 1.4 | 1.7 | 1.0 | 0.9 | 1.2 | 1.3 | 0.9 U | 1.0 U |
| Chrysene | 110 | 460 | 110 | 11 | 18 | 2.1 | 2.7 | 1.6 | 1.6 | 2.0 | 2.1 | 1.1 | 1.0 U |
| Benzofluoranthenes | 230 | 450 | 230 | 12.3 | 18.9 | 3.8 | 4.3 | 3.1 | 3.1 | 4.3 | 2.6 | 2.7 | 1.0 U |
| Benzo(a)pyrene | 99 | 210 | 99 | 5.2 | 7.9 | 1.6 | 1.8 | 1.2 | 1.3 | 1.7 | 1.1 | 1.0 | 1.0 U |
| Indeno(1,2,3-cd)pyrene | 34 | 88 | 34 | 2.0 | 2.7 | 0.9 | 1.0 | 0.8 U | 0.8 | 1.0 | 0.7 U | 0.9 U | 1.0 U |
| Dibenz(a,h)anthracene | 12 | 33 | 12 | 0.8 | 1.5 | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Benzo(g,h,i)perylene | 31 | 78 | 31 | 1.9 | 2.7 | 1.0 | 1.1 | 0.8 U | 0.9 | 1.1 | 0.7 U | 1.0 | 1.0 U |
| Total HPAH | 960 | 5,300 | 150 | 88 | 182.7 | 18 | 18.5 | 13 | 14.0 | 19.5 | 23.5 | 10.3 | 3.8 |
| 1,2-Dichlorobenzene | 2.3 | 2.3 | 0.65 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| 1,4-Dichlorobenzene | 3.1 | 9 | 3.1 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| 1,2,4-Trichlorobenzene | 0.81 | 1.8 | 0.81 | 0.7 U | **1.2 U** | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | **0.9 U** | **1.0 U** |
| Hexachlorobenzene | 0.38 | 2.3 | 0.38 | **0.7 U** | **1.2 U** | **0.7 U** | **0.7 U** | **0.8 U** | **0.8 U** | **0.7 U** | **0.7 U** | **0.9 U** | **1.0 U** |
| Dimethylphthalate | 53 | 53 | 2.4 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Diethylphthalate | 61 | 110 | 61 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Di-n-butylphthalate | 220 | 1,700 | 0.88 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Butylbenzylphthalate | 4.9 | 64.0 | 4.9 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Bis(2-ethylhexyl)phthalate | 47 | 78 | 47 | 2.8 | 3.3 | 1.7 | 1.2 | 1.3 | 1.4 | 2.4 | 1.0 | 1.1 | 1.0 U |
| Di-n-octyl phthalate | 58 | 4,500 | 3.1 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Dibenzofuran | 15 | 58 | 15 | 1.0 | 3.6 | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Hexachlorobutadiene | 3.9 | 6.2 | 3.9 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| N-Nitrosodiphenylamine | 11 | 11 | 11 | 0.7 U | 1.2 U | 0.7 U | 0.7 U | 0.8 U | 0.8 U | 0.7 U | 0.7 U | 0.9 U | 1.0 U |
| Total PCBs | 12 | 65 | 12 | 1.3 | 3.1 | 0.93 | 1.0 | 1.0 | 0.98 | 1.4 U | 1.0 | 0.78 | 0.83 J |
| **ORGANICS (ug/kg dry weight)** | | | | | | | | | | | | | |
| Phenol | 420 | 1,200 | 180 | 20 U | 20 U | 19 U | 20 U | 20 | 20 U | 19 U | 20 U | 38 | 19 U |
| 2-Methylphenol | 63 | 63 | 23 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U |
| 4-Methylphenol | 670 | 670 | 110 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U |
| 2,4-Dimethylphenol | 29 | 29 | 18 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U |
| Pentachlorophenol | 360 | 690 | 180 | 98 U | 98 U | 97 U | 100 U | 98 U | 100 U | 97 U | 98 U | 97 U | 94 U |
| Benzyl Alcohol | 57 | 73 | 57 | 20 U | 20 U | 19 U | 20 U | 20 U | 20 U | 19 U | 20 U | 19 U | 19 U |
| Benzoic Acid | 650 | 650 | 65 | 200 U | 200 U | 190 U | 200 U | 200 U | 200 U | 190 U | 200 U | 220 | 190 U |

U=Chemical is undetected and is reported at the detection limit.
J = Indicates an estimated value.

[ ] = Exceeds 1995 SQS
[shaded] = Exceeds 1995 MCUL.

Table 5. Olympia Harbor Sediment Characterization Data Summary Compared to Marine Sediment Quality Standards (WAC 173-204).

| PARAMETER | SEDIMENT QUALITY CRITERIA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 SQS | 1995 MCUL | Draft 1998 SQS | MCW1 | MCW2 | OC1 | OC2 | OC3 | TBW1 | TBW2 |
| **CONVENTIONALS** | | | | | | | | | | |
| Total Solids (%) | --- | --- | --- | 57.7 | 72.0 | 40.6 | 39.8 | 53.3 | 43 | 71.7 |
| Total Volatile Solids (mg/kg) | --- | --- | --- | 42,000 | 23,000 | 79,000 | 77,000 | 49,000 | 100,000 | 27,000 |
| N-Ammonia (mg/L) | --- | --- | --- | 43 | 50 | 92 | 56 | 40 | 94 | 50 |
| Sulfides (mg/L) | --- | --- | --- | 430 | 1.3U | 950 | 1100 | 46 | 130 | 26 |
| Total Organic Carbon (%) | --- | --- | --- | 1.4 | 0.74 | 2.4 | 2.3 | 1.7 | 3.2 | 1.0 |
| Grain Size | | | | | | | | | | |
| % gravel | --- | --- | --- | 4 | 6.5 | 2.9 | 5 | 3.8 | 2.8 | 4.5 |
| % sand | --- | --- | --- | 52.1 | 65.8 | 28.5 | 22.3 | 49.6 | 18.3 | 71.3 |
| % silt | --- | --- | --- | 27.9 | 18.8 | 39.7 | 42.5 | 28.2 | 49.8 | 16.8 |
| % clay | --- | --- | --- | 16.1 | 9 | 29 | 29.9 | 18.4 | 29.2 | 7.5 |
| **METALS (mg/kg dry weight)** | | | | | | | | | | |
| Arsenic | 57 | 93 | 57 | 9 | 7 U | 8 | 8 | 7 | 9 | 5 |
| Cadmium | 5.1 | 6.7 | 2.7 | 0.9 | 0.7 | 1.8 | 1.7 | 1.2 | 2 | 0.6 |
| Chromium | 260 | 270 | 62 | 28.9 | 24.6 | 42 | 43.5 | 31.1 | 40.9 | 22.3 |
| Copper | 390 | 390 | 270 | 27.6 | 16.6 | 63.2 | 50.7 | 32.2 | 63.9 | 17.3 |
| Lead | 450 | 530 | 360 | 5 | 3 U | 20 | 3 | 8 | 20 | 3 |
| Mercury | 0.41 | 0.59 | 0.41 | 0.08 U | 0.06U | 0.24 | 0.13 | 0.09 | 0.21 | 0.02 |
| Silver | 6.1 | 6.1 | 3.3 | 0.5 U | 0.4 U | 1.2 | 0.7 | 0.4 | 1.1 | 0.3 |
| Zinc | 410 | 960 | 410 | 45.7 | 31.6 | 92 | 80.1 | 52.5 | 92 | 34.9 |
| **ORGANICS (mg/kg OC)** | | | | | | | | | | |
| Naphthalene | 99 | 170 | 39 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 1.2 | 1.8 U |
| Acenaphthylene | 66 | 66 | 5.4 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Acenaphthene | 16 | 57 | 16 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Fluorene | 23 | 79 | 23 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Phenanthrene | 100 | 480 | 100 | 1.4 U | 2.7 U | 0.9 | 1.5 | 1.2 U | 1.5 | 1.8 U |
| Anthracene | 220 | 1,200 | 93 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.7 | 1.8 U |
| 2-Methylnaphthalene | 38 | 64 | 13 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Total LPAH | 370 | 780 | 22 | 1.4 U | 2.7 U | 0.9 | 1.5 | 1.2 U | 3.4 | 1.8 U |
| Fluoranthene | 160 | 1,200 | 160 | 1.4 U | 2.7 U | 1.8 | 1.5 | 1.3 | 2.6 | 2.1 |
| Pyrene | 1,000 | 1,400 | 520 | 2.4 | 2.7 U | 3.2 | 2.5 | 2.0 | 4.6 | 2.7 |
| Benzo(a)anthracene | 110 | 270 | 110 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 1.0 | 1.8 U |
| Chrysene | 110 | 460 | 110 | 1.4 U | 2.7 U | 1.0 | 0.9 | 1.2 U | 1.5 | 1.8 U |
| Benzofluoranthenes | 230 | 450 | 230 | 1.4 U | 2.7 U | 3.0 | 2.4 | 1.2 U | 2.9 | 1.8 U |
| Benzo(a)pyrene | 99 | 210 | 99 | 1.4 U | 2.7 U | 1.0 | 0.9 | 1.2 U | 1.2 | 1.8 U |
| Indeno(1,2,3-cd)pyrene | 34 | 88 | 34 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.7 | 1.8 U |
| Dibenz(a,h)anthracene | 12 | 33 | 12 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Benzo(g,h,i)perylene | 31 | 78 | 31 | 1.4 U | 2.7 U | 0.9 | 0.8 U | 1.2 U | 0.9 | 1.8 U |
| Total HPAH | 960 | 5,300 | 150 | 2.4 | 2.7 U | 10.9 | 8.2 | 3.3 | 15.4 | 4.8 |
| 1,2-Dichlorobenzene | 2.3 | 2.3 | 0.65 | 1.4 U | **2.7 U** | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| 1,4-Dichlorobenzene | 3.1 | 9 | 3.1 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| 1,2,4-Trichlorobenzene | 0.81 | 1.8 | 0.81 | **1.4 U** | **2.7 U** | 0.8 U | 0.8 U | **1.2 U** | 0.6 U | **1.8 U** |
| Hexachlorobenzene | 0.38 | 2.3 | 0.38 | **1.4 U** | **2.7 U** | **0.8 U** | **0.8 U** | **1.2 U** | 0.6 U | **1.8 U** |
| Dimethylphthalate | 53 | 53 | 2.4 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Diethylphthalate | 61 | 110 | 61 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Di-n-butylphthalate | 220 | 1,700 | 0.88 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Butylbenzylphthalate | 4.9 | 64.0 | 4.9 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Bis(2-ethylhexyl)phthalate | 47 | 78 | 47 | 2.2 | 2.7 U | 1.2 | 1.2 | 1.2 U | 1.2 | 1.8 U |
| Di-n-octyl phthalate | 58 | 4,500 | 3.1 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Dibenzofuran | 15 | 58 | 15 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Hexachlorobutadiene | 3.9 | 6.2 | 3.9 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| N-Nitrosodiphenylamine | 11 | 11 | 11 | 1.4 U | 2.7 U | 0.8 U | 0.8 U | 1.2 U | 0.6 U | 1.8 U |
| Total PCBs | 12 | 65 | 12 | 2.7 U | 5.4 U | 0.82 | 0.77 J | 1.0 J | 0.76 | 2.3 |
| **ORGANICS (ug/kg dry weight)** | | | | | | | | | | |
| Phenol | 420 | 1,200 | 180 | 24 | 22 | 20 U | 20 U | 20 U | 20 U | 19 U |
| 2-Methylphenol | 63 | 63 | 23 | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| 4-Methylphenol | 670 | 670 | 110 | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| 2,4-Dimethylphenol | 29 | 29 | 18 | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Pentachlorophenol | 360 | 690 | 180 | 95 U | 98 U | 99 U | 99 U | 99 U | 98 U | 96 U |
| Benzyl Alcohol | 57 | 73 | 57 | 19 U | 20 U | 20 U | 20 U | 20 U | 20 U | 19 U |
| Benzoic Acid | 650 | 650 | 65 | 190 U | 200 U | 200 U | 200 U | 200 U | 200 U | 190 U |

U=Chemical is undetected and is reported at the detection limit.
J = Indicates an estimated value.

[box] = Exceeds 1995 SQS
[shaded box] = Exceeds 1995 MCUL

**Table 6. Relative Depths (feet) of proposed Dredged Material within Olympia Harbor Project Area**

| DMMU Subarea | Station ID | Relative Depth of Dredged Material (feet) |
|---|---|---|
| Ports Berthing Area | 1 | **9** |
| Port's Berthing Area | 2 | 10 |
| Ports Berthing Area | 3 | 10 |
| Ports Berthing Area | 4 | 13 |
| Turning Basin | 5 | 4 |
| Turning Basin | 6 | 3 |
| Turning Basin | 7 | 2 |
| Main Channel | 8 | 2 |
| Turning Basin | 9 | 2 |
| Turning Basin | 10 | 2 |
| Turning Basin Widening | 11 | 8 |
| Turning Basin Widening | 12 | 17 |
| Main Channel | 13 | 4 |
| Main Channel Widening | 14 | 9 |
| Channel Bend | 15 | 3 |
| Channel Bend Widening | 16 | 19 |
| Outer Channel | 17 | 3 |
| Outer Channel | 18 | 3 |
| Outer Channel | 19 | 3 |
| Source area for habitat mitigation | 20 | 2-4 |
| BU Placement Area | 21 | BU Placement Area |

**Table 7. DMMP Sampling Strategy for the Olympia Harbor Federal/Port of Olympia Project for Dioxin/Furans and PAHs[1] (Shaded = Analyzed).**

| DMMU Subarea | Station ID[1] | Depth | Analysis ID | Analytes | Disposition |
|---|---|---|---|---|---|
| Port's Berthing Area | 1a | 0-4 ft | S1 (P1) | Dioxin | Analyze |
| Port's Berthing Area | 1b | 4-9 ft | S27 (A)[2] | Dioxin | Archived |
| Port's Berthing Area | 1c | 9-10 ft | Z-sample (A) | Dioxin | Archived |
| Port's Berthing Area | 2a | 0-4 ft | S2 (P1) | Dioxin | Analyze |
| Port's Berthing Area | 2b | 4-10 ft | S26 (P2) | Dioxin | Analyze |
| Port's Berthing Area | 2c | 10-11 ft | Z-sample (A) | Dioxin | Archived |
| Port's Berthing Area | 3a | 0-4 ft | S3 (P1) | Dioxin | Analyze |
| Port's Berthing Area | 3b | 4-10 ft | S25 (P2) | Dioxin | Analyze |
| Port's Berthing Area | 3c | 10-11 ft | Z-sample (A) | Dioxin | Archived |
| Port's Berthing Area | 4a | 0-4 ft | S4 (P1) | Dioxin, PAHs | Analyze |
| Port's Berthing Area | 4b | 4-13 ft | S24 (P2) | Dioxin, PAHs | Analyze |
| Port's Berthing Area | 4c | 13-14 ft | Z-sample (A) | Dioxin | Archived |
| Turning Basin | 5a | 0-4 ft | C1 (P1)<br>S23 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin | 5b | 4-5 ft | Z-Sample: SZ5 (P2) | Dioxin | Analyze |
| Turning Basin | 6a | 0-4 ft | C1 (P1)<br>S22 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin | 6b | 4-5 ft | Z-Sample: SZ6 (P2) | Dioxin | Analyze |
| Turning Basin | 7a | 0-2 ft | C2 (P1)<br>S21 (P2) | Dioxin | Analyze<br>Analyze |
| Turning Basin | 7b | 2-3 ft | Z-Sample: SZ7 (P2) | Dioxin | Analyze |
| Turning Basin | 8a | 0-2 ft | C2 (P1)<br>S20 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin | 8b | 2-3 ft | Z-Sample: SZ8 (P2) | Dioxin | Analyze |
| Main Channel | 9a | 0-2 ft | C3 (P1)<br>S19 (P2) | Dioxin, PAHs<br>Dioxin | Analyze<br>Analyze |
| Main Channel | 9b | 2-3 ft | Z-Sample: SZ9 (P2) | Dioxin, PAH's | Analyze |
| Main Channel | 10a | 0-2 ft | C3 (P1)<br>S18 (P2) | Dioxin, PAHs<br>Dioxin | Analyze<br>Analyze |
| Main Channel | 10b | 2-3 ft | Z-Sample: SZ10 (P2) | Dioxin | Analyze |
| Turning Basin Widening | 11a | 0-4 ft | C4 (P1)<br>S29 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin Widening | 11b | 4-8 ft | S16 (P2) | Dioxin | Analyze |
| Turning Basin Widening | 11c | 8-9 ft | Z-sample: SZ11 (P2) | Dioxin | Analyze |
| Turning Basin Widening | 12a | 0-4 ft | C4 (P1)<br>S28 (P2) | Dioxin<br>Dioxin | Analyze<br>Analyze |
| Turning Basin Widening | 12b | 4-17 ft | S17 (P2) | Dioxin | Analyze |
| Turning Basin Widening | 12c | 17-18 ft | Z-sample: SZ12 (P2) | Dioxin | Analyze |
| Main Channel | 13a | 0-4 ft | S5 (P1) | Dioxin | Analyze |
| Main Channel | 13b | 4-5 ft | Z-Sample: SZ13 (P2) | Dioxin | Analyze |
| Main Channel Widening | 14a | 0-4 ft | S6 (P1) | Dioxin | Analyze |
| Main Channel Widening | 14b | 4-9 ft | S14 (P1) | Dioxin | Analyze |
| Main Channel Widening | 14c | 9-10 ft | Z-sample (A) | Dioxin | Archived |
| Main Channel | 15a | 0-3 ft | S7 (P1) | Dioxin | Analyze |
| Main Channel | 15b | 3-4 ft | Z-sample (A) | Dioxin | Archived |
| Channel Bend Widening | 16a | 0-4 ft | S8 (P1) | Dioxin | Analyze |
| Channel Bend Widening | 16b | 4-19 ft | S15 (P1) | Dioxin | Analyze |
| Channel Bend Widening | 16c | 19-20 ft | Z-sample (A) | Dioxin | Archived |
| Outer Channel | 17a | 0-3 ft | S9 (P1) | Dioxin | Analyze |
| Outer Channel | 17b | 3-4 ft | Z-sample (A) | Dioxin | Archived |
| Outer Channel | 18a | 0-3 ft | S10 (P1) | Dioxin | Analyze |
| Outer Channel | 18b | 3-4 ft | Z-Sample: SZ18 (P2) | Dioxin | Analyze |
| Outer Channel | 19 | 0-4 ft | S11 (P1) | Dioxin | Analyze |
| Outer Channel | 19 | 4-5 ft | Z-sample (A) | Dioxin | Archived |
| BU Placement Area. | 20 | 0-10 cm | S12 (P1) | Dioxin | Analyze |
| BU Placement Area | 21 | 0-10 cm | S13 (P1) | Dioxin | Analyze |

**Legend:** S = uncomposited samples; C = composited for initial analysis during P1 (analyzed as uncomposited samples in P2); P1 = Initial Phase of analyses; P2 = Second Phase of analyses; A = Archived sample

[1] Z-samples were collected and archived at each Core location
[2] The surface sample (S1) overlying S27 met the Tier 1 guideline (see Table 6 of SDM), and the DMMP agencies using BPJ determined that analysis of this sample was not required.

**CENWS-OD-TS** **17 May 2000**
**Dredged Material Management Office**

**MEMORANDUM FOR RECORD**

**SUBJECT: DETERMINATION OF THE SUITABILITY OF DREDGED MATERIAL TESTED UNDER DMMP EVALUATION PROCEDURES FOR THE OLYMPIA HARBOR NAVIGATION PROJECT FOR DISPOSAL AT THE ANDERSON/KETRON OPEN WATER DISPOSAL SITE.**

1. The Corps of Engineers proposes to dredge the navigation channel at Olympia, Washington. In addition, the Port of Olympia proposes to widen the entrance channel and to deepen the port's berthing area. The total proposed dredged volume is approximately 635,000 cubic yards. The following summary reflects the DMMP agencies (Corps of Engineers, Department of Ecology, Department of Natural Resources and the Environmental Protection Agency) consensus decision on the acceptability of the sampling plan and all relevant test data to make a determination of suitability for the disposal of the material at a PSDDA open-water disposal site.

2. The ranking for this area is "low" based on the DMMP agency review of sediment chemistry data from the 1988 sampling and testing of the Olympia Harbor Navigation Improvement Project, and the lack of any ongoing sources of chemical contamination.

3. A sampling and analysis plan was completed for this project and approved by the PSDDA agencies on 14 February 1999. Sampling for this project was performed from 26 April to 7 May 1999. Additional sampling and testing data for bioaccumulation are discussed in paragraph 7.

| | |
|---|---|
| SAP approval date | 14 February 1999 |
| Sampling dates | 26 April to 7 May 1999 |
| Data Report submittal date | June 1999 |
| Recency determination dates | May 2004 to May 2006 |

4. Core samples were taken from a total of 64 locations and composited for ~~thirteen~~ seventeen analyses. The sampling and compositing scheme is listed in Table 1. Sample depths could not be achieved at stations 6, 7 (composite TBW-2), and Station 47 (composite MCW-2). Core refusal occurred before reaching the planned sampling depths. In each case the maximum bore length was collected and all bores reached native material. The resulting under-representation of deeper native sediments (assumed to be uncontaminated) in the DMMU composite results in potentially

Attachment 1

higher chemical concentrations. This result is more conservative and is therefore usable in making a suitability determination for these samples.

5. There were no exceedances of 1999 DMMP screening levels for the standard list of chemicals of concern. All detection limits were below screening level.

6. A tiered approach was used in the analysis for Tributyltin (TBT). Composites in the berthing are (B1 and B2) were analyzed for TBT. If there were no TBT exceedances in these samples, TBT testing would not be required for the rest of the samples. Composite B1 had a porewater TBT level of 0.28 ug/L, above the screening level of 0.15 ug/L. This exceedance triggered the requirement to test all remaining DMMUs for TBT. One of these DMMU also exceeded the screening level for TBT (TBW-1). DMMU exceeding the screening level for TBT are required to undergo bioaccumulation testing in order to determine suitability for open-water disposal.

7. A separate sampling and analysis effort was undertaken for the bioaccumulation testing of samples B1 and TBW-1. A sampling plan addendum was approved by the agencies in July 1999. Sampling for TBT bioaccumulation analysis was completed in August 1999.

8. Bioaccumulation testing was performed with bivalve *Macoma nasuta* and the polychaete *Nephtys caecoides*. The two species were tested together in the same 18-liter glass aquarium. At the time of project initiation, the standard DMMP bioaccumulation protocol called for 28-day test duration. The project proponents agreed to extend the test to 45 days, based on the recommendation of the DMMP agencies. The extended test provides a better approximation of steady-state tissue concentrations for TBT.

9. Six replicate aquaria (five test replicates and one replicate for steady state monitoring) were run for the two test sediments, the two reference sediments and the negative control.

10. Tissue concentrations from the 45-day exposure were compared to the reference sediments. Initial sediment chemistry was used to adjust the observed tissue concentrations. The sediment chemistry results between the first and second rounds of TBT testing differed, and so a ratio of the two was used to adjust the bioaccumulation tissue concentrations to reflect a "worst case" analytical result. These TBT chemistry results are listed in Table 3.

11. The DMMP agencies agreed to use the target tissue level developed for the East Waterway project, 3 ppm dry weight of TBT in tissue, as the value appropriate for the Olympia Harbor Navigation Project. Given the limited residue-effects data for the Olympia area, it was determined that the number calculated for Elliott Bay would be the closest approximation available for making a determination of suitability. The method of calculation and the data supporting this value is documented in the

suitability determination for the East Waterway project suitability determination (1999), paragraph 18, and in the "Review of Tissue Residue Effects Data for Tributyltin, Mercury and Polychlorinated Biphenyls", prepared by EVS solutions for the Port of Seattle.

12. TBT concentrations in tissues from *Macoma* and *Nephtys* exposed to test sediments were significantly less than the target tissue level of 3 ppm dry weight TBT in tissue. TBT tissue concentrations were also compared to reference and significant differences were observed for both DMMU. These results are listed in Table 4. The DMMP agencies agreed that comparing statistical difference from reference is a necessary but not a sufficient condition to determine a DMMU unsuitable for open-water disposal. Sediments from these two DMMU are suitable because all TBT tissue concentrations are significantly less than the target tissue level, TBT is undetected in most test replicates and differs from reference only when conservative assumptions are applied to non-detected values, and TBT concentrations in the retested samples were all lower than the screening level.

13. In summary, the DMMP-approved sampling and analysis plan was followed, and quality assurance, quality control guidelines specified by the DMMP were followed. The data gathered were deemed sufficient and acceptable for regulatory decision-making under the DMMP program. Based on the results of the chemical testing, the consensus determination of the DMMP agencies is that all 635,000 cubic yards from the Olympia Navigation Channel and the Port of Olympia's berthing area are suitable for open-water disposal.

14. This memorandum documents the suitability of proposed dredged sediments for disposal at a PSDDA open water disposal site or for beneficial use. It does not constitute final agency approval of the project. A dredging plan for this project must be completed as part of the final project approval process. A final decision will be made after full consideration of agency and public input, and after an alternatives analysis is done under section 404 (b) 1 of the Clean Water Act.

**OLYMPIA HARBOR NAVIGATION PROJECT**

***Concur:***

7/20/00
***Date***

***Stephanie Stirling***
***Seattle District Corps of Engineers***

1 August 2000
***Date***

***Justine Barton***
***Environmental Protection Agency, Region 10***

1 Aug 00
***Date***

***Rick Vining***
***Washington Department of Ecology***

25 JUL 00
***Date***

***Ted Benson***
***WA Department of Natural Resources***

Copies Furnished:
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DOE/Rick Vining
CENWS/Hiram Arden

## Table 1. Sampling/Compositing Scheme

| | DMMU | Samples Composited by Core Section | DMMU Volume Represented (cy) |
|---|---|---|---|
| **SURFACE SEDIMENTS** | | | |
| *Berthing Area Maintenance* | | | |
| | B1 | 1A, 2A, 3A, 4A | 30,335 |
| *Turning Basin Widening* | | | |
| | TBW1 | 5A, 6A, 7A | 23,471 |
| *Main Channel O & M Dredging* | | | |
| | MC1 | 8A, 9A, 10A, 11A, 12A | 35,494 |
| | MC2 | 13A, 14A, 15A, 16A, 17A, 18A | 44,114 |
| | MC3 | 19A, 20A, 21A, 22A, 23A | 38,595 |
| | MC4 | 24A, 25A, 26A, 27A, 28A | 36,646 |
| | MC5 | 29A, 30A, 31A, 32A, 33A | 36,053 |
| | MC6 | 34A, 35A, 36A, 37A, 38A | 34,841 |
| | MC7 | 39A, 40A, 41A, 42A, 43A, 44A | 40,779 |
| *Main Channel Widening* | | | |
| | MCW1 | 45A, 46A, 47A, 48A, 49A | 39,463 |
| *Outer Channel O & M Dredging* | | | |
| | OC1 | 50A, 51A, 52A, 53A, 54A | 43,977 |
| | OC2 | 55A, 56A, 57A, 58A, 59A | 36,325 |
| | OC3 | 60A, 61A, 62A, 63A, 64A | 39,052 |
| **SUBSURFACE SEDIMENTS** | | | |
| *Berthing Area Maintenance* | | | |
| | B2 | 1B, 2B, 3B | 15,010 |
| *Turning Basin Widening* | | | |
| | TBW2 | 5B, 5C, 6B, 6C, 6D, 6E, 7B, 7C, 7D, 7E | 52,499 |
| *Main Channel O & M Dredging* | | | |
| | MC8 | 9B, 11B, 12B, 15B, 18B | 23,419 |
| *Main Channel Widening* | | | |
| | MCW2 | 45B, 45C, 46B, 46C, 47B, 47C, 48B, 49B, 49C, 49D | 54,198 |
| | | | 624,271 |

**Table 2. Sediment Conventional Parameters**

| Parameter | B1 | B2 | MC1 | MC2 | MC3 | MC4 | MC5 | MC6 | MC7 | MC8 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Solids (%) | 49.9 | 72.2 | 40.4 | 40.8 | 45.7 | 42 | 38.6 | 38.2 | 44.1 | 61.6 |
| Total Organic Carbon (%) | 2.7 | 1.6 | 2.9 | 2.8 | 2.3 | 2.5 | 2.7 | 2.7 | 2.3 | 1.9 |
| Bulk Ammonia (mg/kg) | 7.8 | 58 | 4.8 | 4.9 | 87 | 9.2 | 78 | 68 | 77 | 69 |
| Total Sulfides (mg/kg) | 360 | 0.62U | 460 | 90 | 19 | 430 | 900 | 170 | 960 | 48 |
| Grain-size | | | | | | | | | | |
| gravel | 22.5 | 32.7 | 7.5 | 0.9 | 1.4 | 2.2 | 0.6 | 1.5 | 1.8 | 14.1 |
| sand | 39 | 50.3 | 26.9 | 25 | 27.1 | 20.1 | 19.2 | 28.5 | 30.8 | 52.8 |
| silt | 20.6 | 10.7 | 36.9 | 42.1 | 43.4 | 45.7 | 46.4 | 38.6 | 38.9 | 21.6 |
| clay | 18 | 6.3 | 28.6 | 31.8 | 28 | 31.9 | 33.9 | 31.5 | 28.5 | 11.6 |

**Table 2. Sediment Conventional Parameters (Continued)**

| Parameter | MCW1 | MCW2 | OC1 | OC2 | OC3 | TBW1 | TBW2 |
|---|---|---|---|---|---|---|---|
| Total Solids (%) | 57.7 | 72 | 40.6 | 39.8 | 53.3 | 43 | 71.7 |
| Total Organic Carbon (%) | 1.4 | 0.74 | 2.4 | 2.3 | 1.7 | 3.2 | 1.0 |
| Bulk Ammonia (mg/kg) | 43 | 50 | 92 | 56 | 40 | 94 | 50 |
| Total Sulfides (mg/kg) | 430 | 1.3U | 950 | 1100 | 46 | 130 | 26 |
| Grain-size | | | | | | | |
| gravel | 4 | 6.5 | 2.9 | 5 | 3.8 | 2.8 | 4.5 |
| sand | 52.1 | 65.8 | 28.5 | 22.3 | 49.6 | 18.3 | 71.3 |
| silt | 27.9 | 18.8 | 39.7 | 42.5 | 28.2 | 49.8 | 16.8 |
| clay | 16.1 | 9 | 29 | 29.9 | 18.4 | 29.2 | 7.5 |

Table 3. TBT Sediment Chemistry Data

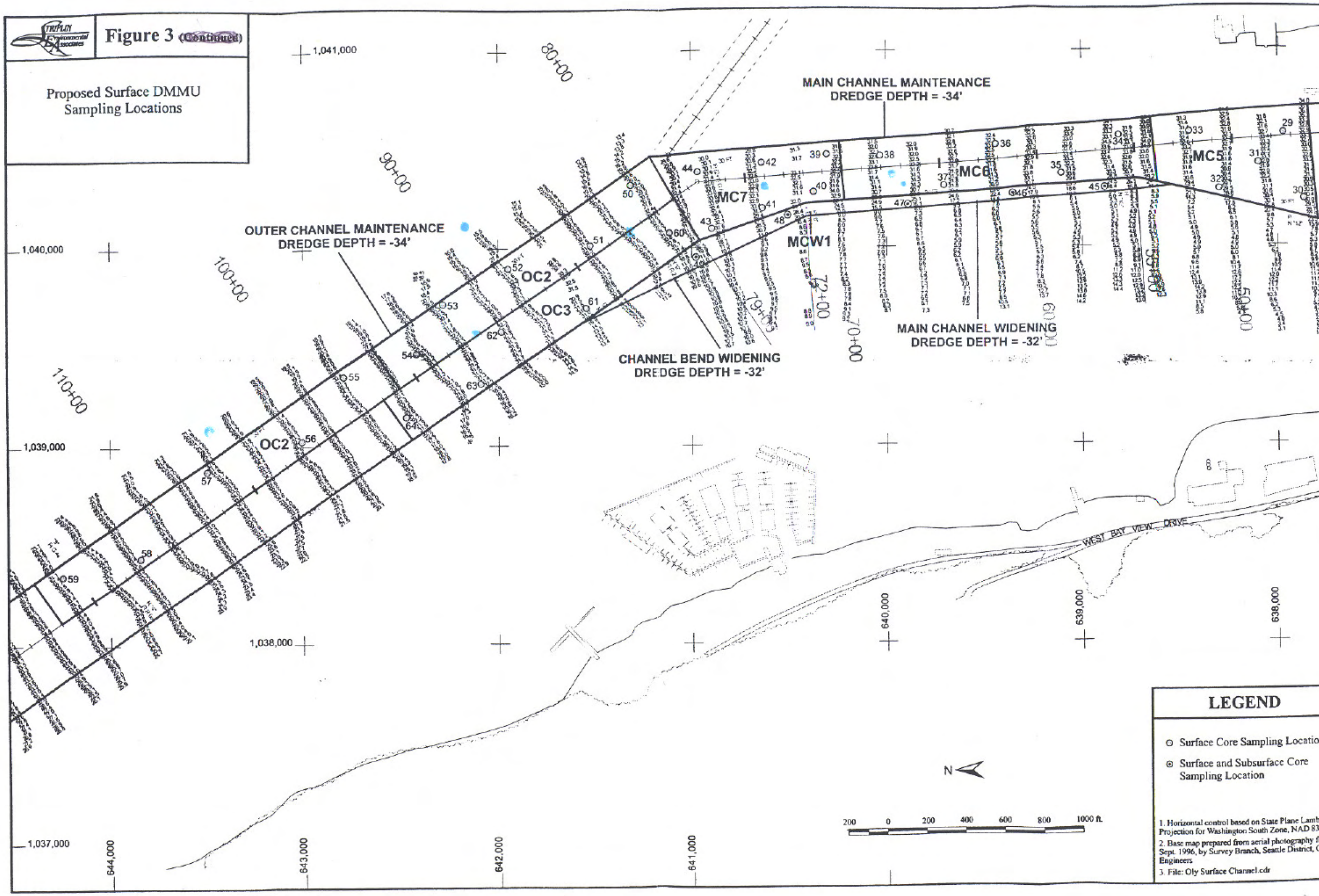
| Parameter | DMMU B1 | | | DMMU TBW1 | | |
|---|---|---|---|---|---|---|
| | Initial (4/99) | Retest (8/99) | Ratio I/R | Initial (4/99) | Retest (8/99) | Ratio I/R |
| TBT Porewater (ug/L) | 0.28 | 0.14 | 2.0 | 0.16 | 0.02 | 8.0 |

## Table 4. Bioaccumulation Test Results

| | | *Nephtys* | | *Macoma* | |
|---|---|---|---|---|---|
| Sample | Replicate | Lipids (% dry wt) | TBT (ug/kg dry wt) | Lipids (% dry wt) | TBT (ug/kg dry wt) |
| Control | A | 2.3 | 10 U | 1.3 | 10 U |
| | B | 2.8 | 10 U | 1.6 | 10 U |
| | D | 2.2 | 10 U | 1.8 | 10 U |
| | E | 2.7 | 10 U | 1.8 | 10 U |
| | F | 3.1 | 10 U | 1.3 | 10 U |
| CR02 | A | 1.7 | 10 U | 1.7 | 2 |
| | B | 2.6 | 10 U | 1.1 | 10 U |
| | D | 3.0 | 10 U | 1.6 | 10 U |
| | E | 2.8 | 10 U | 1.9 | 10 U |
| | F | 2.0 | 10 U | 2.0 | 10 U |
| CR23 | A | 2.3 | 20 U,G | 2.2 | 10 |
| | B | 1.9 | 20 U,G | 1.8 | 10 U |
| | D | 2.8 | 10 U | 1.4 | 10 U |
| | E | 2.2 | 10 U | 1.8 | 10 U |
| | F | 1.8 | 10 U | 2.2 | 10 U |
| TBW1 | A | 2.8 | 20 U,G | 1.9 | 2 |
| | B | 2.0 | 10 U | 1.5 | 17 |
| | D | 1.0 | 30 U,G | 1.5 | 10 U |
| | E | 1.6 | 20 U,G | 1.5 | 10 U |
| | F | 1.5 | 10 U | 1.6 | 10 U |
| B1 | A | 1.9 | 4 U,G | 1.4 | 51 |
| | B | 1.9 | 2 U | 2.0 | 71 |
| | D | 1.6 | 10 U | 1.7 | 72 |
| | E | 1.7 | 20 U,G | 1.6 | 49 |
| | F | 2.2 | 10 U | 1.7 | 54 |

**Figure 3 (Continued)**

Proposed Surface DMMU Sampling Locations



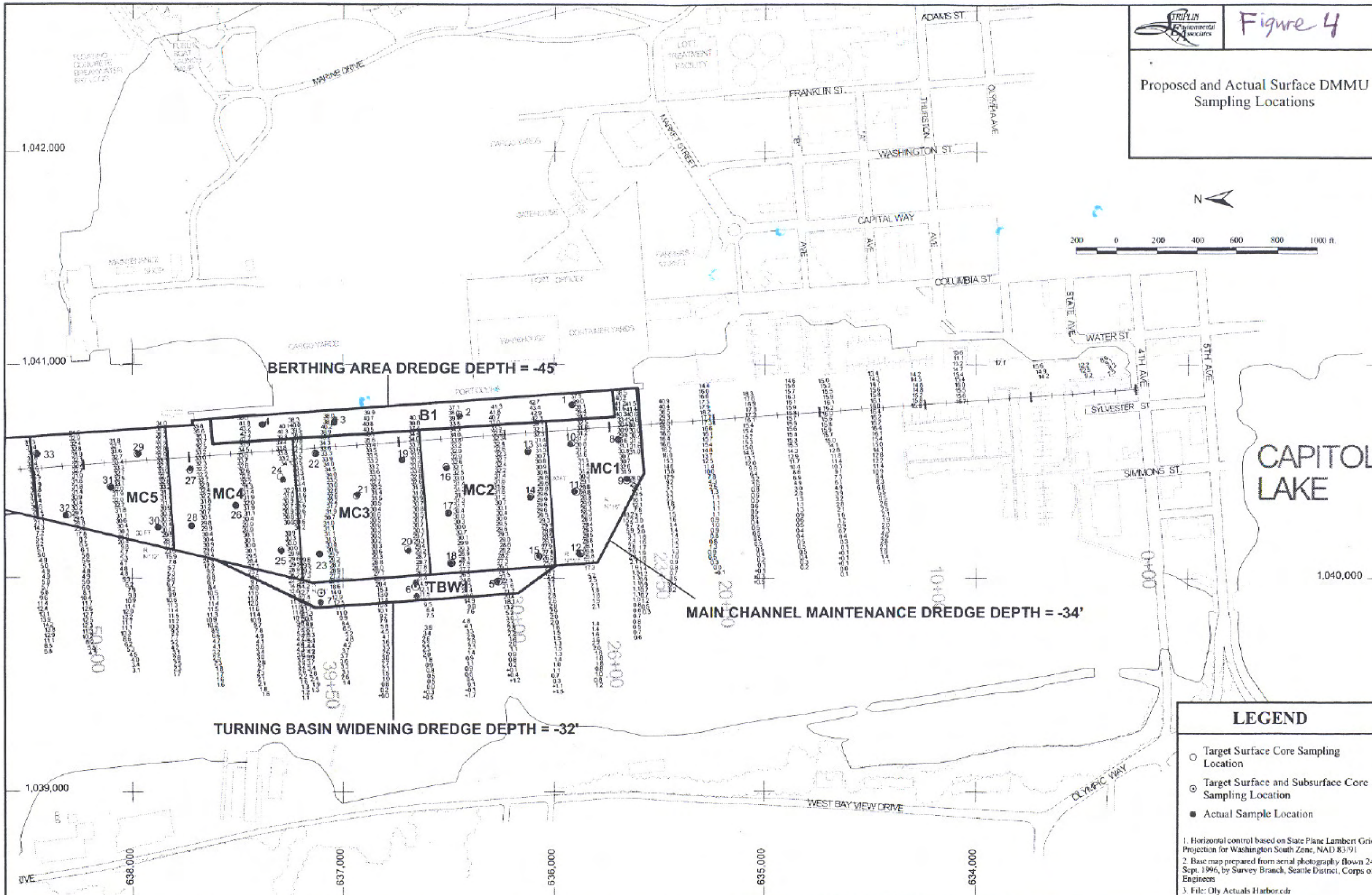
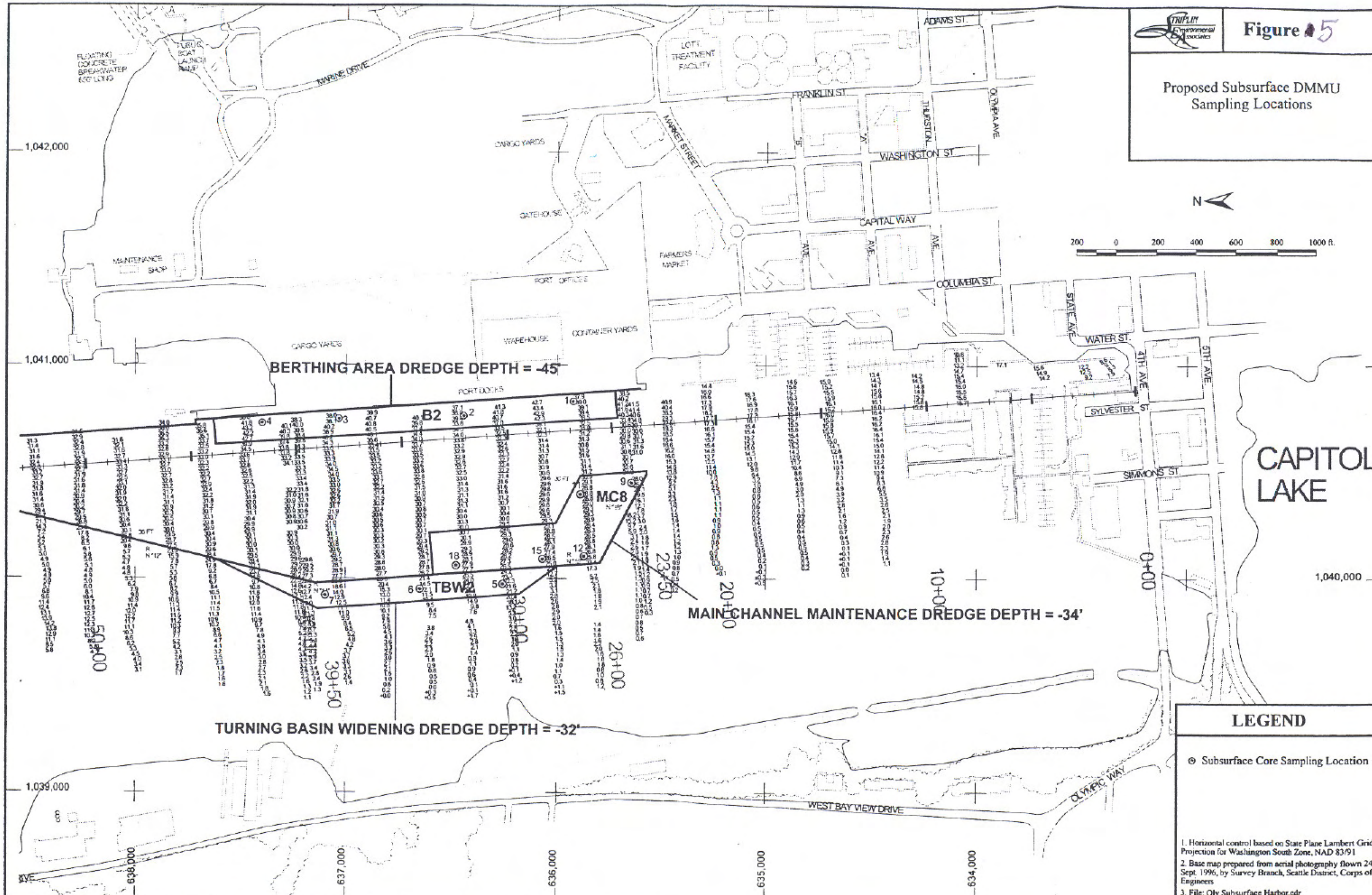
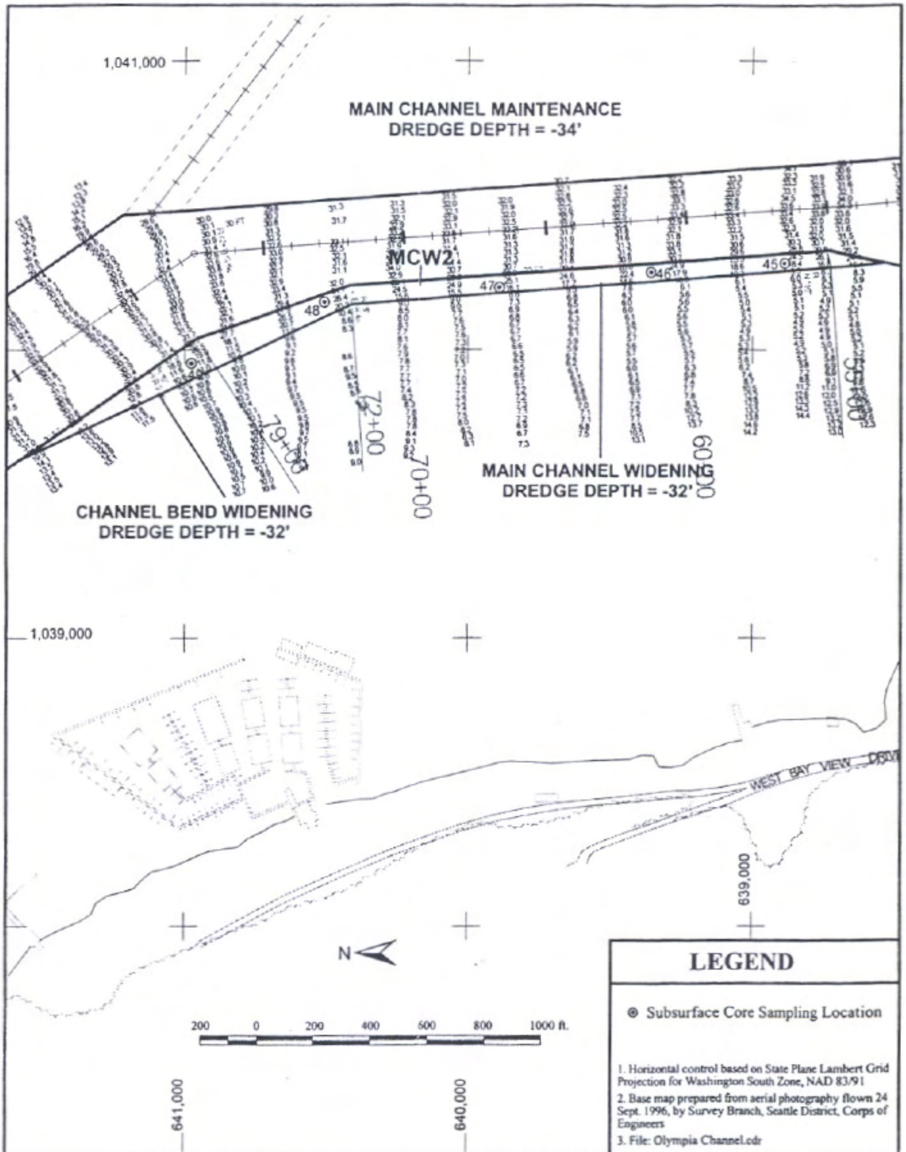


Figure 4
Proposed and Actual Surface DMMU Sampling Locations
BERTHING AREA DREDGE DEPTH = -45'
MAIN CHANNEL MAINTENANCE DREDGE DEPTH = -34'
TURNING BASIN WIDENING DREDGE DEPTH = -32'
B1
MC1
MC2
MC3
MC4
MC5
TBW1
CAPITOL LAKE
ADAMS ST.
FRANKLIN ST.
WASHINGTON ST.
CAPITAL WAY
COLUMBIA ST
WATER ST
SYLVESTER ST
SIMMONS ST.
STATE AVE
4TH AVE
5TH AVE
THURSTON
OLYMPIA AVE
MARKET STREET
MARINE DRIVE
WEST BAY VIEW DRIVE
OLYMPIC WAY
N
200 0 200 400 600 800 1000 ft
1,042,000
1,041,000
1,040,000
1,039,000
638,000
637,000
636,000
635,000
634,000
LEGEND
Target Surface Core Sampling Location
Target Surface and Subsurface Core Sampling Location
Actual Sample Location
1. Horizontal control based on State Plane Lambert Grid Projection for Washington South Zone, NAD 83/91
2. Base map prepared from aerial photography flown 24 Sept. 1996, by Survey Branch, Seattle District, Corps of Engineers
3. File: Oly Actuals Harbor.cdr


Triplin Environmental Associates
Figure 5
Proposed Subsurface DMMU Sampling Locations
N
200 0 200 400 600 800 1000 ft.
LEGEND
Subsurface Core Sampling Location
1. Horizontal control based on State Plane Lambert Grid Projection for Washington South Zone, NAD 83/91
2. Base map prepared from aerial photography flown 24 Sept. 1996, by Survey Branch, Seattle District, Corps of Engineers
3. File: Oly Subsurface Harbor.cdr
BERTHING AREA DREDGE DEPTH = -45'
MAIN CHANNEL MAINTENANCE DREDGE DEPTH = -34'
TURNING BASIN WIDENING DREDGE DEPTH = -32'
B2
MC8
TBW2
CAPITOL LAKE
ADAMS ST.
FRANKLIN ST
WASHINGTON ST
CAPITAL WAY
COLUMBIA ST.
WATER ST.
SYLVESTER ST
SIMMONS ST
MARKET STREET
THURSTON
OLYMPIA AVE
STATE AVE
4TH AVE
5TH AVE
MARINE DRIVE
WEST BAY VIEW DRIVE
OLYMPIC WAY
LOTT TREATMENT FACILITY
CARGO YARDS
GATEHOUSE
PORT OFFICES
WAREHOUSE
CONTAINER YARDS
PORT DOCKS
FARMERS MARKET
MAINTENANCE SHOP
FLOATING CONCRETE BREAKWATER
1,042,000
1,041,000
1,040,000
1,039,000
638,000
637,000
636,000
635,000
634,000
0+00
10+00
20+00
23+50
26+00
30+00
39+50
50+00




STRIPLIN Environmental Associates

**Figure 6 (Continued)**

Proposed Subsurface DMMU Sampling Locations

Olympia Harbor

3/23/99

Oly Subsurface Channel.cdr

CENWS-OD-TS-DMMO

MEMORADUM FOR RECORD 24 May 2005

SUBJECT: SUITABILITY DETERMINATION RECENCY EXTENSION FOR PROPOSED MAINTENANCE DREDGE MATERIAL AT OLYMPIA HARBOR, LOWER BUDD INLET, OLYMPIA, WASHINGTON (Public Notice #23) EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT FOR OPEN-WATER DISPOSAL AT AN APPROVED PSDDA (ANDERSON ISLAND) SITE.

**1. Background**. The proposed dredge material at Olympia Harbor underwent DMMP characterization through April, May, and August 1999. The results of that characterization are documented in a May 17, 2000 suitability determination memorandum (SDM), in which 624,000 cubic yards (cy) were found to be suitable for disposal at a PSDDA open water disposal site or for beneficial use. The consensus determination of the DMMP agencies was that all 624,000 cy from the federal, Olympia Harbor Navigation Channel and the Port of Olympia's berthing area are suitable for open-water disposal. Note: The May 17, 2000 suitability determination included characterization of two feet of potential advance maintenance dredging and areas of minor widening at the bend, entrance and turning basin for the free movement of vessels.

The Corps of Engineers proposes to dredge the deep-draft, navigation channel at Olympia, Washington. In addition, the Port of Olympia proposes to maintenance dredge their existing berthing area. However, the total proposed dredged volume is approximately 478,000 cubic yards which is less that the 624,000 characterization volume because the advance maintenance dredging could not be justified; however, the characterization does confirm that materials below the maintenance dredge cut (Z material) are clean for the resulting sediment / water interface. The following summary reflects the DMMP agencies (Corps of Engineers, Department of Ecology, Department of Natural Resources and the Environmental Protection Agency) consensus decision on the acceptability of all relevant test data to make a determination of suitability for the disposal of the material at a PSDDA open-water disposal site.

The proposed dredging area is ranked "low" based on sediment chemistry data and the lack of any ongoing sources of chemical contamination. There has been no change in adjacent land use or other potential sources of contaminants and no significant (>5 gallons) spills of petroleum or hazardous materials in the immediate vicinity of the proposed dredged area. The amount of sediment accumulation since the original characterization was evaluated by comparing data from bathymetry surveys conducted by the U.S. Army Corps of Engineers in May 1998 and in April 2004. There has been no or minimal sediment accumulation (±0.5 feet) between 1999 and 2004 in much of the proposed dredged area. In some areas, there has been up to 1 foot of sediment accumulation, with a maximum accumulation of up to 1.24 feet in small, isolated spots.

ATTACHMENT 2

Permitting for this project is expected to be complete in time to dredge during the 2006-2007 dredging season. To meet this schedule, the applicant (Corps Navigation & Port, local sponsor) requests that the DMMP suitability for unconfined open-water disposal be extended through May 2008.

**2. Analysis**. In a 2002 Clarification Paper, the DMMP outlined an approach for considering recency extensions for projects that could not be dredged during the standard recency window due to permitting requirements. That approach considers 1) previous characterization data; 2) any new data from the dredge site or vicinity; and 3) site use and character.

The additional areas of Corps minor widening at the bend, entrance channel and turning basin, were included in the 1999 sediment characterization. There were no exceedances of 1999 DMMP screening levels for the standard list of chemicals of concern. All detection limits were below the screening levels. A tiered approach was used in the analysis for Tributyltin (TBT). Composites for the berthing area exceeded the screening level for TBT. Two DMMUs exceeded BT for TBT but passed bioaccumulation testing. A separate sampling and analysis effort was undertaken for the bioaccumulation testing. Sampling for TBT bioaccumulation analysis was completed in August 1999. Sediments from the two DMMUs are suitable because all TBT tissue concentrations are significantly less than the target tissue level.

Based on the above review, the DMMP determined that there is little risk in granting the requested recency extension.

**3. Suitability**. This summary reflects a consensus determination of the agencies that comprise the regional Dredged Material Management Program (DMMP) for the State of Washington. The agencies include the Corps of Engineers, the Environmental Protection Agency, and the Washington Departments of Ecology and Natural Resources. The DMMP agencies concurred that an extension of the recency date of the suitable DMMUs through May 2008 is acceptable. Thus approximately 478,000 cubic yards remain suitable for open water disposal. This recency extension is contingent upon no significant perturbations or unanticipated impacts occurring that would affect the quality of the sediments between the dated of this memorandum and the dredging dates.

This memorandum documents the suitability of sediment to be dredged from the Olympia Harbor Navigation project for disposal at a PSDDA open-water disposal site. However, this suitability determination does not constitute final agency approval of the project. A dredging plan for this project must be completed as part of the final project approval process. A final decision will be made after full consideration of agency input, and after an alternatives analysis is done under Section 404(b)(1) of the Clean Water Act.

**Reference**:

Warner, L.C. 2002. DMMP Clarification Paper: Recency Guidelines – Program Considerations. Prepared by Lauran Cole Warner (US Army Corps of Engineers) for the DMMP agencies, SMARM 2002.

**Concur:**

6/2/2005
Date

Gwyn Puckett, Seattle District Corps of Engineers

6/2/2005
Date

Jonathan Freedman, Environmental Protection Agency

6/2/05
Date

Cinde Donoghue, Washington Department of Ecology

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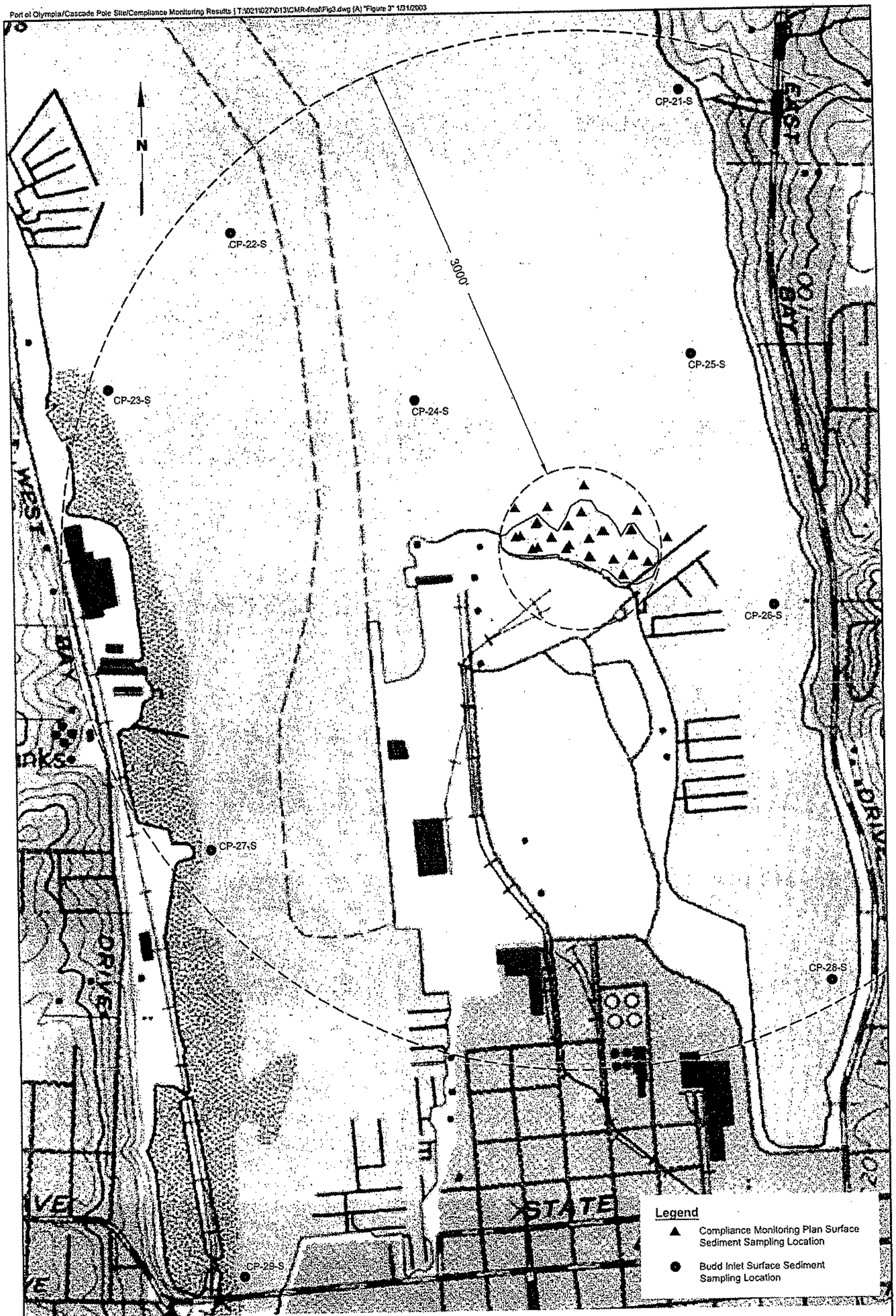
Vicki Fagerness, Integral Consulting
George Hart, COE
Bob Burkle, WDFW
DMMO File

Port of Olympia/Cascade Pole Site/Compliance Monitoring Results | T:\021\027\013\CMR-final\Fig3.dwg (A) "Figure 3" 1/31/2003




*Adapted from: Maptech Terrain Navigator, 1998*

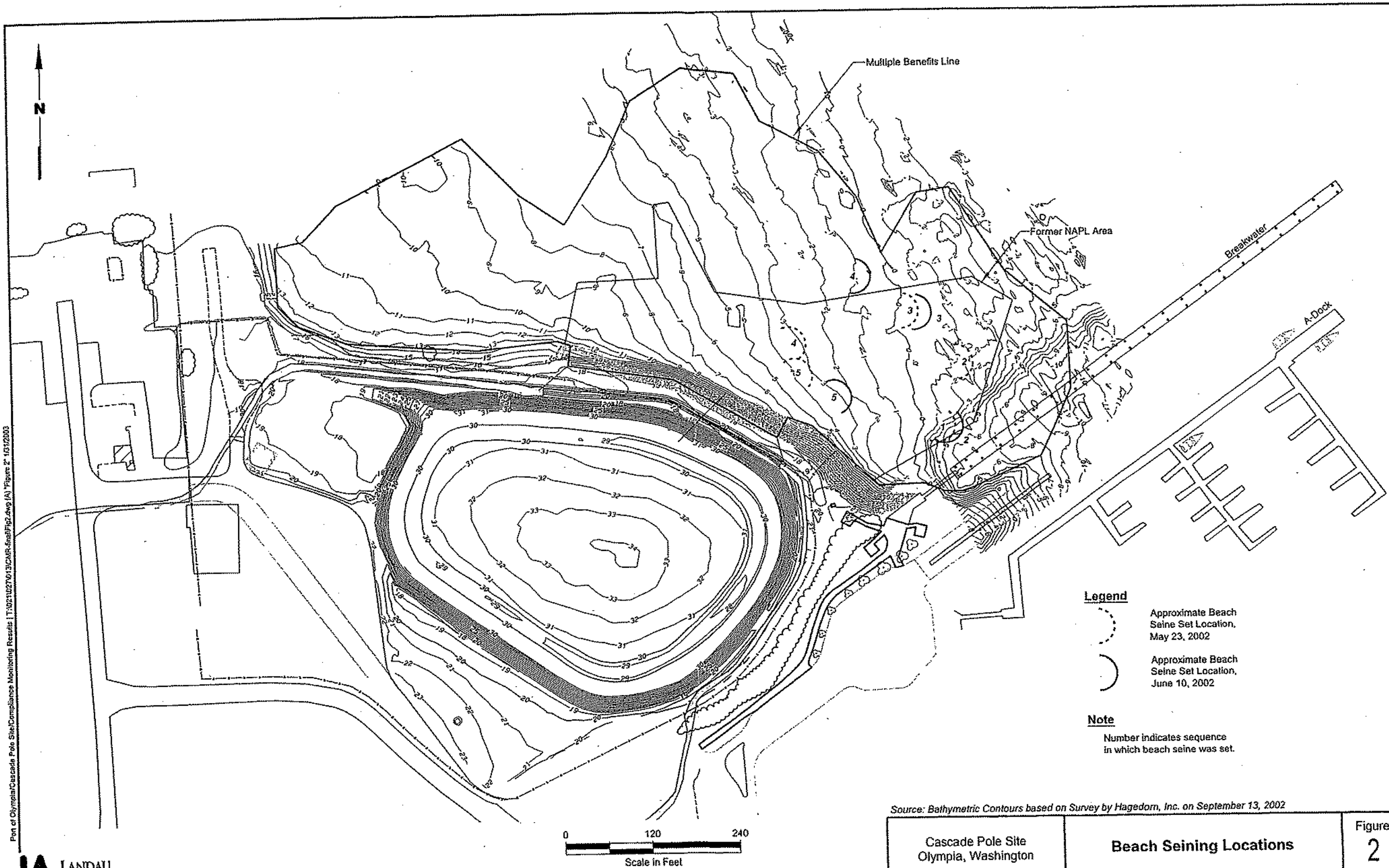
| | | | | |
|---|---|---|---|---|
| LANDAU ASSOCIATES | 0 600 1200 Scale in Feet | Cascade Pole Site Olympia, Washington | **Surface Sediment Sampling Locations** | Figure 3 |

ATTACHMENT 3

# TABLE 7
## SEDIMENT SAMPLE ANALYTICAL RESULTS

| Sample ID: | CP-21-S | CP-22-S | CP-23-S | CP-24-S | CP-25-S | CP-26-S | CP-27-S | CP-28-S | CP-29-S |
|---|---|---|---|---|---|---|---|---|---|
| Lab ID: | 2202374-017 | K2202330-026 | K2202330-027 | K2202330-025 | K2202330-024 | K2202330-023 | K2202330-029 | K2202374-018 | K2202330-030 |
| Sample Date: | 4/12/2002 | 4/11/2002 | 4/11/2002 | 4/11/2002 | 4/11/2002 | 4/11/2002 | 4/11/2002 | 4/12/2002 | 4/11/2002 |
| **Dioxins and Furans (ng/kg)** | | | | | | | | | |
| 2,3,7,8-TCDD | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,2,3,7,8-PeCDD | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 3.316 | 2.5 U | 2.5 UJ | 2.5 U | 2.5 U |
| 1,2,3,4,7,8-HxCDD | 2.5 U | 2.5 U | 2.55 | 2.5 U | 4.775 | 2.933 | 2.5 U | 2.5 U | 2.5 U |
| 1,2,3,6,7,8-HxCDD | 2.5 U | 7.093 | 18.982 | 3.534 | 28.292 | 12.057 | 6.991 | 5.486 | 2.5 U |
| 1,2,3,7,8,9-HxCDD | 2.5 U | 3.619 | 6.65 | 2.5 U | 14.991 | 7.418 | 4.188 | 4.014 | 2.5 U |
| 1,2,3,4,6,7,8-HpCDD | 21.233 | 135.371 | 254.216 | 79.252 | 527.609 | 222.552 | 135.823 | 112.301 | 31.532 |
| OCDD | 144.677 | 810.248 | 1314.234 J | 518.845 | 4290.636 | 1300.39 J | 813.099 | 666.653 | 253.099 |
| 2,3,7,8-TCDF | 1.101 | 1 U | 1.09 | 1 U | 2.893 | 1.891 | 1 U | 1 U | 1 U |
| 1,2,3,7,8-PeCDF | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.865 J | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| 2,3,4,7,8-PeCDF | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 3.876 J | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| 1,2,3,4,7,8-HxCDF | 2.5 U | 2.853 | 4.345 | 2.5 U | 12.999 | 4.244 J | 2.774 | 2.797 | 2.5 U |
| 1,2,3,6,7,8-HxCDF | 2.5 U | 2.5 U | 2.833 | 2.5 U | 5.006 | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| 1,2,3,7,8,9-HxCDF | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| 2,3,4,6,7,8-HxCDF | 2.5 U | 2.5 U | 6.253 | 2.5 U | 4.859 | 3.248 | 2.5 U | 2.5 U | 2.5 U |
| 1,2,3,4,6,7,8-HpCDF | 4.249 | 49.307 | 120.007 | 24.379 | 158.166 | 38.854 | 42.678 | 26.683 | 7.149 |
| 1,2,3,4,7,8,9-HpCDF | 2.5 U | 2.5 U | 3.684 | 2.5 U | 8.445 | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| OCDF | 5 U | 66.776 | 126.464 | 29.803 | 238.564 | 52.899 J | 55.923 | 41.249 | 15.208 |
| Total TCDD | 5 U | 9.509 | 4.827 | 4.355 | 177.151 | 104.522 | 6.354 | 10.558 | 0.324 |
| Total PeCDD | 0.507 | 7.489 | 13.142 | 3.282 | 79.412 | 104.336 | 12.609 | 15.499 | 5 U |
| Total HxCDD | 10.052 | 65.453 | 108.676 | 29.132 | 262.72 | 155.945 | 60.935 | 51.876 | 9.125 |
| Total HpCDD | 47.686 | 336.508 | 562.801 | 184.837 | 1460.398 | 471.96 | 323.638 | 264.633 | 98.879 |
| Total TCDF | 2.095 | 16.443 | 9.357 | 7.115 | 52.602 | 41.881 | 11.991 | 18.114 | 5 U |
| Total PeCDF | 2.164 | 17.648 | 44.317 | 10.386 | 89.719 | 44.88 | 20.352 | 23.74 | 2.586 |
| Total HxCDF | 7.574 | 58.095 | 188.843 | 26.084 | 211.03 | 74.073 | 58.43 | 39.823 | 8.422 |
| Total HpCDF | 10.618 | 143.771 | 359.129 | 61.529 | 475.354 | 119.513 | 100.953 | 65.075 | 20.511 |
| TEQ | 0.510 | 4.01 | 9.36 | 1.91 | 22.4 | 7.09 | 3.99 | 3.29 | 0.640 |
| **Conventionals (percent)** | | | | | | | | | |
| TOC | 0.17 | 3.53 | 4.26 | 1.79 | 3.5 | 1.53 | 5.6 | 2.33 | 3 |
| Total solids | 91.8 | 31.7 | 48 | 55.2 | 34 | 66.4 | 36.1 | 45.2 | 80.3 |

U = Compound not detected at the given detection limit.
J = Estimated value.
TEQ = Toxicity equivalency quotient.




Source: Bathymetric Contours based on Survey by Hagedorn, Inc. on September 13, 2002

| Cascade Pole Site<br>Olympia, Washington | **Beach Seining Locations** | Figure<br>2 |
|---|---|---|

LANDAU ASSOCIATES

# TABLE 6
# FISH TISSUE ANALYTICAL RESULTS

| Sample ID: | CPC-02-T1 | CPC-02-T2 | CPC-02-T3 |
|---|---|---|---|
| Lab ID: | L4688-1 | L4840-1 L | L4840-2 L |
| Sample Date: | 5/23/2002 | 6/10/2002 | 6/10/2002 |
| Sample Locations: | CPC | Hatchery | CPC |
| **Dioxins and Furans (ng/kg)** | | | |
| 2,3,7,8-TCDD | 0.050 U | 0.085 U | 0.050 U |
| 1,2,3,7,8-PeCDD | 0.471 | 0.050 U | 0.241 |
| 1,2,3,4,7,8-HxCDD | 0.199 | 0.050 U | 0.050 U |
| 1,2,3,6,7,8-HxCDD | 1.18 | 0.050 U | 0.520 |
| 1,2,3,7,8,9-HxCDD | 0.345 | 0.050 U | 0.050 U |
| 1,2,3,4,6,7,8-HpCDD | 7.11 | 0.050 U | 1.59 |
| OCDD | 33.5 | 0.066 U | 7.45 |
| | | | |
| 2,3,7,8-TCDF | 0.245 | 0.279 | 0.309 |
| 1,2,3,7,8-PeCDF | 0.133 | 0.050 U | 0.108 |
| 2,3,4,7,8-PeCDF | 0.230 | 0.050 U | 0.050 U |
| 1,2,3,4,7,8-HxCDF | 0.125 | 0.050 U | 0.084 |
| 1,2,3,6,7,8-HxCDF | 0.078 | 0.050 U | 0.050 U |
| 1,2,3,7,8,9-HxCDF | 0.050 U | 0.050 U | 0.050 U |
| 2,3,4,6,7,8-HxCDF | 0.050 U | 0.050 U | 0.050 U |
| 1,2,3,4,6,7,8-HpCDF | 0.050 U | 0.090 U | 0.278 |
| 1,2,3,4,7,8,9-HpCDF | 0.050 U | 0.117 U | 0.050 U |
| OCDF | 0.050 U | 0.050 U | 0.050 U |
| | | | |
| Total TCDD | 0.0500 U | 0.211 | 0.0500 U |
| Total PeCDD | 0.701 U | 0.481 | 0.324 |
| Total HxCDD | 3.75 | 0.669 | 0.428 |
| Total HpCDD | 15.5 | 0.985 | 4.12 |
| Total TCDF | 0.319 | 0.442 | 0.781 |
| Total PeCDF | 1.10 | 0.400 | 0.577 |
| Total HxCDF | 0.607 | 0.366 | 0.341 |
| Total HpCDF | 0.468 | 0.117 U | 0.278 |
| | | | |
| TEQ | 0.679 | 0.028 | 0.244 |
| | | | |
| Lipids (percent) | 2.4 | 5.7 | 4.2 |

U = Compound not detected at the given detection limit.
TEQ = Toxicity equivalency quotient.