Final Data Report
Kenmore Federal Navigation Channel
Dredged Material Characterization

Kenmore, Washington

Contract: W912DW-14-T-0002

Prepared for:

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of Engineers®
Seattle District

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LIST OF ACRONYMS AND ABBREVIATIONS

AFDW	ash-free dry weight
ARI	Analytical Resources, Inc.
ASTM	American Society of Testing Materials
BT	bioaccumulation trigger
COC	chemical of concern
CSL	Cleanup Screening Level
CTR	Contract Technical Representative
cy	cubic yard
DGPS	Differential Global Positioning System
DMMO	Dredged Material Management Office
DMMP	Dredged Material Management Program
DMMU	Dredged Material Management Unit
DOF	Dalton, Olmsted and Fuglevand, Inc.
DVR	data validation report
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EIM	Environmental Information Management System
GPS	Global Positioning System
GC/MS	Gas Chromatography/Mass Spectroscopy
HPAH	high molecular weight polycyclic aromatic hydrocarbon
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LWLW	Lake Washington Low Water
MDL	method detection limit
ML	maximum level
MRL	method reporting limit
NAD 83	North American Datum of 1983
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyls
PSEP	Puget Sound Estuary Program
PWS	Performance Work Statement
SAP	sampling and analysis plan
SEE	Science and Engineering for the Environment, LLC
SL	screening level
SMARM	sediment management annual review meetings
SMS	Washington State Sediment Management Standards
SQS	Sediment Quality Standard
SVOC	semi-volatile organic compound
TEF	toxic equivalency factor
TEQ	toxicity equivalent
TPH	total petroleum hydrocarbons
pptr	parts per trillion
USACE	U.S. Army Corps of Engineers
WDNR	Washington Department of Natural Resources

µg/kg	microgram per kilogram
mg/kg	milligram per kilogram
mg/kg OC	milligram per kilogram organic carbon.

1 INTRODUCTION

This Data Report (Report) presents the results of sediment characterization conducted for the Kenmore federal navigation channel at Kenmore, Washington. Sediment samples were collected from Kenmore (Figure 1-1), and submitted for conventional and chemical analyses in accordance with the approved Sampling and Analysis Plan (SAP). The SAP (Appendix A) described the overall sampling strategy, sediment collection methods, chemical testing methods, and data reporting requirements for the dredged material characterization.

In addition to the results of the sampling and analyses, this Report discusses where and why additions/deviations from the SAP occurred, quality assurance and quality control measures undertaken, reviews and validation of the data, and the collected field and laboratory data.

This sediment characterization effort was conducted by a team led by Dalton, Olmsted and Fuglevand Inc. (DOF), Science and Engineering for the Environment (SEE), Marine Sampling Systems (MSS), Pyron Environmental (Pyron), Analytical Resources Inc. (ARI), and Exa Data Services (Exa). Work was conducted for the U.S. Army Corps of Engineers (USACE), Seattle District. The USACE and the other Dredged Material Management Program (DMMP) Agencies[1] approved the Sampling and Analysis Plan (SAP).

1.1 PROJECT DESCRIPTION

The USACE is responsible for maintenance dredging of the federal navigation project at Kenmore (Figure 1-1). The authorized depth of the channel is minus 15-feet LWLW (Lake Washington Low Water datum), with an allowance for one foot of advanced maintenance and one foot of overdepth dredging. Thus, the total characterization depth for this project is -17 ft LWLW.

A bathymetric survey was conducted by the Corps in April 2014. As part of the preparation of this SAP, DOF/SEE were provided the hydrosurvey data (Figure 1-1) and recalculated the volumes of material required to dredge to the authorized federal channel depth, with one foot of advanced maintenance and one foot of over-depth. To account for the uncertainty as to the final volume of material that will be dredged, the DMMP required that a 30% contingency be added to the 2014 estimated dredged material volume. That recalculated volume, and the assigned Dredged Material Management Units (DMMUs), are given in Table 1-1. The process for determining the dredged material volume, and the samples required to characterize the sediments in those DMMUs were described in detail in Section 4.1 of the SAP.

Material dredged from the Kenmore Channel that is found suitable for unconfined open water disposal will be disposed of at the Elliott Bay non-dispersive open-water disposal site. As such, the results of the analytical characterization of the dredge prism material are compared to the DMMP Marine Guideline Values (Section 4). In addition to characterizing the dredged material,

[1] The agencies that jointly manage the Dredged Material Management Program (DMMP) in Washington State include the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, and the Washington Departments of Ecology and Natural Resources.

the z-layer, the sediment that will be exposed after removal of the dredge prism was assessed for Washington State's anti-degradation compliance determination. The z-layer sediments were analyzed separately for the chemicals listed in the Washington State Sediment Management Standards (SMS) Freshwater Sediment Chemical Criteria (WAC 173-204-563). The results of the chemical analyses for the z-layer material were compared to the Freshwater Sediment Chemical Criteria (Section 4).

The sampling approach utilized a modified tiered strategy for biological testing, in which chemical testing is first conducted, and bioassays are performed on a DMMU only if the DMMU has one or more chemicals exceeding the marine chemical screening levels (SLs). Freshwater biological testing was necessary to fully evaluate anti-degradation compliance where the analytical results for the z-layer exceed the Freshwater Standards. Results of the biological testing are discussed in Section 5.

The purpose of this report is to provide the data required by the Dredged Material Management Program (DMMP) agencies to make a determination regarding the suitability of the proposed dredged material for disposal at the Elliott Bay non-dispersive open-water disposal site.

1.2 REPORT ORGANIZATION

This report is organized by sections as follows:

- Section 1.0 – Introduction
- Section 2.0 – Field and Laboratory Methods
- Section 3.0 – Summary of Data Validation Findings
- Section 4.0 – Analytical Results
- Section 5.0 – Biological Testing Results
- Section 6.0 – References
- Appendix A – Sampling and Analysis Plan
- Appendix B – Daily Report Logs
- Appendix C – Sediment Drive Logs
- Appendix D – Field and Lab Notebook
- Appendix E – Sediment Core Logs
- Appendix F – Sediment Core Photographs
- Appendix G – Chain-of-Custody Forms
- Appendix H – ARI Data Reports
- Appendix I – Data Validation Report
- Appendix J – Validated Analytical Data
- Appendix K – EIM Deliverable
- Appendix L – Puget Sound Standard Reference Material Results
- Appendix M – Biological Testing Results and Validation Report

Table 1-1 Kenmore DMMU Estimated Volumes and Volumes with Contingency Factor

DMMU [1]	**DMMU Volume (cy)**		
	2014 Hydrosurvey Estimated Volume [2]	**Contingency Factor** [3]	**Final DMMU Volume**
KEN-01	2877	30%	3750
KEN-02	2839	30%	3700
KEN-03	2907	30%	3800
KEN-04	2862	30%	3750
KEN-05	2830	30%	3700
KEN-06	2929	30%	3800
KEN-07	2891	30%	3750
KEN-08	2872	30%	3750

Notes:

1. DMMUs are numbered sequentially from north-to-south
2. Volume estimated based on the federal navigation channel boundaries, a total dredge depth to -17 ft LWLW, and a 1V:2H side slope
3. Contingency factor calculated based on a conservative target dredged volume of 30,000 cy, divided by the estimated volume from the 2014 survey
4. All final DMMU volume quantities are rounded to the nearest 50 cy. All estimated volumes are rounded to the nearest 1 cy.

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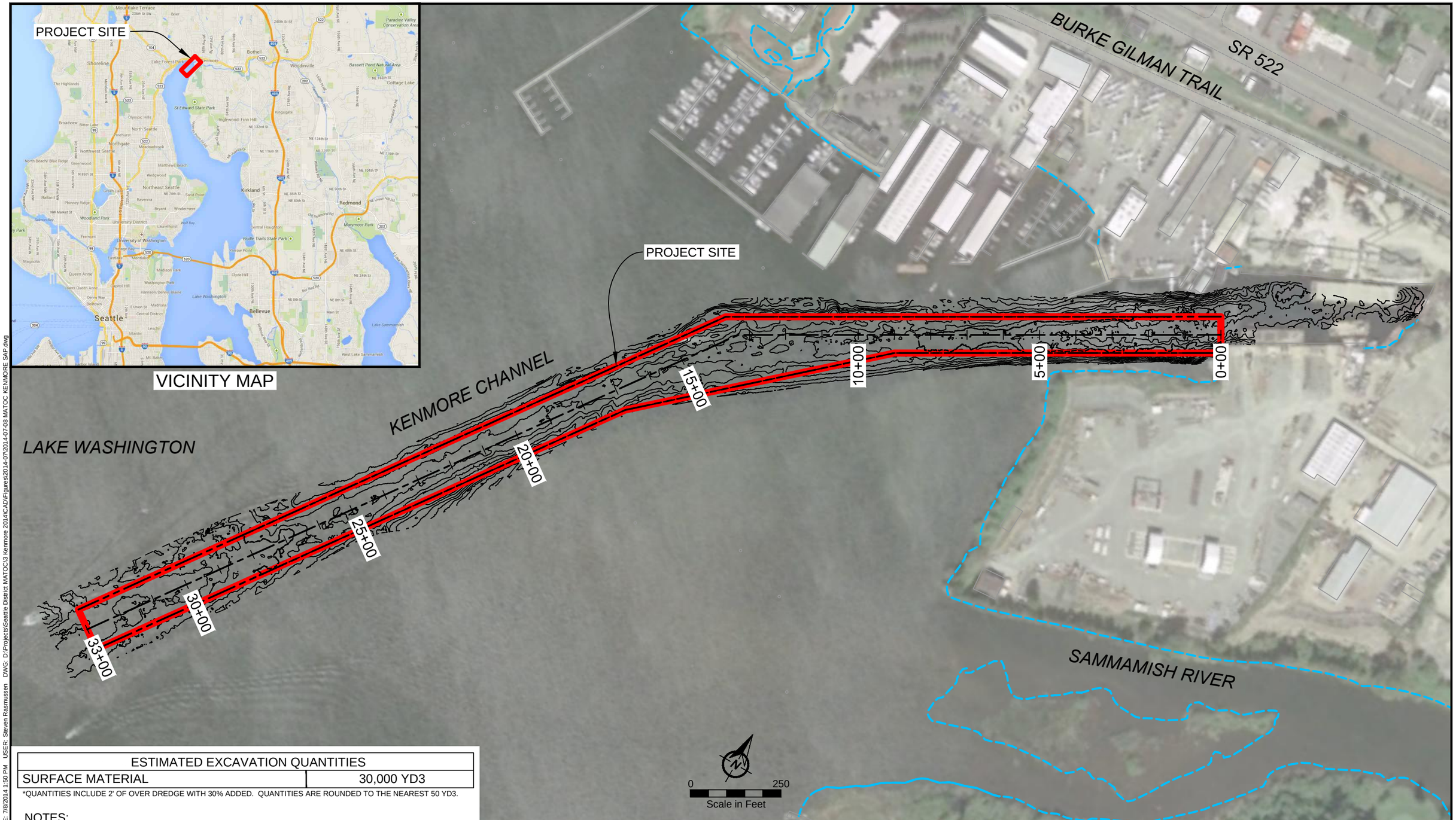


ESTIMATED EXCAVATION QUANTITIES	
SURFACE MATERIAL	30,000 YD3

*QUANTITIES INCLUDE 2' OF OVER DREDGE WITH 30% ADDED. QUANTITIES ARE ROUNDED TO THE NEAREST 50 YD3.

NOTES:

1. BATHYMETRIC CONTOURS GENERATED FROM HYDRO SURVEY DATA COLLECTED APRIL 7, 2014 BY USACE.
2. HORIZONTAL COORDINATE SYSTEM WASHINGTON STATE PLANE NORTH, VERTICAL LAKE WASHINGTON LOW WATER DATUM, US FOOT.
3. BASE MAP DRAWING INFORMATION PROVIDED BY USACE.
4. BACKGROUND IMAGE SOURCE: GOOGLE EARTH 5/4/2013

LEGEND

- PROJECT BOUNDARY
- NAVIGATION CHANNEL
- NAVIGATION CHANNEL CENTERLINE
- EXISTING CONTOURS
- EXISTING SHORELINE

U.S. ARMY CORPS OF ENGINEERS

SEATTLE DISTRICT MATOC
SEATTLE, WASHINGTON

VICINITY MAP FOR THE KENMORE FEDERAL NAVIGATION CHANNEL

DALTON OLMSTED FUGLEVAND

FIGURE
2-1

JULY 8, 2014

PLOT TIME: 7/8/2014 1:52 PM MOD TIME: 7/8/2014 1:50 PM USER: Steven Rasmussen DWG: D:\Projects\Seattle District MATOC\3 Kenmore 2014\CAD\Figures\2014-07\2014-07-08 MATOC KENMORE SAP.dwg

2 METHODS

The sampling and analysis activities were conducted according to the procedures defined in the *Sampling and Analysis Plan for the Kenmore Federal Navigation Project Dredged Material Characterization* (SAP; DOF/SEE 2014). The SAP, which is provided as Appendix A to this report, provides the background, sampling strategy, targeted sample locations, procedures for collecting and compositing the sediments to be characterized, procedures for analyzing the sediments, and data reporting requirements. The SAP was written to ensure that the collection, handling, and analysis of representative sediments fully characterize the sediments in accordance with the DMMP User Manual (2014) and quality assurance/quality control (QA/QC) requirements (USACE 1994). The SAP also reflects modifications made through the DMMP annual review process (Sediment Management Annual Review Meetings [SMARM] updates).

The SAP was approved by the USACE, Dredged Material Management Office (DMMO), and the Navigation Section, Seattle District, in coordination with the other DMMP agencies prior to sample collection. Changes to the SAP program are discussed in this section.

The SAP included 16 unique sediment core locations within the boundaries of four Dredged Material Management Units (DMMU) where vibracores were collected (Figure 2-1). As will be discussed in more detail, below, at total of 18 cores were collected. Field activities are documented in the daily reports found in Appendix B.

2.1 SAMPLING VESSEL, NAVIGATION AND POSITIONING

Sediment cores and reference sediment grab samples were collected aboard the *R/V Peter R*, owned and operated by Marine Sampling Services. Sediment sampling occurred on July 10 – 12, 2014. For core collection at Kenmore, the *R/V Peter R* was outfitted with a hydraulically actuated vibracore. A Trimble AG132 DGPS utilizing the U.S. Coast Guard differential signal from Seattle, WA was used for positioning. The receiver is located on the top of the A-frame of the *R/V Peter R* so that when the vibracore is deployed the unit is directly over the sampling location. The differential signal was interfaced to a computer running software enabling real-time plan view navigation to the required sampling stations, and the recording of the sampling point at the time of collection (Table 2-1). Station coordinates were digitally recorded, as well as written in the drive logs and/or field logs at the time of collection of each sample (Appendix C and D). All station coordinates were recorded in latitude and longitude as decimal minutes with a minimum precision of four (4) decimal places[2] using the North American Datum of 1983 (NAD 83).

Daily horizontal control checks were made at two points: a green navigational buoy that marks the channel west of Harbor Village Marina, and the southeast corner of the Harbor Village Marina day pier. All navigation checks were within ± 3 ft of the reported coordinates on the Kenmore navigation charts.

[2] The DMMP standard and Performance Work Statement requirement of recording decimal-degrees to six (6) decimal places is equivalent to degree decimal-minutes to four (4) decimal places.

Vertical control was based on the reported real-time operating lake levels maintained by the Corps for Lake Washington at the Kenmore Gage[3]. The SAP stated that this gage reports Lake Washington elevations in feet above Lake Washington Low Water datum (LWLW). In a closer evaluation with the Corps' Contract Technical Representative (CTR) and the DMMP, it was determined that the lake levels provided on the Corps' website are referenced to the Hiram Chittenden Locks; which is equivalent to the Corps' Datum for Lake Washington. To correct the elevations to the LWLW datum was based then on the following formula:

Mudline Elevation (LWLW) = Reported Lake Level (Corps' Datum) – measured water depth – 20 ft.

The corresponding water depths (depth to mudline) were confirmed at each station with a direct lead-line reading and corrected to LWLW using the Lake Washington elevation. Throughout the sampling period, the lake level fluctuated between 21.85 – 21.92 (Corps' Datum). All elevations were converted to LWLW using an average lake level of 21.9 ft. Depth-to-mudline and LWLW-corrected elevations were recorded on the drive log and in the field log (Appendix C and D).

2.2 CORE LOCATIONS

A total of 16 unique core locations were identified in the SAP to be composited into eight DMMU composites, and eight z-layer composite samples. Actual core locations, date, time of collection, and mudline elevation are given in Table 2-1. The planned and actual core locations are shown in Figure 2-1.

Table 2-1 also provides the core drive length, penetration and acquisition, and percent recovery. All cores achieved the required penetration elevation of at least -19.0 ft LWLW (Table 2-1). However, acquisition of cores with the minimum percent recovery of 75% was challenging due to a variety of unexpected conditions, including woody debris in the sediment column, and in some cases due to poor retention of native glacial clays below the dredge prism. Multiple attempts were made at 8 locations before acceptable cores were collected. A total of the 32 core attempts were made; of these 24 attempts had less than 75% recovery. Following the SAP, if a successful core was not collected after three tries the CTR was contacted immediately for advice on where to move the sample location to.

After three or more attempts, and in consultation with the CTR, the following stations were accepted with less than the target percent recovery: KEN02-3 Core 4 (71%), KEN02-4 Core 4 (69%), KEN02-4 Core 5 (73%), KEN05-10 Core 4 (66%), and KEN08-16 Core 3 (66%). Native glacial clay was encountered below the dredge prism at two core locations that likely influenced percent recovery: KEN04-7 Core 1 (67%) and KEN07-13 Core 2 (67%). The clay was very hard and dense, capable of standing on end in one-foot sections from the tube. The CTR was unavailable on the afternoon of July 11 when this was encountered at KEN02-13. A field-decision was made to accept cores with substantive blue clay in the core catcher, and was

[3] Those water elevations are reported hourly by the Corps on the internet at http://www.nwd-wc.usace.army.mil/nws/hh/www/index.html#.

reported in the 7/11/2014 Daily Report. The native blue clay in the z-layer was again encountered when collecting at KEN04-7 on 7/12/2014, so that core was accepted after one attempt.

Cores initially collected on the first day of sampling at DMMU KEN02 Stations 3 and 4 had poor recoveries (<53%) after three attempts. At these stations a high degree of matted woody debris was encountered, which may have contributed to the low recoveries. In consultation with the CTR, those stations were moved in an attempt to improve recoveries (Figure 2-1). The recoveries on the subsequent (fourth) attempt were 71 and 69%, respectively. Those two cores were then retained for further processing. On the last day of sampling, KEN02 Stations 3 and 4 were re-occupied in an attempt to get improved recovery. On the fifth attempt at these two locations, the percent recoveries had improved to 94 and 73%, respectively. In consultation with the CTR, all four cores collected at DMMU KEN02 were retained for logging and compositing (Table 2-1).

2.3 CORE LOGS AND COMPOSITING

At the end of each sampling day the cores were transferred to ARI on ice, and held upright at 4° C until processing. Core processing at ARI began on July14th and was completed on July 16th.

Prior to splitting the cores for processing, each core tube was re-measured for length and then weighed to get a field measure of bulk density. The method for calculating the wet bulk density is given in Section 4.4 of the SAP. While the SAP only required one of the core tubes per DMMU, all core tubes (with the exceptions of KEN01-1 and KEN03-5) were re-measured and weighed. Those weights, measures, and the estimated field bulk densities are given in Table 2-2.

Cores were processed by scoring the outside of the aluminum tube using a power saw, then split by drawing a knife through the middle of the core. All cores were photographed, logged for major lithological features, and classified according to the Unified Soil Classification System. Core processing logs are in Appendix E, and will be discussed further in Section 3. Core photographs are in Appendix F.

Sediment cores were processed as described in Sections 4.4 and 4.5 of the SAP. Sampling intervals and samples collected for all cores and DMMUs are given in Table 2-3. For each DMMU, a sulfide sample was taken from the first core opened representing the DMMU. The sulfide sample was taken from the entire length of the core representing the dredged material (mudline to -17 ft LWLW), and then fixed with zinc acetate. For each core, a separate 8 oz. archived sample was collected from the dredged material (mudline to -17 ft LWLW) and the z-sample (-17 to -19 ft LWLW). After completion of the individual core subsampling each sediment core was the strata to be composited. Once all cores were subsampled, the composite was mixed to uniform color and texture, placed in sample jars and then held on ice until final delivery to ARI.

Samples collected and delivered to ARI are listed in Table 2-4. Available sediment volume in the cores was an issue for compositing, especially in the z-layer. Each foot of core tube provides approximately 2 L of material. With two cores per DMMU and only two-feet of z-

layer, the maximum available volume was 8 L. During the development of the SAP additional analyses and procedures were identified that required a total volume of approximately 9.5 L. This included up to a full liter of material to extract ammonia and sulfide porewater for analysis, additional bioassay beakers that might be needed for potential salinity acclimatization, and replicate bioassay beakers for measuring ammonia and sulfides in the overlying water. After consultation with the CTR it was decided that for z-samples with insufficient sediment to collect all the required samples, the composite z-layer chemistry archive and the wood waste samples would not be collected.

All four cores collected at DMMU KEN02 were processed to provide for additional volume in the z-layer and enough material for a field duplicate. Individual subsamples were collected from all four cores and intervals (dredged material and z-layer) for KEN02.

A field duplicate of the KEN02 DMMP-characterization material was submitted blind to the lab as KEN09 C 07122014. The field duplicate samples were taken from the same composite mixture as KEN02.

A field grain size characterization was conducted from each DMMU composite. Approximately 100 g of the composited sediment was weighed on a scale and washed through a size 4 ϕ (62 µm) sieve. The fraction retained on the sieve, representing the sand fraction, was then re-weighed and converted to a percentage by dividing the weight of the retained sand by the pre-wash weighed mass. The percentage of fines (silts plus clays) was then calculated by subtracting the percentage of sand fraction from 100. Results of the field grain size measures are given in Table 2-5.

2.4 LABORATORY METHODS

Samples were transferred under Chain-of-Custody (Appendix G) to Analytical Resources Inc. With the exceptions described in Section 3, sediment samples were analyzed in accordance with the methods and procedures prescribed in the SAP.

2.5 BIOASSAYS

Bioassays were required for this characterization. As will be discussed further in Section 3, some DMMP Chemicals of Concern were above DMMP Screening Level guideline values and the Washington State Freshwater Sediment Management Standards. Bioassays are discussed in Section 4.

Table 2-1 Kenmore Core Locations, Surface and Drive Elevations, Penetration, Acquisition and Percent Recovery

DMMU	Station	Core	Date	Time	Latitude	Longitude	Measured Water Depth	Mudline Elevation [1]	Penetration	Acquisition	Recovery	Acquisition Elevation [2]	Accept/Reject
					NAD 1983		(ft)	(LWLW)	(ft)	(ft)	(%)	(LWLW)	
KEN01	1	1	7/10/2014	9:38:43	47 45.33561	122 15.54782	15.4	-13.5	7	4.8	69%	-18.3	Reject
KEN01	1	2	7/10/2014	10:14:47	47 45.33564	122 15.54685	16.7	-14.8	7	4.1	59%	-18.9	Reject
KEN01	1	3	7/10/2014	11:16:34	47 45.33528	122 15.54705	16.3	-14.4	7	5.4	77%	-19.8	Accept
KEN01	2	1	7/10/2014	11:56:09	47 45.30411	122 15.62635	15.9	-14	7	3.4	49%	-17.4	Reject
KEN01	2	2	7/10/2014	12:18:36	47 45.30376	122 15.62796	15.9	-14	5.9	5.3	90%	-19.3	Accept
KEN02	3	1	7/10/2014	13:09:26	47 45.28822	122 15.66511	15.5	-13.6	7	2.5	36%	-16.1	Reject
KEN02	3	2	7/10/2014	13:46:15	47 45.28778	122 15.66558	15.5	-13.6	7	3	43%	-16.6	Reject
KEN02	3	3	7/10/2014	14:17:53	47 45.28668	122 15.66317	15.9	-14	7	3.7	53%	-17.7	Reject
KEN02	3	4	7/10/2014	14:59:25	47 45.28485	122 15.65951	18.4	-16.5	7	5	71%	-21.5	Accept
KEN02	3	5 [(3)]	7/12/2014	13:22:03	47 45.28747	122 15.66454	15	-13.1	7	6.6	94%	-19.7	Accept
KEN02	4	1	7/10/2014	16:04:38	47 45.26832	122 15.63726	15.9	-14	7	1.8	26%	-15.8	Reject
KEN02	4	2	7/10/2014	16:46:41	47 45.26851	122 15.63590	15.7	-13.8	7	2.8	40%	-16.6	Reject
KEN02	4	3	7/10/2014	17:32:19	47 45.27010	122 15.63865	17.8	-15.9	7	3.2	46%	-19.1	Reject
KEN02	4	4	7/10/2014	18:56:03	47 45.26290	122 15.64437	15.5	-13.6	7	4.8	69%	-18.4	Accept
KEN02	4	5 [(3)]	7/12/2014	13:52:24	47 45.26895	122 15.63707	15.4	-13.5	7	5.1	73%	-18.6	Accept
KEN03	5	1	7/12/2014	12:42:37	47 45.26392	122 15.69121	15.6	-13.7	7	6.4	91%	-20.1	Accept
KEN03	6	1	7/12/2014	11:54:58	47 45.24994	122 15.66757	15.2	-13.3	7	7.3	104%	-20.6	Accept
KEN04	7	1	7/12/2014	11:05:42	47 45.23729	122 15.68710	13.8	-11.9	9	6	67%	-17.9	Accept
KEN04	8	1	7/12/2014	10:15:46	47 45.22396	122 15.73117	16.4	-14.5	7	5.9	84%	-20.4	Accept
KEN05	9	1	7/12/2014	9:37:08	47 45.20996	122 15.74528	16.9	-15	6.7	5.6	84%	-20.6	Accept
KEN05	10	1	7/11/2014	17:44:27	47 45.20102	122 15.72655	13.8	-11.9	9	0	0%	-11.9	Reject
KEN05	10	2	7/11/2014	18:20:21	47 45.20218	122 15.72694	14.1	-12.2	9	4.9	54%	-17.1	Reject
KEN05	10	3	7/11/2014	19:06:15	47 45.20300	122 15.72994	14.9	-13	9	5.4	60%	-18.4	Reject
KEN05	10	4	7/12/2014	8:56:42	47 45.20220	122 15.73010	15.2	-13.3	9	5.9	66%	-19.2	Accept
KEN06	11	1	7/11/2014	14:31:42	47 45.19392	122 15.76004	16.5	-14.6	7	5	71%	-19.6	Accept
KEN06	12	1	7/11/2014	15:13:10	47 45.17992	122 15.75057	14.7	-12.8	9	7.4	82%	-20.2	Accept
KEN07	13	1	7/11/2014	13:16:15	47 45.16717	122 15.78745	16.8	-14.9	7	4.5	64%	-19.4	Reject
KEN07	13	2	7/11/2014	13:58:32	47 45.16760	122 15.78793	16.4	-14.5	7	4.7	67%	-19.2	Accept
KEN07	14	1	7/11/2014	12:41:08	47 45.15474	122 15.77536	15.7	-13.8	7	6.8	97%	-20.6	Accept
KEN08	15	1	7/11/2014	10:16:39	47 45.13614	122 15.79381	15.7	-13.8	6.7	4.5	67%	-18.3	Reject
KEN08	15	2	7/11/2014	11:57:49	47 45.13618	122 15.79274	14.4	-12.5	7	6.4	91%	-18.9	Accept
KEN08	16	1	7/11/2014	9:17:28	47 45.11369	122 15.84462	16.6	-14.7	7	4.5	64%	-19.2	Reject
KEN08	16	2	7/11/2014	9:44:48	47 45.11434	122 15.84522	15.9	-14	7	4.3	61%	-18.3	Reject
KEN08	16	3	7/11/2014	17:08:18	47 45.11386	122 15.84511	16.4	-14.5	7	4.6	66%	-19.1	Accept
Notes:		32							**Average of accepted cores**		80%		

1 Lake Elevation-corrected. During the sample period the reported Lake Washington levels were 21.85 - 21.92 ft LWLW. These calculations are based on an average of 21.9 ft LWLW.

2 Penetration elevation = mudline elevation – length of acquired core; the target acquisition elevation was -17 ft LWLW; sediment collected deeper than this elevation was discarded during processing.

3 Two additional cores were collected at DMMU KEN02. These were identified as KEN02-3 Core 5, and KEN02-4 Core 5. See Daily Monitoring Report 07122014

Green highlight indicates that core was accepted for processing

ft = feet LWLW = Lake Washington Low Water Datum

Table 2-2 Kenmore Field Bulk Density Measures

DMMU	Station	Core	Tube Interval (ft) [(1)]	Weight (lbs)	Wet Sediment Density (lbs/ft3) [2]
KEN01	1	3	Data not taken		---
KEN01	2	2	0 – 5.50	38.0	73.46
KEN02	3	4	0 – 3.95	32.0	80.97
KEN02	3	5	0 – 6.25	46.0	71.31
KEN02	4	4	0 – 4.20	30.0	68.48
KEN02	4	5	0 – 4.90	37.0	73.80
KEN03	5	1	Data not taken		---
KEN03	6	1	0 – 7.50	49.0	60.5
KEN04	7	1	0 – 5.65	44.0	76.9
KEN04	8	1	0 – 5.75	46.0	79.7
KEN05	9	1	0 – 5.35	47.0	89.9
KEN05	10	4	0 – 5.35	41.0	75.3
KEN06	11	1	0 – 4.75	36.0	74.2
KEN06	12	1	0 – 3.95	30.0	74.4
KEN06	12	1	3.95 – 7.35	30.0	90.4
KEN07	13	2	0 – 4.40	36.0	82.0
KEN07	14	1	0 – 6.45	51.0	78.4
KEN08	15	2	0 – 6.30	49.0	76.8
KEN08	16	3	0 – 4.35	34.0	77.3

Notes:

1. Tube interval based on depth below mudline (0)
2. The weight of the aluminum tube is 1.89 lbs/linear foot. The weight of the tube (length x 1.89 lb/ft) is subtracted from the total measured weight to calculate the bulk density.

Table 2-3 Kenmore Core Sampling Intervals

DMMU	Station	Core	Dredged Material Sampling			Z-layer Sampling		
			Mudline Elevation [1]	Design Elevation	Sampling Interval [(2)]	Design Elevation	Bottom Z-layer	Sampling Interval [(2)]
			(ft LWLW)	(ft LWLW)	(ft)	(ft LWLW)	(ft LWLW)	(ft)
KEN01	1	3	-14.4	-17.0	0 - 2.6	-17.0	-19.0	2.6 - 4.6
KEN01	2	2	-14.0	-17.0	0 - 3.0	-17.0	-19.0	3.0 - 5.0
KEN02	3	4	-16.5	-17.0	0 - 0.5	-17.0	-19.0	0.5 - 2.5
KEN02	3	5 [(3)]	-13.1	-17.0	0 - 3.9	-17.0	-19.0	3.9 - 5.9
KEN02	4	4	-13.6	-17.0	0 - 3.4	-17.0	-18.4	3.4 - 4.4
KEN02	4	5 [(3)]	-13.5	-17.0	0 - 3.5	-17.0	-18.6	3.5 - 4.6
KEN03	5	1	-13.7	-17.0	0 - 3.3	-17.0	-19.0	3.3 - 5.3
KEN03	6	1	-13.3	-17.0	0 - 3.7	-17.0	-19.0	3.7 - 5.7
KEN04	7	1	-11.9	-17.0	0 - 5.1	-17.0	-17.9	5.1 – 0.9
KEN04	8	1	-14.5	-17.0	0 - 2.5	-17.0	-19.0	2.5 - 4.5
KEN05	9	1	-15.0	-17.0	0 - 2.0	-17.0	-19.0	2.0 - 4.0
KEN05	10	4	-13.3	-17.0	0 - 3.7	-17.0	-19.0	3.7 - 5.7
KEN06	11	1	-14.6	-17.0	0 - 2.4	-17.0	-19.0	2.4 - 4.4
KEN06	12	1	-12.8	-17.0	0 - 4.2	-17.0	-19.0	4.2 - 6.2
KEN07	13	2	-14.5	-17.0	0 - 2.5	-17.0	-19.0	2.5 - 4.5
KEN07	14	1	-13.8	-17.0	0 - 3.2	-17.0	-19.0	3.2 - 5.2
KEN08	15	2	-12.5	-17.0	0 - 4.5	-17.0	-18.9	4.5 - 6.4
KEN08	16	3	-14.5	-17.0	0 - 2.5	-17.0	-19.0	2.5 - 4.5

Notes:

1 Lake Elevation-corrected. During the sample period the reported Lake Washington levels were 21.85 - 21.92. These calculations are based on an average of 21.9 ft.

2 Sampling Interval represents the feet below the mudline (0). For the z-layer samples, the interval began at the bottom of the dredged material sample.

3 Two additional cores were collected at DMMU KEN02. These were identified as KEN02-3 Core 5, and KEN02-4 Core 5. See Daily Monitoring Report 07122014

ft = feet

LWLW = Lake Washington Low Water Datum

Table 2-4 Kenmore Sample Inventory

Sample ID	Samples Delivered to ARI																					
	Grain Size	Conventionals	Metals	SVOCs/Pest/ PCBs	TBT (porewater)	Dioxins	MS/MSD	PBDE	TPH	Wood Waste	Total Sulfides (discrete) [1]	Sulfides Composite Day 0	Sulfides Composite Day 21	Sulfides porewater Day 21	Ammonia Composite Day 0	Ammonia Composite Day 21	Ammonia Porewater Day 21	Temperature, pH and salinity porewater Day 21	Marine Bioassay [2]	Freshwater Bioassay [2]	Individual Core Chemistry Archive (all cores)	Composite Archive
KEN01 C 07102014	✓	✓	✓	✓	✓	✓	---	✓	---	A	Core 1	✓	✓	✓	✓	✓	✓	✓	8 L	---	A	A
KEN01 Z 07102014	✓	✓	✓	✓	✓	✓	---	A	✓	---	---	✓	✓	✓	✓	✓	✓	✓	---	< 5 L	A	---
KEN02 C 07102014	✓	✓	✓	✓	✓	✓	---	✓	---	A	Core 3	✓	✓	✓	✓	✓	✓	✓	7 L	---	A	A
KEN02 Z 07102014	✓	✓	✓	✓	✓	✓	---	A	✓	---	---	✓	✓	✓	✓	✓	✓	✓	---	7 L	A	A
KEN03 C 07112014	✓	✓	✓	✓	✓	✓	✓	✓	---	A	Core 5	✓	✓	✓	✓	✓	✓	✓	6 L	---	A	A
KEN03 Z 07112014	✓	✓	✓	✓	✓	✓	---	A	✓	---	---	✓	✓	✓	✓	✓	✓	✓	---	5 L	A	*i.s.*
KEN04 C 07122014	✓	✓	✓	✓	✓	✓	---	A	---	A	Core 7	✓	✓	✓	✓	✓	✓	✓	8 L	---	A	A
KEN04 Z 07122014	✓	✓	✓	✓	✓	✓	---	A	✓	---	---	✓	✓	✓	✓	✓	✓	✓	---	2 L	A	*i.s.*
KEN05 C 07122014	✓	✓	✓	✓	✓	✓	---	A	---	A	Core 9	✓	✓	✓	✓	✓	✓	✓	7 L	---	A	A
KEN05 Z 07122014	✓	✓	✓	✓	✓	✓	---	A	✓	*i.s.*	---	✓	✓	✓	✓	✓	✓	✓	---	3.5 L	A	*i.s.*
KEN06 C 07112014	✓	✓	✓	✓	✓	✓	---	A	---	A	Core 11	✓	✓	✓	✓	✓	✓	✓	8 L	---	A	A
KEN06 Z 07112014	✓	✓	✓	✓	✓	✓	---	A	✓	*i.s.*	---	✓	✓	✓	✓	✓	✓	✓	---	4 L	A	*i.s.*
KEN07 C 07112014	✓	✓	✓	✓	✓	✓	---	not archived	---	A	Core 13	✓	✓	✓	✓	✓	✓	✓	6 L	---	A	A
KEN07 Z 07112014	✓	✓	✓	✓	✓	✓	---	not archived	✓	---	---	✓	✓	✓	✓	✓	✓	✓	---	5 L	A	*i.s.*
KEN08 C 07112014	✓	✓	✓	✓	✓	✓	---	not archived	---	A	Core 15	✓	✓	✓	✓	✓	✓	✓	4.5 L	---	A	A
KEN08 Z 07112014	✓	✓	✓	✓	✓	✓	---	not archived	✓	*i.s.*	---	✓	✓	✓	✓	✓	✓	✓	---	3.5 L	A	*i.s.*
KEN09 C 07122014 [(3)]	✓	✓	✓	✓	✓	✓	---	A	---	---	---	✓	✓	✓	✓	✓	✓	✓	---	---	---	A

Notes:

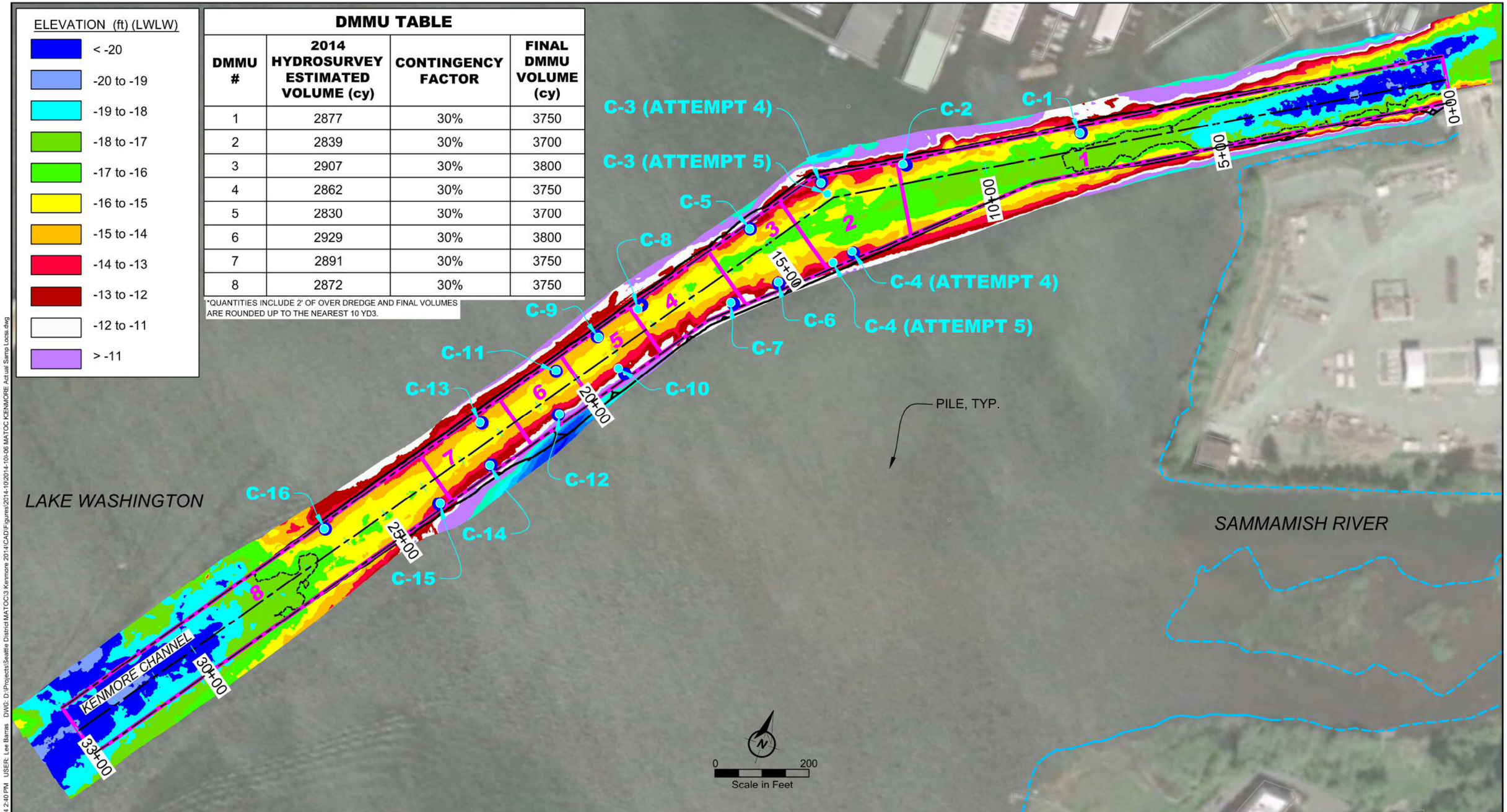
1. Indicates the core from which the individual sulfide sample was collected.
2. Indicates the approximate volume (L) of material archived for bioassay
3. KEN09 C is blind field duplicate for KEN02 C

✓ = indicates sample submitted for analysis
A = sample submitted for archiving
i.s. = insufficient sediment for targeted sample
Not archived indicates samples not subsampled and archived

Table 2-5 Kenmore Field and Lab Grain Size Measures

Grain Size	Dredged Material Composite															
	KEN01		KEN02		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab
Gravel/Sand (%)	42	45.6	38	44	41	46.4	36	41.1	38	47.1	28	45.9	49	53.6	45	46.1
Fines(%)	58	54.4	62	56	59	53.6	64	58.9	62	52.9	72	54.1	51	46.4	55	53.9

Grain Size	Z-layer Composite															
	KEN01		KEN02		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab
Gravel/Sand (%)	62	57.4	32	43.4	38	48.6	24	28.3	40	44.3	24	54.3	49	48.5	53	52.6
Fines(%)	38	42.6	68	56.6	62	51.4	76	71.7	60	55.7	76	45.7	51	51.5	47	47.4



DMMU TABLE

DMMU #	2014 HYDROSURVEY ESTIMATED VOLUME (cy)	CONTINGENCY FACTOR	FINAL DMMU VOLUME (cy)
1	2877	30%	3750
2	2839	30%	3700
3	2907	30%	3800
4	2862	30%	3750
5	2830	30%	3700
6	2929	30%	3800
7	2891	30%	3750
8	2872	30%	3750

*QUANTITIES INCLUDE 2' OF OVER DREDGE AND FINAL VOLUMES ARE ROUNDED UP TO THE NEAREST 10 YD3.

NOTES:

1. BATHYMETRIC CONTOURS GENERATED FROM HYDRO SURVEY DATA COLLECTED APRIL 7, 2014 BY USACE.
2. HORIZONTAL COORDINATE SYSTEM WASHINGTON STATE PLANE NORTH, VERTICAL LAKE WASHINGTON LOW WATER DATUM, US FOOT.
3. BASE MAP DRAWING INFORMATION PROVIDED BY USACE.

LEGEND

- PROPOSED SAMPLE LOCATION
- C-x ACTUAL SAMPLE LOCATION (7/10-12/2014)
- X DMMU
- SURFACE SEDIMENT BEING DREDGED IN ORDER TO REACH CHARACTERIZATION DEPTH OF -17 LWLW
- NAVIGATION CHANNEL
- -15 CONTOUR MAJOR (5')
- -14 CONTOUR MINOR (1')
- SLOPE
- EXISTING SHORELINE

U.S. ARMY CORPS OF ENGINEERS

SEATTLE DISTRICT MATOC
SEATTLE, WASHINGTON

KENMORE FEDERAL NAVIGATION CHANNEL DMMUs AND ACTUAL SEDIMENT SAMPLING LOCATIONS

DALTON OLMSTED FUGLEVAND

FIGURE 3-2

OCTOBER 6, 2014

PLOT TIME: 10/6/2014 2:40 PM MOD TIME: 10/6/2014 2:40 PM USER: Lee Barnes DWG: D:\Projects\Seattle District MATOC\3 Kenmore 2014\CAD\Figures\2014-10\2014-10-06 MATOC KENMORE Actual Samp Locs.dwg

3 SUMMARY OF DATA VALIDATION FINDINGS

All analytical data underwent the review and validation procedures defined in the SAP (Sections 6.4 and 6.5). Pyron Environmental conducted a Level III evaluation for metals and the DMMP conventional analyses. A Level IV validation was conducted for dioxins and furans, SVOCs, PCBs, pesticides, and polybrominated diethyl phenols (PBDE).

All data supporting the chemical analyses are included in Appendices H through J. Appendix H includes the data deliverable packages from ARI. Appendix I is the Data Validation Report (DVR) from Pyron. Appendix J is an Excel spreadsheet containing all of the analytical data in a searchable format. Appendix K includes the data spreadsheets for input into Ecology's Environmental Information Management system (EIM) by Exa Environmental. Appendix L includes the DMMP-required reporting elements for the Puget Sound Reference Material. Appendix L contains the deliverables required for the Puget Sound Sediment Reference Material. Appendices H through L are available only on the DVD submitted to the DMMP agencies.

Data qualifiers assigned during validation by the validator are listed in Table 3-2 and carried forward into the tables in Section 4. All data are considered to be of known quality and acceptable for use as qualified. The DVR includes a quality assurance review for data precision, accuracy, representativeness, completeness, and usability.

3.1 SAMPLE COMPLETENESS

Table 3-1 cross-references laboratory sample IDs with DMMU IDs and indicates the analyses done for each DMMU. Table 3-1 also serves as a check-list of the samples analyzed by DMMU composite (C and Z) and/or individual cores. With the exceptions discussed below, all samples were analyzed according to the PWS and the SAP.

3.2 FIELD AND LABORATORY PRECISION

For the Kenmore project, field duplicates were run on the dredged material composite for DMMU KEN02. The field replicate was assigned the identification of KEN09. The replicate sample jars were taken from the same homogenate as KEN02, and were submitted "blind" to ARI. The Relative Percent Difference (RPD) of the analytical measures for both KEN02 and KEN09 are indicative of the combination of field and laboratory precision and sample homogeneity.

The calculated RPDs for the DMMP COCs are presented in the Data Validation Report

(Appendix I – page 45). There are no formal criteria specified in the National Functional Guidelines for Data Review (EPA 2005, 2008, 2010) for field duplicate evaluation. The DMMP Warning and Action Limits for the standard COCs are as follows:

QA Element	Warning Limits	Action Limits
Precision		
Metals:	none	20% RPD or COV
Organics:	35% RPD or COV	50% COV or a factor of 2 for duplicates

Pyron applied the DMMP criteria in evaluating the RPD values of sediment field duplicate results that were greater than five (5) times the reporting limit. For results that were less than five times the reporting limit, Pyron applied a more stringent advisory criterion of ± two (2) times the RL to evaluate the concentration differences. The advisory criteria were set forth collectively in reference of common industry practices, and the criteria for laboratory duplicate analyses and those recommended in Naval Facilities Engineering Command Northwest (NAVFAC NW) Standard Operation Procedure (SOP): Field Standard Operating Procedures, Version 4.0. August, 2006

With the exception of the following COCs, the majority of the COC results were within the advisory criteria:

- di-n-octylphathalate (> 2X RL)
- 4,4'DDE (>2X RL), DDD (>2X RL), DDT (>2X RL) *[DDx]*
- penta, hepta, hexa, and octa dioxins and furans (RPD range 56 - 140%)

A large divergence between the field replicates was found for the DDx compounds, and is discussed in more detail in Section 4.

3.3 LAB-ASSIGNED AND FINAL DATA QUALIFIERS

The laboratory-assigned and final validated qualifiers (VQ) assigned by Pyron may be found in Appendix J. The validator did not find any reported values that required changing, but did modify the laboratory qualifier when any one or more of the following conditions occurred:

- Sediment Reference Material result greater than the upper confidence limit
- Sediment Reference Material result less than the lower confidence limit
- Laboratory triplicate analyses percent relative standard deviation was greater than 20%
- Laboratory duplicated analysis relative percent difference was greater than 20%
- Matrix spike, or matrix-spike duplicate, percent recovery was less than the lower confidence limit
- Continuing calibration verification percent difference was greater than the upper confidence limits
- Dual column relative percent difference was greater than 40% (pesticides and PCBs)
- The reporting limit (RL) was raised due to chromatographic interference and is considered an estimated reporting limit.
- Polychlorinated biphenyl ether interference (co-elution) was present and affected target compound quantitation (false positive).
- Field duplicate result was outside the advisory criteria

The data in Appendix J also includes an assigned "Do Not Report" (DNR) qualifier. Polycyclic aromatic hydrocarbons were analyzed two ways: by EPA Method 8270 with the semi-volatile organic compounds and by SW8270D-Selective Ion Monitoring (SIM) to achieve lower reporting limits. PAHs measured by both methods were valid data. However, Pyron assigned the "DNR" to the results by SW8270 to ensure that the SIM-reported values with lower reporting limits would be used. The semi-volatile organic compound 2,4-dimethylphenol was also analyzed and reported by SIM.

As required by the PWS and SAP and DMMP guidance for reporting dioxin data (DMMP, 2010), dioxin/furan results reported as estimated maximum possible concentrations (EMPCs) by the laboratory were converted by Pyron to nondetects (U) at the EMPC value.

3.4 PUGET SOUND REFERENCE MATERIAL

The Puget Sound Sediment Reference Material (PS-SRM) was analyzed as required for Aroclors and dioxin/furans. The results were within the acceptance limits for all listed compounds. Required reporting for the PS-SRM is in Appendix L.

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Table 3-1 Inventory of Kenmore Analyzed Samples by DMMU and Method. Table includes sample identification (ID) and Lab ID.

DMMU	Sample ID	Lab Sample ID	Analyte & Method																
			Total Solids	TOC	Grain size	Ammonia in Sediment[1]	Ammonia in Porewater [1,2]	Sulfide in Sediment[1]	Sulfide in Porewater[1]	Metals	Se	Hg	Pesticide	PCBs	Semivolatiles	Semivolatiles and TBT [3]	Dioxin/ Furans	PBDE	TPH
			SM2540G	PLUMB	PSEP-PS	EPA350.1	EPA350.1	EPA 376.2	EPA376.2	SW6010 C	EPA200	SW7471	SW8081B	SW8082	SW8270D	SW8270DSIM	EPA 1613B	EPA 1614	NWTP H-DX
1	KEN01 C	14-14038-YR82E	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		
	KEN01 C	14-14044-YR82K														✓			
	KEN01 C	14-14295-YS21E														✓			
	KEN01 C	14-15670-YU50A	✓			Day 21		Day 21											
	KEN01 C	14-15674-YU51A					Day 21		Day 21										
	KEN01 C	L21737-1 WG48247																✓	
	KEN01 C Core 01	14-14048-YR82O	✓					Day 0											
	KEN01 Z	14-14039-YR82F	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		✓
	KEN01 Z	14-14045-YR82L														✓			
	KEN01 Z	14-14296-YS21F														✓			
	KEN01 Z	14-15671-YU50B	✓			Day 21		Day 21											
	KEN01 Z	14-15675-YU51B					Day 21		Day 21										
2	KEN02 C	14-14087-YR91C	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		
	KEN02 C	14-14094-YR91J														✓			
	KEN02 C	14-14396-YS48C														✓			
	KEN02 C	14-15672-YU50C	✓			Day 21		Day 21											
	KEN02 C	14-15676-YU51C					Day 21		Day 21										
	KEN02 C	L21737-2 WG48247																✓	
	KEN02 C Replicate 1	14-23652-ZI36A											✓						
	KEN02 C Replicate 2	14-23652-ZI36ADUP											✓						
	KEN02 C Replicate 3	14-26045-ZM72A											✓						
	KEN02 C Replicate 4	14-26045-ZM72D											✓						
	KEN02 C Replicate 5	14-26045-ZM72E											✓						
	KEN02 C Replicate 6	14-26045-ZM72F											✓						
	KEN02 C Core 3b	14-14099-YR91O 14-26081-ZM72B	✓					Day 0											
	KEN02 C Core 3a	14-23653-ZI36B											✓						
	KEN02 C Core 3b	14-18185-YZ10C											✓						
	KEN02 C Core 4a	14-23654-ZI36C											✓						
	KEN02 C Core 4b	14-18184-YZ10B 14-26081-ZM72C											✓						
	KEN02 Z	14-14088-YR91D	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		✓
	KEN02 Z	14-14095-YR91K														✓			
	KEN02 Z	14-14397-YS48D														✓			
	KEN02 Z	14-15673-YU50D	✓			Day 21		Day 21											
	KEN02 Z	14-15677-YU51D					Day 21		Day 21										
3	KEN03 C	14-14085-YR91A	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		

Table 3-1 Inventory of Kenmore Analyzed Samples by DMMU and Method. Table includes sample identification (ID) and Lab ID.

DMMU	Sample ID	Lab Sample ID	Analyte & Method																
			Total Solids	TOC	Grain size	Ammonia in Sediment[1]	Ammonia in Porewater [1,2]	Sulfide in Sediment[1]	Sulfide in Porewater[1]	Metals	Se	Hg	Pesticide	PCBs	Semivolatiles	Semivolatiles and TBT [3]	Dioxin/ Furans	PBDE	TPH
			SM2540G	PLUMB	PSEP-PS	EPA350.1	EPA350.1	EPA 376.2	EPA376.2	SW6010 C	EPA200	SW7471	SW8081B	SW8082	SW8270D	SW8270DSIM	EPA 1613B	EPA 1614	NWTP H-DX
	KEN03 C	14-14092-YR91H														✓			
	KEN03 C	14-14394-YS48A														✓			
	KEN03 C	L21737-3 WG48247																✓	
	KEN03 C Core 05	14-14098-YR91N	✓					Day 0											
	KEN03 Z	14-14086-YR91B	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		✓
	KEN03 Z	14-14093-YR91I														✓			
	KEN03 Z	14-14395-YS48B														✓			
	KEN03 Z	14-15843-YU80A	✓			Day 21		Day 21											
	KEN03 Z	14-15849-YU81A					Day 21		Day 21										
4	KEN04 C	14-14089-YR91E	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		
	KEN04 C	14-14114-YR91AC														✓			
	KEN04 C	14-14398-YS48E														✓			
	KEN04 C	14-15844-YU80B	✓			Day 21		Day 21											
	KEN04 C	14-15850-YU81B					Day 21		Day 21										
	KEN04 C Core 07	14-14100-YR91P	✓					Day 0											
	KEN04 Z	14-14090-YR91F	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		✓
	KEN04 Z	14-14096-YR91L														✓			
	KEN04 Z	14-14399-YS48F														✓			
	KEN04 Z	14-15845-YU80C	✓			Day 21		Day 21											
	KEN04 Z	14-15851-YU81C					Day 21		Day 21										
5	KEN05 C	14-14198-YS05A	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		
	KEN05 C	14-14202-YS05F														✓			
	KEN05 C	14-14375-YS45A														✓			
	KEN05 C	14-15847-YU80E	✓			Day 21		Day 21											
	KEN05 C	14-15853-YU81E					Day 21		Day 21										
	KEN05 C Core 09	14-14206-YS05J	✓					Day 0											
	KEN05 Z	14-14199-YS05B	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		✓
	KEN05 Z	14-14203-YS05G														✓			
	KEN05 Z	14-14376-YS45B														✓			
	KEN05 Z	14-15848-YU80F	✓			Day 21		Day 21											
	KEN05 Z	14-15854-YU81F					Day 21		Day 21										
6	KEN06 C	14-14200-YS05C	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		
	KEN06 C	14-14204-YS05H														✓			
	KEN06 C	14-14377-YS45C														✓			
	KEN06 C	14-15739-YU66E	✓			Day 21		Day 21											
	KEN06 C	14-15745-YU67E					Day 21		Day 21										

Table 3-1 Inventory of Kenmore Analyzed Samples by DMMU and Method. Table includes sample identification (ID) and Lab ID.

DMMU	Sample ID	Lab Sample ID	Analyte & Method																
			Total Solids	TOC	Grain size	Ammonia in Sediment[1]	Ammonia in Porewater [1,2]	Sulfide in Sediment[1]	Sulfide in Porewater[1]	Metals	Se	Hg	Pesticide	PCBs	Semivolatiles	Semivolatiles and TBT [3]	Dioxin/ Furans	PBDE	TPH
			SM2540G	PLUMB	PSEP-PS	EPA350.1	EPA350.1	EPA 376.2	EPA376.2	SW6010 C	EPA200	SW7471	SW8081B	SW8082	SW8270D	SW8270DSIM	EPA 1613B	EPA 1614	NWTP H-DX
	KEN06 C Core 11	14-14208-YS05L	✓					Day 0											
	KEN06 Z	14-14201-YS05D	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		✓
	KEN06 Z	14-14205-YS05I														✓			
	KEN06 Z	14-14378-YS45D														✓			
	KEN06 Z	14-15740-YU66F	✓			Day 21		Day 21											
	KEN06 Z	14-15746-YU67F					Day 21		Day 21										
7	KEN07 C	14-14036-YR82C	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		
	KEN07 C	14-14042-YR82I														✓			
	KEN07 C	14-14293-YS21C														✓			
	KEN07 C	14-15737-YU66C	✓			Day 21		Day 21											
	KEN07 C	14-15743-YU67C					Day 21		Day 21										
	KEN07 C Core 13c	14-14047-YR82N	✓					Day 0											
	KEN07 Z	14-14037-YR82D	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		✓
	KEN07 Z	14-14043-YR82J														✓			
	KEN07 Z	14-14294-YS21D														✓			
	KEN07 Z	14-15738-YU66D	✓			Day 21		Day 21											
	KEN07 Z	14-15744-YU67D					Day 21		Day 21										
8	KEN08 C	14-14034-YR82A	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		
	KEN08 C	14-14040-YR82G														✓			
	KEN08 C	14-14291-YS21A														✓			
	KEN08 C	14-15735-YU66A	✓			Day 21		Day 21											
	KEN08 C	14-15741-YU67A					Day 21		Day 21										
	KEN08 Z	14-14035-YR82B	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		✓
	KEN08 Z	14-14041-YR82H														✓			
	KEN08 Z	14-14292-YS21B														✓			
	KEN08 Z	14-15736-YU66B	✓			Day 21		Day 21											
	KEN08 Z	14-15742-YU67B					Day 21		Day 21										
	KEN08C Core 15c	14-14046-YR82M	✓					Day 0											
9 (Field Replicate of KEN02)	KEN09 C	14-14091-YR91G	✓	✓	✓	Day 0		Day 0		✓	✓	✓	✓	✓	✓	✓	✓		
	KEN09 C	14-14097-YR91M														✓			
	KEN09 C	14-14400-YS48G														✓			
	KEN09 C	14-15846-YU80D	✓			Day 21		Day 21											
	KEN09 C	14-15852-YU81D					Day 21		Day 21										

Notes:

1 "Day 0" and "Day 21" are relative dates to the time after sampling. Actual analysis dates are given in Table 4-9

2 Ammonia in porewater also included measures of pH, salinity and temperature

Table 3-1 Inventory of Kenmore Analyzed Samples by DMMU and Method. Table includes sample identification (ID) and Lab ID.

DMMU	Sample ID	Lab Sample ID	Analyte & Method																
			Total Solids	TOC	Grain size	Ammonia in Sediment[1]	Ammonia in Porewater [1,2]	Sulfide in Sediment[1]	Sulfide in Porewater[1]	Metals	Se	Hg	Pesticide	PCBs	Semivolatiles	Semivolatiles and TBT [3]	Dioxin/ Furans	PBDE	TPH
			SM2540G	PLUMB	PSEP-PS	EPA350.1	EPA350.1	EPA 376.2	EPA376.2	SW6010 C	EPA200	SW7471	SW8081B	SW8082	SW8270D	SW8270DSIM	EPA 1613B	EPA 1614	NWTP H-DX

3 SW8270D SIM was used to measure low level PAHs, 2,4-dimethylphenol, and TBT ions

✓ Sample analyzed

4 ANALYTICAL RESULTS

This section summarizes chemical findings for DMMP conventionals[4], standard marine and freshwater COCs, butyltins, dioxin/furans, PBDE, and the ammonia and sulfide pre-testing. For the proposed dredged material, the COCs are presented and compared to the marine SLs, maximum levels (ML), and bioaccumulation triggers (BT). The z-layer results are compared to the Washington State freshwater Sediment Management Standards (SMS) for the anti-degradation evaluation. For dioxin/furans, disposal at non-dispersive sites, projects must have a volume weighted average of 4 parts-per-trillion (pptr) TEQ or less, with no single DMMU having a concentration greater than 10 pptr TEQ. PBDE results are also presented; there are no interpretive guidelines for PBDEs. All analyses were conducted by ARI, except for PBDE analysis which was conducted by Axys Analytical of Victoria, B.C., Canada. All data were validated by Pyron Environmental.

4.1 CONVENTIONAL ANALYSES

Grain-size, total solids, total volatile solids, and total organic carbon results for the dredged material composites are presented in Table 4-1. Results for the z-layer composites are given in Table 4-2. Sediments in the dredged material composites were classified as sandy silts. Sediments in the z-layer composites were also categorized as sandy silts. Total solids were relatively low in the dredged material composites, ranging from 33 – 46.5% solids. Z-layer composites were somewhat higher for total solids; ranging from 41 – 62% solids. Bulk and porewater ammonia and sulfides are discussed in Section 4.4.

4.2 DMMP CHEMICALS OF CONCERN

Results of the COC analyses for the dredged material composite are compared to the DMMP Guideline Values in Table 4-1. All DMMUs had levels of benzyl alcohol that exceeded the DMMP Screening Level (SL). The SL for benzoic acid was exceeded at DMMU KEN08; the Maximum Level (ML) for benzoic acid was exceeded at KEN03. The ML for benzoic acid and the SL for benzoic acid were also exceeded in the KEN02-Replicate (KEN09), However, these exceedances were not corroborated in KEN02. The RPD between the two measures of benzoic acid was 46.5%. Levels of DDx compounds exceeded both the DMMP guidelines at DMMU KEN02, specifically for the 4,4'DDx compounds. Levels of 4,4' DDD (290 µg/kg), 4,4' DDE (170 µg/kg), and 4,4'DDT (5,500 µg/kg) exceed the DMMP ML.

The results of the blind field replicate for DMMU KEN02, designated as KEN02-Replicate, are also presented in Table 4-1. The relative percent differences between the field replicates for the DMMP COCs were previously discussed in Section 3.2. The results for KEN02-Rep of 4,4'DDD (4.3 µg/kg), 4,4' DDE (2.7 µg/kg) and 4,4'DDT (< 1.8 µg/kg) were orders of magnitude lower than that reported for KEN02. Additional studies to characterize the nature and extent of the apparent DDx hits are discussed further in Section 4.6.

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[4] The list of conventional analyses includes total solids, total volatile solids, grain size, ammonia, TOC, and sulfides (DMMP 2013).

4.3 SMS CHEMICALS OF CONCERN

The z-layer composites were analyzed for all of the SMS freshwater COCs as well as the DMMP marine COCs; the results are presented in Table 4-2. To evaluate the potential for exceeding the anti-degradation requirement, Table 4-2 compares the results to the SMS Freshwater Sediment Cleanup Objectives (SCO) and the Cleanup Screening Levels (CSL)[5] for those COCs for which criteria have been published.

Nickel was the only COC that exceeded the SMS criteria, and was exceeded at all stations. Levels of DDx in the z-layer were well below the SQS criteria. Z-layers with SMS exceedances underwent freshwater biological testing (see section 5).

Bulk butyltins, which have freshwater SMS criteria, were not measured in this study. The Performance Statement of Work from the Corps had specified porewater butyltins for the z-layer sample, and this was reflected in the SAP. However, there was insufficient volume of material in the z-layer to run the porewater analyses.

4.4 DIOXIN/FURAN RESULTS

Results of dioxin/furan analyses for the dredged material composite are presented in Table 4-3, and results for the z-layer are in Table 4-4. Toxicity Equivalents (TEQs) were calculated following the methodology outlined in the DMMP User Manual (USACE 2014). For each station the dioxin/furan concentration was multiplied by the corresponding toxicity equivalent factor (TEF) and then all values were summed to yield the TEQ, with non-detect values summed at both 0 and ½ the reporting limit (RL). As required by the SAP, ARI reported estimated maximum potential concentrations (EMPCs) for dioxin/furans. During data validation EMPCs were converted to nondetects (U) at the EMPC value. Those values were then used to calculate TEQs in accordance with DMMP policy.

For disposal at non-dispersive sites, projects must have a volume weighted average of 4 pptr TEQ or less, with no single DMMU having a concentration greater than 10 pptr TEQ. Disposal of material with more than 10 pptr TEQ or not meeting the volume weighted average of 4 pptr TEQ not allowed without bioaccumulation testing (DMMP, 2010). For all dredged material stations the TEQ is greater than the 4 pptr guideline, and is above 10 pptr TEQ in DMMUs KEN01, KEN02, and KEN03.

Results of dioxin analyses in the z-layer are presented in Table 4-4. At present, there are no SMS benthic criteria for dioxins. Dioxin TEQs ranged from 1.89 (DMMU KEN01) to 10.97 (DMMU KEN03), using the TEQ calculation method of ½ of the estimated detection limit for the non-detected dioxin/furans.

[5] The DMMP User Manual (2014) refers to the SCO and CSL as Screening Level 1 (SL1) and Screening Level 2 (SL2), respectively. Table 4-2 refers to both the SCO/SL1 and the CSL/SL2, but the criteria listed are those of the SMS, and not the User Manual.

4.5 ADDITIONAL DDX EVALUATION AT KEN02

To further evaluate the nature and extent of the apparent DDx exceedances in the dredged material layer in DMMU KEN02, the DMMP elected to conduct additional investigations, including chemical analyses on the archived samples. Results for all analyses of DDx at KEN02 are presented in Table 4-5.

As mentioned previously, a field duplicate of KEN02, KEN02-Replicate, was analyzed with the original samples. The field duplicate results did not corroborate the elevated levels of DDx in the dredged material - the sum of DDTs at KEN02 (5,960 µg/kg) is more than two orders of magnitude greater than that measured in KEN02-Replicate (7 µg/kg). Prior to additional chemical analyses, the analytical laboratory reviewed the results of the elevated levels of DDx in KEN02, and concluded that the compounds were present in the samples (Appendix H4 – January 12, 2015 email from ARI to USACE). In addition to the standard QA review of the data, the laboratory analyzed the same sample extract used in the original analyses using a GC-MS method, which confirmed the presence of the DDx compounds.

With this information which appeared to confirm the elevated DDx detections in the original sample, additional pesticide analyses on two of the individual cores from within DMMU KEN02 were performed to determine if DDx was found throughout the DMMU or if it was concentrated on either the northern or southern side of the DMMU. As noted previously, four cores were collected and contributed to the composite at KEN02; two cores from the north side (3a and 3b) of the DMMU, and two cores from the south side (4a and 4b). To save project funds, the DMMP decided to have two of the four archived core samples analyzed (KEN02-3b and KEN02-4b) for the DMMP suite of chlorinated pesticides. Results from the individual archive analyses for KEN02-3b and KEN02-4b showed low levels of DDx, with the highest value 4 µg/kg. These results did not corroborate the original elevated results, but are similar to the results reported for the field replicate KEN09.

The DMMP considered this new information, and decided that additional analyses were warranted to try to elucidate the apparent conflict over concentrations of DDx in the dredge prism. Thus, the DMMP elected to analyze the other two archived individual core samples (KEN02-3a and KEN02-4a) and re-analyze in duplicate the dredged material composite sample KEN02. For re-analysis of the KEN02 composite sample, two separate sediment aliquots were subjected to extraction, cleanup, and chemical analysis using the same methods as the original sample. Results from the second two individual cores and the duplicate analyses of the composite were all low, below the DMMP SLs and similar to the original results from the field duplicate (Table 4-5).

The aforementioned composite re-analysis samples were not taken from the original jar with the high DDx results, but were instead taken from the composite chemistry archive jar. Therefore, ARI undertook one additional set of analyses on the composite sample and on the archived samples for KEN02-3b and KEN02-4b (Table 4-6). Four separate extractions were conducted on the composite sample that was taken from the same sample jar for which the high DDx levels were first reported. Three of the composite extracts were subject to cleanup by gel permeation chromatography to exactly replicate the initial analysis, and one of the composite extracts was subjected to acid cleanup. The two individual core archive samples were extracted

and also subject to acid cleanup the purpose of which was to remove any labile interference in the samples (Appendix H4 – January 13, 2015 email from ARI to USACE). Acid cleanup will not affect the DDx, but in ARI's experience for some sediment samples these cleanups can improve peak shape and result in closer correlation between dual column results. Results from all replicates were low, between 0.98 and 6.3 µg/kg, below the DMMP SLs and in line with all the previous re-analysis and re-extraction results. Again, these results did not corroborate the high values reported from the original analysis of KEN02.

Laboratory contamination by accidentally spiking the sample with a spiking solution was eliminated as a possible explanation of the original elevated results for the following reasons: 1) the pesticide spiking solution contains mixtures of target pesticides, not just DDT, and no other pesticides were reported at elevated levels in the original sediment sample; 2) the pesticide breakdown standard, which contains DDD and DDE, also contains other breakdown products such as pentachlorophenol (PCP) and decafluorotriphenylphosphine (DFTPP), neither of which were detected in the GC/MS re-run of the original elevated extract; and 3) spiking solutions that are used are not concentrated enough to give the reported results (Appendix H4 – January 12, 2015 email from ARI to USACE).

In conclusion, a total of 14 separate analyses were conducted for DDx on the samples from DMMU KEN02. Eight were done on the composite sample. Of those, only the initial analysis for KEN02 showed the elevated levels of DDx. In the field replicate (KEN02-Replicate), and the subsequent 6 re-analyses of the composite samples all levels of DDx were similarly low; the individual isomers were at or below 4.7 µg/kg. Six separate analyses were conducted on the individual cores that made up the composite samples; the individual isomers were at or below 7.6 µg/kg. The initial reported levels were not corroborated by any subsequent analysis.

4.6 PBDE CONGENERS

Three dredged material composite samples were analyzed for polybrominated diphenyl ether (PBDE) congeners using high-resolution gas chromatography/mass spectrometry (GC/MS) by EPA Method 1614 at Axys Analytical. These DMMUs were selected as those most closely approximating the locations that had the highest reported levels of DMMP COCs in the 2012 grab sampling event (DMMP 2013b)[6]: DMMUs KEN01, KEN02, and KEN03. The results are presented in Table 4-7.

4.7 BULK AND POREWATER AMMONIA AND SULFIDE RESULTS

Bulk sediment ammonia and sulfide results are presented in Table 4-8. The bulk ammonia values in the dredged material composites ranged from 217 – 396 mg/kg for the Day 0 measurements, and 220 – 496 for Day 21 measurements. For the z-composites the Day 0 bulk ammonia measurements ranged from 75 – 259 mg/kg, and the Day 21 measurements ranged from 76.5 – 266 mg/kg. Sulfides in the dredged material composite measured for Day 0 ranged

[6] In the 2012 sampling, the stations identified as SG05, SG06, and SG07 had levels of zinc, bis-2-ethylhexylphthalate, phenol, benzyl alcohol and/or benzoic acid that exceeded the SL.

from 176 – 457 mg/kg; for Day 21 measured between 149 – 322 mg/kg. The bulk single core measurements in the dredged material ranged between 166 – 500 mg/kg.

Porewater ammonia and sulfides for the dredged material and z-layer samples are given in Table 4-9[7]. Table 4-9 also includes pH and temperature at the time of analysis, and salinity in the porewater sample. For the dredged material composite the ammonia levels ranged between 24.4 – 59.9 mg/L, while the sulfides were all undetected at 0.057 mg/L or less. For the z-layer composite, the ammonia levels ranged between 6.23 – 43.9 mg/L; sulfides were undetected at 0.05 mg/L with the exception of KEN03Z which was measured at 0.072 mg/L.

[7] Due to the limited volume of sediment in the KEN03 dredged material composite the CTR requested that that volume not be used for porewater analysis, but saved for potential bioassays.

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Table 4-1 Dredged Material Composite Analytical Results Compared to the DMMP Chemicals of Concern Guidelines.

Chemical	DMMP Marine Guidelines			Dredged Material (C) Composite																	
				KEN01		KEN02		KEN02 - Replicate		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	SL	BT	ML	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Conventionals																					
Gravel (%)	---	---	---	9.9		0.3		2.2		4.4		0.8		0.6		0.6		0.2		3.3	
Sand (%)	---	---	---	35.7		43.7		43.2		41.91		40.3		46.5		45.2		53.4		42.7	
Silt (%)	---	---	---	44.2		44.2		43.1		42.2		45.9		42.6		43.7		37.7		44.1	
Clay (%)	---	---	---	10.3		11.8		11.3		11.5		13		10.2		10.4		8.8		9.9	
Total Solids (%)	---	---	---	36.2		35.8		35.18		37.5		40.9		33		39.7		46.5		43.1	
Total Volatile Solids (%)	---	---	---	12.8		14.3		15.13		12.5		11.8		12.9		10.8		9.3		10.5	
TOC (%)	---	---	---	3.57		2.77	J	5.37	J	2.71		2.07		4.63		2.45		2.46		1.7	
Ammonia (bulk) (mg/kg - N)	---	---	---	226		218.5		220		242		258.5		432.5		297		238.5		302.5	
Sulfide (bulk - single core) (mg/kg)	---	---	---	500		456		No value		309		166		350		349		216		360	
Sulfide (bulk - composite) (mg/kg)	---	---	---	389.5		319		307		290		195		273		226.5		199.5		201.5	
Metals (mg/kg)																					
Antimony	150	---	200	2.1	J	10	UJ	1.4	J	1	J	1	J	1.3	J	0.9	J	1.5	J	1.7	J
Arsenic	57	507.1	700	7.2	J	9.4	J	8.8	J	8.9	J	7.4	J	9.2	J	8.3	J	6.3	J	8.6	J
Cadmium	5.1	11.3	14	0.8		0.8		0.8		0.8		0.7		0.8		0.8		0.6		0.8	
Chromium	260	260	---	46		49		46		61		48		49		53		45		48	
Copper	390	1027	1300	35.1		34.2	J	33.8	J	33.5	J	28.9	J	32.9	J	34.5	J	26.7		31.1	
Lead	450	975	1200	28		29		27		31		22		26		23		23		24	
Mercury	0.41	1.5	2.3	0.1	J	0.11		0.1		0.09		0.09		0.09		0.09		0.08	J	0.09	J
Selenium(1)	---	3	---	0.48	J	0.66	J	0.61	J	0.69	J	0.68	J	0.68	J	0.62	J	0.38	J	0.47	J
Silver	6.1	6.1	8.4	0.106	J	0.106	J	0.105	J	0.12	J	0.086	J	0.117	J	0.132	J	0.105	J	0.113	J
Zinc	410	2783	3800	140		160		130		120		102		129		129		110		125	
Organotin Compounds *(µg/L)*																					
Tributyltin (interstitial water)	---	0.15	---	0.017		0.01		0.005	U	0.014	J	0.006		0.005	U	0.005	U	0.005	U	0.005	U
Polycyclic Aromatic Hydrocarbons (µg/kg)	---	---	---																		
Total LPAH	5200	---	29000	*50.6*		*48.7*		*76.6*		*77.1*		*94.4*		*64.4*		*82.7*		*70*	*J*	*81.5*	J
Naphthalene	2100	---	2400	4.1	J	5.4		7.8		6.5		5.5		4.4	J	7		4.6	J	3.8	J
Acenaphthylene	560	---	1300	4.8	U	4.9	U	4.8	U	4.8	U	4.9	U	4.9	U	5	U	4.7	U	4.9	U
Acenaphthene	500	---	2000	5.1		2.7	J	4.2	J	5		4.9		6.1		4.1	J	2.7	J	3.7	J
Fluorene	540	---	3600	4.5	J	4.4	J	5.8	J	8.6	J	8	J	8.4	J	6.6	J	5	J	6.3	J
Phenanthrene	1500	---	21000	30	J	30	J	44	J	49	J	65	J	39	J	55	J	49	J	59	J
Anthracene	960	---	13000	6.9	J	6.2	J	8.7	J	8	J	11	J	6.5	J	10	J	8.7	J	8.7	J
1-Methylnaphthalene(2)	---	---	---	4.8	U	4.9	U	4.8	U	4.8	U	4.9	U	4.9	U	5	U	4.7	U	4.9	U
2-Methylnaphthalene(2)	670	---	1900	4.8	U	4.2	J	6.1		5.6		3.8	J	5.3		5.6		4.6	J	3.6	J

Table 4-1 Dredged Material Composite Analytical Results Compared to the DMMP Chemicals of Concern Guidelines.

Chemical	DMMP Marine Guidelines			Dredged Material (C) Composite																	
				KEN01		KEN02		KEN02 - Replicate		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	SL	BT	ML	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Total HPAH	12000	---	69000	*369.8*		*312.6*		*444.7*		*476.4*		*649.8*		*421.4*		*731.7*		*576.4*		*639.2*	
Fluoranthene	1700	4600	30000	69		66	J	96	J	100		140		82		140		120		140	
Pyrene	2600	11980	16000	100	J	65	J	110	J	100	J	140	J	100	J	140	J	140	J	170	J
Benz(a)anthracene	1300	---	5100	26	J	22	J	30	J	33	J	44	J	27	J	47	J	39	J	40	J
Chrysene	1400	---	21000	40		40		50		56		72		46		77		62		70	
Benzo(b)fluoranthene	---	---	---	31		26		34		44		52		36		91		47		50	
Benzo(k)fluoranthene	---	---	---	16		12		17		22		29		18		46		24		26	
Benzo(j)fluoranthene	---	---	---	14		12		16		22		27		18		44		23		25	
Benzofluoranthenes (b, j ,k)	3200	---	9900	*62*		*50*		67		*88*		*110*		*72*		*180*		*94*		*100*	
Benzo(a)pyrene	1600	---	3600	26		22		31		40		51		30		57		42		44	
Indeno(1,2,3-c,d)pyrene	600	---	4400	16	J	17	J	20	J	21	J	33	J	22	J	32	J	28	J	27	J
Dibenz(a,h)anthracene	230	---	1900	4.8	J	4.6	J	6.7	J	6.4	J	9.8	J	6.4	J	8.7	J	9.4	J	9.2	J
Benzo(g,h,i)perylene	670	---	3200	26	J	26	J	34	J	32	J	50	J	36	J	50	J	42	J	39	J
Chlorinated Hydrocarbons (µg/kg)																					
1,4-Dichlorobenzene	110	---	120	19	U	19	U	19	U	19	U	19	U	20	U	20	U	19	U	20	U
1,2-Dichlorobenzene	35	---	110	19	U	19	U	19	U	19	U	19	U	20	U	20	U	19	U	20	U
1,2,4-Trichlorobenzene	31	---	64	19	U	19	U	19	U	19	U	19	U	20	U	20	U	19	U	20	U
Hexachlorobenzene (HCB)	22	168	230	0.99	U	0.99	U	0.99	U	1	U	0.98	U	0.97	U	1	U	0.97	U	0.99	U
Phthalate Esters (µg/kg)																					
Dimethyl phthalate	71	---	1400	15	J	19	U	19	U	19	U	19	U	20	U	20	U	19	U	20	U
Diethyl phthalate	200	---	1200	19	U	37		19	U	19	U	22		20	U	20	U	19	U	33	
Di-n-butyl phthalate	1400	---	5100	19	U	26		19	U	19	U	19	U	20	U	110		19	U	20	U
Butyl benzyl phthalate	63	---	970	14	J	9.6	J	19	U	19	U	18	J	19	J	12	J	28		20	
Bis(2-ethylhexyl) phthalate	1300	---	8300	160		120		210		290		280		140		200		230		260	
Di-n-octyl phthalate	6200	---	6200	19	U	19	UJ	68	J	19	U	19	U	20	U	20	U	19	U	11	J
Phenols and Substituted Phenols (µg/kg)																					
Phenol	420	---	1200	86		51		81		110		37		41		24		72		110	
2-Methylphenol	63	---	77	19	U	19	U	19	U	19	U	19	U	20	U	20	U	19	U	20	U
4-Methylphenol	670	---	3600	31		25		39		54		22		19	J	16	J	19		35	
2,4-Dimethylphenol	29	---	210	24	U	24	U	24	U	24	U	24	U	25	U	25	U	24	U	24	U
Pentachlorophenol	400	504	690	96	UJ	96	UJ	97	UJ	96	UJ	97	UJ	98	UJ	98	UJ	96	UJ	97	UJ
Miscellaneous Extractables (µg/kg)																					
Benzyl alcohol	57	---	870	82		120		190		130		91		100		64		150		110	
Benzoic acid	650	---	760	580		560	J	**900**	J	**950**		460	J	500	J	310	J	600		730	
Dibenzofuran	540	---	1700	14	J	19	U	19	U	19	U	19	U	20	U	20	U	19	U	20	U
Hexachlorobutadiene	11	---	270	0.99	U	0.99	U	0.99	U	1	U	0.98	U	0.97	U	1	U	0.97	U	0.99	U
N-Nitrosodiphenylamine	28	---	130	19	U	19	U	19	U	19	UJ	19	U	20	U	20	U	19	U	20	U

Table 4-1 Dredged Material Composite Analytical Results Compared to the DMMP Chemicals of Concern Guidelines.

Chemical	DMMP Marine Guidelines			Dredged Material (C) Composite																	
				KEN01		KEN02		KEN02 - Replicate		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	SL	BT	ML	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Organochlorine Pesticides/SVOCs (µg/kg)																					
4,4' DDD	16	---	---	3.3		290	J	4.3	J	4.3		2.9		4.4		3.4		3		3.6	
4,4' DDE	9	---	---	2.5		170	J	2.7	J	2.6		2.5	J	2.8		2.4		2.1		2.9	
4,4' DDT	12	---	---	3	U	5500	J	1.8	UJ	2.6	U	1.9	U	3.2	U	1	U	1.9	U	1.6	U
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	---	50	69			**5960**		7		9.5		7.3		10.4		6.8		7		8.1	
2,4' DDD	---	---	---	0.99	U	170	U	2.8	U	3	U	0.98	U	2.8	U	2	U	0.97	U	0.99	U
2,4' DDE	---	---	---	0.99	U	3.8	U	0.99	U	1	U	0.98	U	0.97	U	1	U	0.97	U	0.99	U
2,4' DDT	---	---	---	5.7	U	21	U	4	U	9.9	U	8.7	U	5.2	U	1.3	U	13	U	5.6	U
Aldrin	9.5	---	---	0.49	U	0.49	U	0.49	U	0.5	U	0.49	U	1	U	0.5	U	0.48	U	0.5	U
Beta-Hexachlorocyclohexane	---	---	---	0.49	U	0.49	U	0.49	U	0.5	U	0.49	U	2	U	0.5	U	0.48	U	0.5	U
Total Chlordane	2.8	37	---	*1.7*	*J*	*2.8*		*2.2*	J	*1.4*		*1.1*		*2.6*		*2.1*		*1.5*	*J*	*1.6*	
trans-Chlordane				1.7	J	2.8		2.2	J	1.4		1.1		2.6		2.1		1.5	J	1.6	
cis-Chlordane				1.5	U	1.6	U	1.8	U	2.1	U	1.4	U	2.3	U	1.7	U	2	U	1.9	U
oxy Chlordane				0.99	U	0.99	U	0.99	U	1	U	0.98	U	0.97	U	1	U	0.97	U	0.99	U
cis-Nonachlor				0.99	U	0.99	U	0.99	U	1	U	0.98	U	0.97	U	1	U	0.97	U	0.99	U
trans-Nonachlor				0.99	U	2.1	U	2.5	U	2.5	U	0.98	U	2.7	U	2.7	U	0.97	U	0.99	U
Endrin Ketone	---	---	---	0.99	U	0.99	U	0.99	U	1	U	0.98	U	0.97	U	1	U	0.97	U	0.99	U
Carbazole	---	---	---	19	U	19	U	15	J	14	J	16	J	20	U	20	U	10	J	12	J
Dieldrin	1.9	---	1700	0.99	U	0.99	U	0.99	U	1	U	0.98	U	0.97	U	1	U	0.97	U	0.99	U
Heptachlor	1.5	---	270	0.49	U	0.49	U	0.49	U	0.5	U	0.49	U	1.5	U	0.5	U	0.48	U	0.5	U
PCBs Aroclors (µg/kg)	130	38 (3)	3100	*25.6*	J	*29.9*		*33*		*23.7*	J	*21.1*		*26.8*		*45.3*	J	*22*		*26.2*	
Aroclor 1016	---	---	---	9.1	U	9	U	9.7	U	9.1	U	9.4	U	9.7	U	9.8	U	9.1	U	9.8	U
Aroclor 1242	---	---	---	9.1	U	9	U	9.7	U	9.1	U	9.4	U	9.7	U	9.8	U	9.1	U	9.8	U
Aroclor 1248	---	---	---	9.1	U	9	U	9.7	U	9.1	U	9.4	U	9.7	U	12	U	9.1	U	9.8	U
Aroclor 1254	---	---	---	18	J	21		25		16	J	15		19		27	J	16		18	
Aroclor 1260	---	---	---	7.6	J	8.9	J	8	J	7.7	J	6.1	J	7.8	J	6.3	J	6	J	8.2	J
Aroclor 1221	---	---	---	9.1	U	9	U	9.7	U	9.1	U	9.4	U	9.7	U	9.8	U	9.1	U	9.8	U
Aroclor 1232	---	---	---	9.1	U	9	U	9.7	U	9.1	U	9.4	U	9.7	U	9.8	U	9.1	U	9.8	U
Aroclor 1262	---	---	---	9.1	U	9	U	9.7	U	9.1	U	9.4	U	9.7	U	9.8	U	9.1	U	9.8	U
Aroclor 1268	---	---	---	9.1	U	9	U	9.7	U	9.1	U	9.4	U	9.7	U	9.8	U	9.1	U	9.8	U
Dioxins/Furans (ng/kg)	4 (5)	10	---	***See Table 4-3***																	

Notes Shaded cells indicate exceeding the SL. Cells that are **shaded and bold** exceed the ML.

[1] As no SL value exists to trigger toxicity testing, this chemical is evaluated only for its bioaccumulative potential.

[2] 1-Methylnaphthalene is not a DMMP COC, but is an SMS COC. 2-Methylnaphthalene is not included in the summation for total LPAH for the Marine guideline values.

[3] For comparison to the DMMP marine guidelines, only the 4,4' isomers of DDx are used. The 2,4' isomers of DDx were measured and reported, but are only used for comparison to the SMS criteria.

[4] This value is normalized to total organic carbon, and is expressed in mg/kg carbon.

Table 4-1 Notes, continued

[5] For disposal at non-dispersive sites, projects must have a volume weighted average of 4 pptr TEQ or less, with no single DMMU having a concentration greater than 10 pptr TEQ.

Validation Qualifiers (VQ):

J - The reported concentration is an estimated value.

U - The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.

UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value

Table 4-2 Z-Layer Composite Analytical Results Compared to the SMS Freshwater Criteria.

Chemical	SMS Freshwater Criteria		Z-Layer Composite															
			KEN01		KEN02		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	SQO/SL1	CSL/SL2	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Conventionals																		
Gravel	---	---	11.5		1.3		0.7		1.7		0.1		0.9		0.4		0.7	
Sand (%)	---	---	45.9		42		47.9		26.6		44.2		53.4		48.2		52.0	
Silt (%)	---	---	29.8		43.5		39.5		54.1		40.4		36.1		38.7		35.7	
Clay (%)	---	---	12.9		13.1		11.9		17.6		15.4		9.7		12.9		11.6	
Total Solids	---	---	59.8		39.7		41.4		48.1		48.9		48.2		43.8		47.5	
Total Volatile Solids			6.1		11.4		12.8		8.4		7.1		9.9		10.5		10.4	
TOC (%)	---	---	1.8		2.4		2.7		2.7		1.8		3.1		1.5		2.4	
Ammonia (bulk) (mg/kg-N)	---	---	75		156		159	J	157	J	211		113.0	J	259		198.0	
Sulfide (bulk - single core) (mg/kg)	---	---	no value		no value		no value		no value		no value		no value		no value		no value	
Sulfide (bulk - composite) (mg/kg)	---	---	15.4		109		150		24.4		96.5		30.1		108		33.4	
Metals (mg/kg)																		
Antimony	---	---	0.80	J	10	UJ	10	UJ	10	UJ	0.9	J	9	UJ	1.6	J	0.8	J
Arsenic	14	120	3.39	J	7.6	J	8.2	J	5.7	J	4.8	J	7.16	J	7.1	J	6.7	J
Cadmium	2.1	5.4	0.40		0.7		0.7		0.5		0.60		0.5		0.6		0.6	
Chromium	72	88	49		47		45		56		47		42.2		46		46	
Copper	400	1200	22.7		27.5	J	26.7	J	23.6	J	22	J	19.6	J	24.6		24.9	
Lead	360	>1,300	10		29		34		25		15		24		23		65	
Mercury	0.66	0.8	0.04	J	0.09		0.08		0.07		0.06		0.07		0.08	J	0.09	J
Nickel	26	110	45		42	J	40	J	44	J	39	J	38	J	41		43	
Selenium(1)	11	>20	0.3	J	0.57	J	0.57	J	0.51	J	0.50	J	0.49 J	J	0.47	J	0.48	J
Silver	0.57	1.7	0.06	J	0.10	J	0.11	J	0.08	J	0.09	J	0.08	J	0.09	J	0.10	J
Zinc	3200	>4,200	61		100		94		78		82		77		96		85	
Organotin Compounds *Butyltins were not analyzed for the z-layer*																		
Polycyclic Aromatic Hydrocarbons (µg/kg)																		
Total PAHs	17000	30000	***876.9***		***410.8***		***686.7***		***294.5***		***620.6***		***398.2***		***535.5***		***412.4***	
Total LPAH	---	---	643		56.4		113.5		59.1		69.8		71.3		67.9		58.0	
Naphthalene	---	---	26		5.8		12.0		6.6		4.3	J	6.6		6.0		5.9	
Acenaphthylene	---	---	4.7	U	4.8	U	2.8	J	4.8	U	4.3	J	4.9	U	4.8	U	4.8	U
Acenaphthene	---	---	160		2.8	J	8.3		5.2		3.7	J	4.3	J	3.5	J	2.7	J
Fluorene	---	---	24	J	4.4	J	8.4	J	5.8	J	5.4	J	7.1	J	5.0	J	5.1	J
Phenanthrene	---	---	400	J	36	J	70	J	36	J	44	J	45	J	47	J	38	J
Anthracene	---	---	33	J	7.4	J	12	J	5.5	J	8.1	J	8.3	J	6.4	J	6.3	J
1-Methylnaphthalene(2)	---	---	4.7	U	4.8	U	3.1	J	4.8	U	4.8	U	4.0	J	4.8	U	4.8	U
2-Methylnaphthalene(2)	---	---	13		4.1	J	7		5.7		3.2	J	6.5		3.7	J	4.0	J
Total HPAH	---	---	233.9		354		573.2		235.4		550.8		326.9		467.6		354.4	
Fluoranthene	---	---	75		72		130		48		140		60		92		73	
Pyrene	---	---	81	J	86	J	160	J	60	J	130	J	68	J	130	J	88	J
Benzo(a)anthracene	---	---	14	J	26	J	40	J	16	J	33	J	23	J	29	J	22	J
Chrysene	---	---	24		42		61		28		65		43		50		40	

Table 4-2 Z-Layer Composite Analytical Results Compared to the SMS Freshwater Criteria.

Chemical	SMS Freshwater Criteria		Z-Layer Composite															
			KEN01		KEN02		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	SQO/SL1	CSL/SL2	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Benzo(b)fluoranthene	---	---	13		29		41		17		43		27		36		27	
Benzo(k)fluoranthene	---	---	5.6		14		21		9.3		21		16		18		14	
Benzo(j)fluoranthene	---	---	5.6		15		21		9.1		20		14		18		14	
Benzofluoranthenes (b, j ,k)	---	---	24		58		83		36		83		58		72		55	
Benzo(a)pyrene	---	---	4.7	U	25		34		16		35		28		33		26	
Indeno(1,2,3-c,d)pyrene	---	---	6	J	16	J	22	J	12	J	24	J	17	J	22	J	18	J
Dibenz(a,h)anthracene	---	---	4.7	UJ	5.4	J	6.2	J	3.4	J	6.8	J	4.9	J	6.6	J	5.4	J
Benzo(g,h,i)perylene	---	---	9.9	J	24	J	37	J	16	J	34	J	25	J	33	J	27	J
Chlorinated Hydrocarbons (µg/kg)																		
1,4-Dichlorobenzene	---	---	19	U	19	U	20	U	19	U	19	U	19	U	20	U	19	U
1,2-Dichlorobenzene	---	---	19	U	19	U	20	U	19	U	19	U	19	U	20	U	19	U
1,2,4-Trichlorobenzene	---	---	19	U	19	U	20	U	19	U	19	U	19	U	20	U	19	U
Hexachlorobenzene (HCB)	---	---	0.99	U	0.98	U	0.99	U	0.99	U	0.99	U	0.99	U	0.98	U	1.0	U
Phthalate Esters (µg/kg)																		
Dimethyl phthalate	---	---	19	U	19	U	20	U	19	U	19	U	19	U	20	U	19	U
Diethyl phthalate	---	---	28		19	U	20	U	18	J	19	U	19	U	27		19	U
Di-n-butyl phthalate	380	1000	19	U	19	U	20	U	19	U	19	U	19	U	20	U	19	U
Butyl benzyl phthalate	---	---	19	U	14	J	36		10	J	25		19	U	20	U	19	U
Bis(2-ethylhexyl) phthalate	500	22000	48		120		150		290		220		130		160		190	
Di-n-octyl phthalate	39	>1,100	19	U	19	U	20	U	19	U	19	U	19	U	20	U	19	U
Phenols and Substituted Phenols (µg/kg)																		
Phenol	120	210	46		42		88		47		21		64		130		92	
2-Methylphenol	---	---	19	U	19	U	20	U	19	U	19	U	19	U	20	U	19	U
4-Methylphenol	260	2000	17	J	32		35		30		19	U	35		34		45	
2,4-Dimethylphenol	---	---	24	U	24	U	25	U	24	U	24	U	24	U	25	U	24	U
Pentachlorophenol	1200	>1,200	95	UJ	96	UJ	99	UJ	95	UJ	96	UJ	96	UJ	99	UJ	94	UJ
Miscellaneous Extractables (µg/kg)																		
Benzyl alcohol	---	---	22		48		97		42		36		63		110		88	
Benzoic acid	2900	3800	400		490	J	1000	J	720	J	280	J	720	J	1100		830	
Dibenzofuran	200	680	19	U	19	U	20	U	19	U	19	U	19	U	20	U	19	U
N-Nitrosodiphenylamine	---	---	19	U	19	U	20	U	19	U	19.0	U	19	U	20	U	19	U
Hexachlorobutadiene	---	---	0.99	U	0.98	U	0.99	U	0.99	U	0.99	U	0.99	U	0.98	U	1.0	U
Organochlorine Pesticides/SVOCs (µg/kg)																		
4,4' DDE	---	---	1.1	J	2.5		3.8		1.5		1.4		1.8		2		2.5	
4,4' DDD	---	---	2.4		5.3		10.0		3.2		2.2		4.2		3.7		5.6	
4,4' DDT	---	---	0.99	U	4.4		51		0.99	U	0.99	U	0.99	U	1.6	U	1.0	U
Sum DDx (DMMP) (3)	---	69	3.5		12.2		64.8		4.7		3.6		6.0		5.7		8.1	
2,4' DDD	---	---	0.99	U	2.9	U	2.9	U	0.99	U	0.99	U	0.99	U	0.98	U	3.0	U
2,4' DDE	---	---	0.99	U	0.98	U	0.99	U	0.99	U	0.99	U	0.99	U	0.98	U	1.0	U
2,4' DDT	---	---	0.99	U	3.0	U	5.5	U	0.99	U	3.6	U	0.99	U	6.3	U	1.0	U

Table 4-2 Z-Layer Composite Analytical Results Compared to the SMS Freshwater Criteria.

Chemical	SMS Freshwater Criteria		Z-Layer Composite															
			KEN01		KEN02		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	SQO/SL1	CSL/SL2	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
DDE [3] (SMS)	21	33	1.1		2.5		3.8		1.5		1.4		1.8		2.0		2.5	
DDD [3] (SMS)	310	860	2.4		5.3		10		3.2		2.2		4.2		3.7		5.6	
DDT [3] (SMS)	100	8100	0.99	U	4.4		51		0.99	U	3.6	U	0.99	U	6.3	U	1.0	U
Aldrin	---	---	0.49	U	0.49	U	0.5	U	0.49	U	0.49	U	0.5	U	0.49	U	0.5	U
gamma-BHC			4.4	U	0.49	U	0.5	U	0.49	U	0.49	U	0.5	U	0.49	U	0.5	U
beta-BHC	7.2	11	0.49	U	0.49	U	0.5	U	0.49	U	0.49	U	0.5	U	0.5	U	0.5	U
Total Chlordane	---	---	0.99	U	1.5	U	1.8		0.67		1.1		1.2		1.2		1.4	
trans-Chlordane			0.49	U	0.49	U	1.8	J	0.67		1.1	J	1.2		1.2		1.4	
cis-Chlordane			0.49	U	1.5	U	1.9	U	0.96	U	1.0	U	1.3	U	1.4	U	1.6	U
Oxychlordane			0.99	U	0.98	U	0.99	U	0.99	U	0.99	U	0.99	U	0.98	U	1.0	U
cis-Nonachlor			0.99	U	0.98	U	0.99	U	0.99	U	0.99	U	0.99	U	0.98	U	1.0	U
trans-Nonachlor			0.99	U	0.98	U	0.99	U	0.99	U	0.99	U	0.99	U	0.98	U	1.0	U
Endrin Ketone	8.5	**	0.99	U	0.98	U	0.99	U	0.99	U	0.99	U	0.99	U	0.98	U	1.0	U
Carbazole	900	1100	19	U	19	U	9.90	J	19	U	19	U	19	U	20	U	19	U
Dieldrin	4.9	9.3	0.99	U	0.98	U	0.99	U	0.99	U	0.99	U	0.99	U	0.98	U	1.0	U
Heptachlor	---	---	0.49	U	0.49	U	0.50	U	0.49	U	0.49	U	0.50	U	0.49	U	0.50	U
PCBs Aroclors (µg/kg)	110	2500	8.7		25.6		33.9		15		19.5		19.9		21.8		23.30	
Aroclor 1016	---	---	8.9	U	9.3	UJ	9.3	U	8.9	U	9.7	U	8.7	U	9.0	U	9.5	U
Aroclor 1221	---	---	8.9	U	9.3	UJ	9.3	U	8.9	U	9.7	U	8.7	U	9.0	U	9.5	U
Aroclor 1232	---	---	8.9	U	9.3	UJ	9.3	U	8.9	U	9.7	U	8.7	U	9.0	U	9.5	U
Aroclor 1242	---	---	8.9	U	9.3	UJ	9.3	U	8.9	U	9.7	U	8.7	U	9.0	U	9.5	U
Aroclor 1248	---	---	8.9	U	9.3	U	9.3	U	8.9	U	9.7	U	8.7	U	9.0	U	9.5	U
Aroclor 1254	---	---	8.7	J	18		24	J	15	J	14		14	J	16		17	J
Aroclor 1260	---	---	8.9	U	7.6	J	9.9		8.9	U	5.5	J	5.9	J	5.8	J	6.3	J
Aroclor 1262	---	---	8.9	U	9.3	U	9.3	U	8.9	U	9.7	U	8.7	U	9.0	U	9.5	U
Aroclor 1268	---	---	8.9	U	9.3	U	9.3	U	8.9	U	9.7	U	8.7	U	9.0	U	9.5	U
Dioxins/Furans (ng/kg)	***See Table 4-4***																	
Total Petroleum Hydrocarbons (mg/kg) NW-TPH Method																		
TPH-Diesel	340	510	25		40		41		37		32		42		22		47	
TPH-Residual	3600	4400	50		110		110		98		110		120		72		150	

Notes:

Shaded cells indicate exceedance of the Sediment Quality Objective (SQO)/Screening Level 1 (SL1). Cells that are **shaded and bold** exceed the Cleanup Screening Level (CSL)/Screening Level 2 (SL2).

[1] As no SL value exists to trigger toxicity testing, this chemical will only be evaluated for its bioaccumulative potential.

[2] Both 1-Methylnaphthalene and 2-Methylnaphthalene are included in the sum of total PAHs for comparison to the freshwater SQO/SL1 and the CSL/SL2.

[3] For comparison to the freshwater standards, DDTs and derivatives are calculated as follows: total DDDs, total DDEs, and total DDTs, (2,4' and 4,4' isomers in each case).

** No freshwater criteria available

Validation Qualifiers (VQ):

J - The reported concentration is an estimated value.

U - The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.

UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value

Table **4-3** Dredged Material Composite Dioxin/Furan Results

Chemical Name	TEF	STATION																			
		KEN01				KEN02				KEN02 - Replicate				KEN03				KEN04			
		Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	0.582	U	0	0.291	0.778	U	0	0.389	0.614	U	0	0.307	0.658	U	0	0.329	0.513	U	0	0.2565
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	3.05		3.05	3.05	5.02	J	5.02	5.02	2.79	J	2.79	2.79	3.28		3.28	3.28	2.39		2.39	2.39
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	4.52		0.452	0.452	8.04	J	0.804	0.804	4.11	J	0.411	0.411	4.58		0.458	0.458	3.3		0.33	0.33
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	16.8		1.68	1.68	29.9	J	2.99	2.99	14.8	J	1.48	1.48	16.3		1.63	1.63	11.7		1.17	1.17
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	9.52		0.952	0.952	16.3	J	1.63	1.63	8.98	J	0.898	0.898	9.88		0.988	0.988	7.29		0.729	0.729
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	347		3.47	3.47	656	J	6.56	6.56	300	J	3	3	327		3.27	3.27	227		2.27	2.27
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	2610		0.783	0.783	5380	J	1.614	1.614	2260	J	0.678	0.678	2500		0.75	0.75	1680		0.504	0.504
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	1.65		0.165	0.165	1.79		0.179	0.179	1.61		0.161	0.161	1.65		0.165	0.165	1.26		0.126	0.126
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	1.31		0.0393	0.0393	1.54		0.0462	0.0462	1.25	U	0	0.01875	1.35		0.0405	0.0405	1.1		0.033	0.033
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	1.52		0.456	0.456	1.79		0.537	0.537	1.49		0.447	0.447	1.65	U	0	0.2475	1.31		0.393	0.393
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	3.26		0.326	0.326	5.15		0.515	0.515	3.26		0.326	0.326	3.62		0.362	0.362	2.93		0.293	0.293
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	2.9		0.29	0.29	4.35		0.435	0.435	2.78		0.278	0.278	3.11		0.311	0.311	2.36		0.236	0.236
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	1.29	U	0	0.0645	1.66		0.166	0.166	1.22		0.122	0.122	1.49		0.149	0.149	1.21		0.121	0.121
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	3.78		0.378	0.378	5.71	J	0.571	0.571	3.66	J	0.366	0.366	3.95		0.395	0.395	2.86		0.286	0.286
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	48.3		0.483	0.483	143	J	1.43	1.43	44.6	J	0.446	0.446	48.5		0.485	0.485	32.6		0.326	0.326
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	2.92		0.0292	0.0292	6.92	J	0.0692	0.0692	2.91	J	0.0291	0.0291	3.14		0.0314	0.0314	2.29		0.0229	0.0229
Octachlorodibenzofuran (OCDF)	0.0003	149		0.0447	0.0447	718	J	0.2154	0.2154	127	J	0.0381	0.0381	125		0.0375	0.0375	80.5		0.02415	0.02415
Total TEQ				12.6	12.95			22.78	23.17			14.35	14.68			12.35	12.93			9.25	9.51

Notes:
For disposal at non-dispersive sites, projects must have a volume weighted average of 4 pptr TEQ or less, with no single DMMU having a concentration greater than 10 pptr TEQ.
EDL = Estimated Detection Limit
TEQ = Toxicity Equivalent

Validation Qualifiers (VQ):
J - The reported concentration is an estimated value
U - The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Table 4-3 Dredged Material Composite Dioxin/Furan Results (continued)

Chemical Name	TEF	STATION															
		KEN05				KEN06				KEN07				KEN08			
		Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	0.631	U	0	0.3155	0.557	U	0	0.2785	0.463	U	0	0.2315	0.548	U	0	0.274
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	2.53		2.53	2.53	2.29		2.29	2.29	1.85		1.85	1.85	2.06		2.06	2.06
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	3.59		0.359	0.359	3.11		0.311	0.311	2.54		0.254	0.254	2.8		0.28	0.28
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	11.6		1.16	1.16	9.97		0.997	0.997	8.72		0.872	0.872	9.05		0.905	0.905
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	7.71		0.771	0.771	6.8		0.68	0.68	5.36		0.536	0.536	6.15		0.615	0.615
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	234		2.34	2.34	208		2.08	2.08	175		1.75	1.75	193		1.93	1.93
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	1790		0.537	0.537	1710		0.513	0.513	1330		0.399	0.399	1530		0.459	0.459
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	1.4		0.14	0.14	1.26		0.126	0.126	1.02		0.102	0.102	1.14		0.114	0.114
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	1.05		0.0315	0.0315	0.946	J	0.02838	0.02838	0.839	J	0.02517	0.02517	0.895	U	0	0.013425
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	1.37		0.411	0.411	1.16		0.348	0.348	1.01		0.303	0.303	1.07		0.321	0.321
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	3.06		0.306	0.306	2.52	U	0	0.126	2.17		0.217	0.217	2.47		0.247	0.247
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	2.45		0.245	0.245	2.16		0.216	0.216	1.77		0.177	0.177	2.21		0.221	0.221
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	1.13		0.113	0.113	0.93	J	0.093	0.093	0.917	J	0.0917	0.0917	0.901	J	0.0901	0.0901
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	3.17		0.317	0.317	2.8		0.28	0.28	2.3		0.23	0.23	2.86		0.286	0.286
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	38.4		0.384	0.384	33.7		0.337	0.337	28.5		0.285	0.285	30.3		0.303	0.303
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	2.61		0.0261	0.0261	2.21		0.0221	0.0221	1.85		0.0185	0.0185	2.16		0.0216	0.0216
Octachlorodibenzofuran (OCDF)	0.0003	105		0.0315	0.0315	97.2		0.02916	0.02916	73.9		0.02217	0.02217	82.9		0.02487	0.02487
Total TEQ				9.7	10.02			8.35	8.76			7.13	7.36			7.88	8.16

Notes:
For disposal at non-dispersive sites, projects must have a volume weighted average of 4 pptr TEQ or less, with no single DMMU having a concentration greater than 10 pptr TEQ.
EDL = Estimated Detection Limit
TEQ = Toxicity Equivalent

Validation Qualifiers (VQ):
J - The reported concentration is an estimated value
U - The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Table **4-4** Z-Layer Composite Dioxin/Furan Results

Chemical Name	TEF	STATION															
		KEN01 Z				KEN02 Z				KEN03 Z				KEN04 Z			
		Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	0.26	U	0	0.13	0.633	J	0.633	0.633	0.655	U	0	0.3275	0.425	U	0	0.2125
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	0.478	J	0.478	0.478	2.42		2.42	2.42	2.51		2.51	2.51	1.14		1.14	1.14
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.613	J	0.0613	0.0613	3.28		0.328	0.328	3.4		0.34	0.34	1.37		0.137	0.137
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	2.04		0.204	0.204	13.6		1.36	1.36	14.3		1.43	1.43	5.72		0.572	0.572
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	1.34		0.134	0.134	7.5		0.75	0.75	7.77		0.777	0.777	3.35		0.335	0.335
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	40	J	0.4	0.4	258		2.58	2.58	273		2.73	2.73	93.6		0.936	0.936
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	321	J	0.0963	0.0963	2030		0.609	0.609	2200		0.66	0.66	649		0.195	0.1947
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	0.4	J	0.04	0.04	1.61		0.161	0.161	1.7		0.17	0.17	0.92	U	0	0.046
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	0.246	J	0.00738	0.00738	1.21		0.036	0.0363	1.28		0.0384	0.0384	0.615	J	0.018	0.01845
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	0.314	J	0.0942	0.0942	1.54		0.462	0.462	1.6		0.48	0.48	0.695	J	0.209	0.2085
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	0.551	J	0.0551	0.0551	2.91		0.291	0.291	3.29		0.329	0.329	1.45		0.145	0.145
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	0.523	J	0.0523	0.0523	2.5		0.25	0.25	2.77		0.277	0.277	1.2		0.12	0.12
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	0.262	J	0.0262	0.0262	1.16		0.116	0.116	1.28		0.128	0.128	0.609	U	0	0.03045
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	0.364	J	0.0364	0.0364	3.27		0.327	0.327	3.44		0.344	0.344	1.46		0.146	0.146
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	6.44		0.0644	0.0644	35.7		0.357	0.357	37.4		0.374	0.374	12.8		0.128	0.128
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	0.388	U	0	0.00194	2.26		0.023	0.0226	2.57		0.0257	0.0257	0.85	J	0.009	0.0085
Octachlorodibenzofuran (OCDF)	0.0003	14.4		0.00432	0.00432	98.2		0.029	0.02946	102		0.0306	0.0306	24.4		0.007	0.00732
Total TEQ				1.75	1.89			10.73	10.73			10.64	10.97			4.1	4.39

Notes:
For disposal at non-dispersive sites, projects must have a volume weighted average of 4 pptr TEQ or less, with no single DMMU having a concentration greater than 10 pptr TEQ.
EDL = Estimated Detection Limit
TEQ = Toxicity Equivalent

Validation Qualifiers (VQ):
J - The reported concentration is an estimated value
U - The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Table 4-4 Z-Layer Composite Dioxin/Furan Results (continued)

Chemical Name	TEF	STATION															
		KEN05				KEN06				KEN07				KEN08			
		Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)	Value (ng/kg)	VQ	TEQ (U = 0)	TEQ (U=1/2 EDL)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	0.423	U	0	0.2115	0.459	U	0	0.2295	0.539	U	0	0.2695	0.463	U	0	0.2315
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	1.43		1.43	1.43	1.44		1.44	1.44	2.03		2.03	2.03	1.55		1.55	1.55
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	1.85		0.185	0.185	1.76		0.176	0.176	2.91		0.291	0.291	1.84		0.184	0.184
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	6.62		0.662	0.662	7.08		0.708	0.708	9.5		0.95	0.95	6.25		0.625	0.625
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	4.32		0.432	0.432	4.05		0.405	0.405	6.44		0.644	0.644	3.94	U	0	0.197
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	130		1.3	1.3	138		1.38	1.38	195		1.95	1.95	127		1.27	1.27
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	977		0.2931	0.2931	1100		0.33	0.33	1290		0.387	0.387	943		0.283	0.2829
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	0.856	J	0.0856	0.0856	0.964	J	0.096	0.0964	1.02		0.102	0.102	1.17		0.117	0.117
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	0.653	J	0.01959	0.01959	0.772	J	0.023	0.02316	1.02		0.0306	0.0306	0.816	J	0.024	0.02448
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	0.721	J	0.2163	0.2163	0.918	J	0.275	0.2754	1.16		0.348	0.348	0.909	J	0.273	0.2727
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	1.53		0.153	0.153	2.05		0.205	0.205	3.59		0.359	0.359	1.91		0.191	0.191
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	1.41		0.141	0.141	1.68		0.168	0.168	2.58		0.258	0.258	1.65		0.165	0.165
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	0.619	J	0.0619	0.0619	0.816	U	0	0.0408	1.83		0.183	0.183	0.714	U	0	0.0357
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	1.79		0.179	0.179	1.99		0.199	0.199	3.21		0.321	0.321	2.06		0.206	0.206
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	18.1		0.181	0.181	20.6		0.206	0.206	38.1		0.381	0.381	19.8		0.198	0.198
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	1.28		0.0128	0.0128	1.48		0.015	0.0148	2.58		0.0258	0.0258	1.44		0.014	0.0144
Octachlorodibenzofuran (OCDF)	0.0003	49.4		0.01482	0.01482	41.9		0.013	0.01257	69		0.0207	0.0207	47.1		0.014	0.01413
Total TEQ				5.37	5.58			5.64	5.91			8.28	8.55			5.11	5.58

Notes:

For disposal at non-dispersive sites, projects must have a volume weighted average of 4 pptr TEQ or less, with no single DMMU having a concentration greater than 10 pptr TEQ.

EDL = Estimated Detection Limit

TEQ = Toxicity Equivalent

Validation Qualifiers (VQ):

J - The reported concentration is an estimated value

U - The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.

UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Table 4-5 Analytical Results for DDx Evaluation at DMMU KEN02. Composite replicates and individual parent core samples

Chemical				Kenmore Station 02 Composite Samples								Kenmore Individual Core Samples							
	Sample I.D.			KEN02 Composite		KEN09 Composite		KEN02 Composite Rep 1		KEN02 Composite Rep 2		KEN02 CORE 3a		KEN02 CORE3b		KEN02 CORE4a		KEN02 CORE4b	
	Lab Analysis Date			7/30/2014		7/30/2014		11/15/2014		11/15/2014		11/15/2014		9/16/2014		11/15/2014		9/16/2014	
	Lab Identification			14-14087-YR91C		14-14091-YR91G		14-23652-ZI36A		14-23652-ZI36ADUP		14-23653-ZI36B		14-18185-YZ10C		14-23654-ZI36C		14-18184-YZ10B	
	DMMP Marine Guidelines			Results								Results							
	SL	BT	ML	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Organochlorine Pesticides/SVOCs (µg/kg)																			
4,4' DDD	16	---	---	290	J	4.3	J	4.7		4.2		7.6		4		2.8		3.1	
2,4' DDD	---	---	---	170	U	2.8	U	2	U	2	U	4.3	U	0.99	U	2.0	U	0.99	U
4,4' DDE	9	---	---	170	J	2.7	J	2	J	1.9	J	2.9		1.6	J	1.4	J	1.8	J
2,4' DDE	---	---	---	3.8	U	0.99	U	2	U	2	U	2	U	0.99	U	2	U	0.99	U
4,4' DDT	12	---	---	5500	J	1.8	UJ	2	U	2	U	2	U	0.99	U	2	U	2.4	U
2,4' DDT	---	---	---	21	U	4	U	2	U	2	U	2	U	0.99	U	2	U	28	U
Aldrin	9.5	---	---	0.49	U	0.49	U	0.98	U	0.98	U	1	U	0.5	U	0.98	U	0.49	U
Beta-Hexachlorocyclohexane	---	---	---	0.49	U	0.49	U	0.98	U	0.98	U	1	U	0.5	U	0.98	U	0.49	U
Total Chlordane	2.8	37	---	*2.8*		*2.2*	*J*	*3*	*U*	*2*	*U*	*3.4*	*U*	*1.3*	*U*	*2*	*U*	*1.6*	*U*
trans-Chlordane				2.8		2.2	J	0.98	U	0.98	U	2.7	U	0.5	U	0.98	U	1.6	U
cis-Chlordane				1.6	U	1.8	U	0.98	U	1.8	U	2.7	U	1.1	U	1.4	U	1.3	U
oxy Chlordane				0.99	U	0.99	U	2	U	2	U	2	U	0.99	U	2	U	0.99	U
cis-Nonachlor				0.99	U	0.99	U	2	U	2	U	2	U	0.99	U	2	U	0.99	U
trans-Nonachlor				2.1	U	2.5	U	3	U	2	U	3.4	U	1.3	U	2	U	0.99	U
Endrin Ketone	---	---	---	0.99	U	0.99	U	2	U	2	U	2	U	0.99	U	2	U	0.99	U
Dieldrin	1.9	---	1700	0.99	U	0.99	U	2	U	2	U	2	U	0.99	U	2	U	0.99	U
Heptachlor	1.5	---	270	0.49	U	0.49	U	0.98	U	0.98	U	1	U	0.5	U	0.98	U	0.49	U
Hexachlorobutadiene	11	---	270	0.99	U	0.99	U	2	U	2	U	2	U	0.99	U	2	U	0.99	U
Hexachlorobenzene (HCB)	22	168	230	0.99	U	0.99	U	2	U	2	U	2	U	0.99	U	2	U	0.99	U

Table 4-6 Analytical Results for DDx Re-Evaluation at DMMU KEN02. Composite replicates and individual parent core samples

Chemical				Kenmore Station 02 Composite Samples								Kenmore Individual Core Samples			
	Sample I.D.			KEN02 Composite Rep 1		KEN02 Composite Rep 2		KEN02 Composite Rep 3		KEN02 Composite Rep 4		KEN02 CORE 3b		KEN02 CORE4b	
	Lab Analysis Date			12/24/2014		12/24/2014		12/24/2014		12/16/2014		12/16/2014		12/16/2014	
	Lab Identification			14-26045-ZM72A		14-26081-ZM72D		14-26081-ZM72E		14-26081-ZM72F		14-26081-ZM72C		14-26081-ZM72B	
	Cleanup Method			GPC		GPC		GPC		Acid		Acid		Acid	
	DMMP Marine Guidelines			Results											
	SL	BT	ML	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
4,4' DDD	16	---	---	4.6		4.4	J	5.5	J	5		6.3		3.4	
4,4' DDE	---	---	---	2.3	J	2.5	J	2.5	J	4.2	J	3.7		3.5	J
4,4' DDT	9	---	---	3.1	U	0.99	U	3.3	U	2.9	J	2.3	UJ	0.98	UJ

Notes:

GPC = Gel Permeation Chromatography

Table 4-7 Polybrominated Diethyl Ether Congeners (µg/kg)

Chemical	Dredged Material (C) Composite					
	KEN01		KEN02		KEN03	
	Value	VQ	Value	VQ	Value	VQ
BDE-007	0.0864		0.0628		0.0411	
BDE-008/011	0.0147		0.012		0.00859	
BDE-010	0.0002	U	0.00038	U	0.00023	J
BDE-012/013	0.00332	J	0.00346	J	0.00282	J
BDE-015	0.00261	J	0.00466	J	0.00515	
BDE-017/025	0.1		0.0995		0.0596	
BDE-028/033	0.0219		0.029		0.0263	
BDE-030	0.00026	U	0.00047	U	0.00039	U
BDE-032	0.00082	J	0.00085	J	0.00063	U
BDE-035	0.00036	U	0.00094	J	0.00064	U
BDE-037	0.00224	J	0.00307	J	0.00222	J
BDE-047	0.364		0.437		0.37	
BDE-049	0.191		0.194		0.133	
BDE-051	0.0305		0.0289		0.019	
BDE-066	0.0225		0.0268		0.0226	
BDE-071	0.0268		0.0269		0.0159	
BDE-075	0.00116	U	0.00127	U	0.00145	J
BDE-077	0.00081	J	0.00085	J	0.00068	J
BDE-079	0.00066	U	0.00082	U	0.00057	J
BDE-085	0.0188		0.0194		0.0172	
BDE-099	0.527		0.694		0.511	
BDE-100	0.141		0.182		0.134	
BDE-105	0.00294	U	0.00281	U	0.00235	U
BDE-116	0.00406	U	0.00387	U	0.00324	U
BDE-119/120	0.00429	J	0.00426	J	0.00247	U
BDE-126	0.00127	U	0.00151	U	0.00132	U
BDE-128	0.0111	U	0.0361	U	0.0438	U
BDE-138/166	0.015		0.0185		0.0211	U
BDE-140	0.00719		0.00515	U	0.00469	J
BDE-153	0.1		0.12		0.0872	
BDE-154	0.0829		0.099		0.0629	
BDE-155	0.0077		0.0166		0.0129	
BDE-181	0.00561	U	0.0076	U	0.00643	U
BDE-183	0.0627		0.116		0.0402	
BDE-190	0.0101	U	0.0136	U	0.0116	U
BDE-203	0.0811		0.105		0.0567	
BDE-206	0.747	J	0.624	J	0.37	J
BDE-207	0.714	J	0.782	J	0.346	J
BDE-208	0.448	J	0.488	U	0.251	J
BDE-209	13.8		7.4		7.24	

Validation Qualifiers (VQ):

J - The reported concentration is an estimated value

U - The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.

Table 4-8 Results of Bulk Ammonia and Sulfides Analyses

	DMMU																	
	KEN01		KEN02		KEN02 - Field Replicate		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
Analysis	**Value**	**VQ**	**Value**	**VQ**	**Value**	**VQ**	**Value**	**VQ**	**Value**	**VQ**	**Value**	**VQ**	**Value**	**VQ**	**Value**	**VQ**	**Value**	**VQ**
Dredged Material Composite																		
Collection Date	7/10/2014		7/10/2014		7/10/2014		7/12/2014		7/12/2014		7/12/2014		7/11/2014		7/11/2014		7/11/2014	
Ammonia Day 0 (bulk - mg/kg)	232		217		218		242		270		369		279		240		303	
Analysis Date	7/16/2014		7/16/2014		7/16/2014		7/16/2014		7/16/2014		7/17/2014		7/17/2014		7/16/2014		7/16/2014	
Number of Days from Collection to Extraction	6		6		6		4		4		5		6		5		5	
Ammonia Day 21 (bulk - mg/kg)	220		220		222	J	*		247	J	496	J	315	J	237	J	302	J
Analysis Date	7/31/2014		7/31/2014		8/4/2014		*		8/4/2014		8/4/2014		8/1/2014		8/1/2014		8/1/2014	
Number of Days from Collection to Extraction	21		21		25		*		23		23		21		21		21	
Sulfides (bulk - single core) (mg/kg)	500		456		---		309		166		350		349		216		360	
Analysis Date	7/16/2014		7/17/2014		7/17/2014		7/17/2014		7/17/2014		7/17/2014		7/17/2014		7/16/2014		7/16/2014	
Number of Days from Collection to Extraction	6		7		7		5		5		5		6		5		5	
Sulfides Composite Day 0 (bulk - mg/kg)	457		331		351		290		176		290		258		239		254	
Analysis Date	7/16/2014		7/16/2014		7/17/2014		7/17/2014		7/17/2014		7/17/2014		7/17/2014		7/16/2014		7/16/2014	
Number of Days from Collection to Extraction	6		6		7		5		5		5		6		5		5	
Sulfides Composite Day 21 (bulk - mg/kg)	322		307		263		*		214		256		195		160		149	
Analysis Date	8/6/2014		8/6/2014		8/6/2014		*		8/6/2014		8/6/2014		8/6/2014		8/6/2014		8/6/2014	
Number of Days from Collection to Extraction	27		27		27		*		25		25		26		26		26	
Z-Composite																		
Ammonia Day 0 (bulk - mg/kg)	75		156		---		172		172		211		123		259		198	
Analysis Date	7/16/2014		7/16/2014		---		7/16/2014		7/16/2014		7/17/2014		7/17/2014		7/16/2014		7/16/2014	
Number of Days from Collection to Extraction	6		6		---		4		4		5		6		5		5	
Ammonia Day 21 (bulk - mg/kg)	76.5		169		---		159	J	157	J	211	J	113	J	266	J	200	J
Analysis Date	7/31/2014		7/31/2014		---		8/4/2014		8/4/2014		8/4/2014		8/1/2014		8/1/2014		8/1/2014	
Number of Days from Collection to Extraction	21		21		---		23		23		23		21		21		21	
Sulfides Day 0 (bulk - mg/kg)	15.4		164		---		150		42		96.7		30.1		126		90.4	
Analysis Date	7/16/2014		7/17/2014		---		7/17/2014		7/17/2014		7/17/2014		7/17/2014		7/16/2014		7/16/2014	
Number of Days from Collection to Extraction	6		7		---		5		5		5		6		5		5	
Sulfides Day 21 (bulk - mg/kg)	7.86		109		---		98.3		24.4		96.5		52.7		108		33.4	
Analysis Date	8/6/2014		8/6/2014		8/6/2014		8/6/2014		8/6/2014		8/6/2014		8/6/2014		8/6/2014		8/6/2014	
Number of Days from Collection to Extraction	27		27		27		25		25		25		26		26		26	

Table 4-9 Results of Porewater Ammonia and Sulfides Analyses

Dredged Material Composite	KEN01 C		KEN02 C		KEN03 C		KEN04 C		KEN05 C		KEN06 C		KEN07 C		KEN08 C	
	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Collection Date	7/10/2014		7/10/2014		7/12/2014		7/12/2014		7/11/2014		7/11/2014		7/11/2014		7/11/2014	
Porewater Extraction Date	8/5/2014		8/5/2014		8/5/2014		8/5/2014		8/5/2014		8/5/2014		8/5/2014		8/5/2014	
Number of Days from Collection to Extraction	26		26		*		24		25		25		25		25	
Temperature at time of extraction (^{0}C)	18.6		18.3		*		6.0		3.3		5.9		5.9		6.8	
Ammonia (NH3) as Nitrogen (N) (mg/L)	27.7		24.4		*		32.1		59.9		45.8		49.6		56.7	
pH	6.8		6.9		*		6.6		6.7		6.7		6.8		6.8	
Salinity (parts-per-thousand)	0.3		0.3		*		0.4		0.6		0.4		0.5		0.5	
Sulfide (mg/L)	0.057	U	0.05	U	*		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
Z-Layer Composite	KEN01 Z		KEN02 Z		KEN03 Z		KEN04 Z		KEN05 Z		KEN06 Z		KEN07 Z		KEN08 Z	
	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Collection Date	7/10/2014		7/10/2014		7/12/2014		7/12/2014		7/11/2014		7/11/2014		7/11/2014		7/11/2014	
Porewater Extraction Date	8/5/2014		8/5/2014		8/5/2014		8/5/2014		8/5/2014		8/5/2014		8/5/2014		8/5/2014	
Number of Days from Collection to Extraction	26		26		24		24		25		25		25		25	
Temperature at time of extraction (^{0}C)	19.8		16.8		6.3		6.0		3.4		5.4		3.8		6.4	
Ammonia (NH3) as Nitrogen (N) (mg/L)	6.23		16		18.5		13		28.9		14		43.9		22.5	
pH	6.9		6.9		6.6		6.6		6.7		6.8		6.8		6.7	
Salinity (parts-per-thousand)	0.1		0.2		0.3		0.1		0.3		0.2		0.4		0.2	
Sulfide (mg/L)	0.051	U	0.05	U	0.072		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U

*Insufficient sediment volume to run 21 day ammonia and sulfide for KEN03

Validation Qualifiers (VQ):

U - The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.

J - The reported concentration is an estimated value.

5 BIOLOGICAL ANALYSES

The DMMP made a determination that with the exceedances of the state Sediment Quality Standards in the z-layer, that it was necessary to conduct freshwater bioassays for those stations that exceeded the freshwater SQS. Given that all eight of the z-layer samples exceeded at least the SQS for dibenzofuran, all eight samples were sent to Northwestern Aquatic Science in Newport, OR facility, for bioassay testing using the following tests:

- 20-day *Chironomus dilutes* survival and growth test
- 10-day *Hyalella azteca* survival test

The freshwater interpretive guidelines for these three tests are given in Table 5-2.

Prior to testing all test sediment samples were stored at ARI at 4°C with no head space, (i.e., anaerobic environment). With the decision to conduct biological testing, ARI shipped the bioassay sediments to NWAS under chain-of-custody (Appendix M). All bioassays were begun within the 56 days holding time.

All test data, the NWAS laboratory report, the bioassay data validation review, and statistical analyses may be found in Appendix M.

5.1 REFERENCE SEDIMENT

Bioassay testing for antidegradation characterization did not require comparing the results of the test sediment to suitable reference sediment; instead the results are compared to the control sediment. The clean negative control sediment that NWAS collects from Beaver Creek, approximately 8 miles south of Newport, OR, was used for comparison to the test sediment results. To allow for comparison of the physical characteristics of the control sediment to the dredged sediment, NWAS collected additional sediment and submitted those samples to ARI for conventional analyses. The results of the Beaver Creek analysis is given in Table 5-1.

5.2 *HYALELLA AZTECA* 10-DAY MORTALITY TESTING

The results of the 10-day freshwater amphipod mortality test may be seen in Table 5-3. The percent mortality in the control sediment met the relevant performance criteria; the test may be considered a valid test. All tested sediments (control and DMMUs) had mortality less than or equal to 2.5%. All test sediments were well below the one and two-hit criteria, and are considered to have passed relative to these guidelines.

5.3 *CHIRONOMUS DILUTUS* 20-DAY MORTALITY TESTING

The results of the 20-day freshwater midge mortality test may be seen in Table 5-4. The percent mortality in the Beaver Creek control sediment met the relevant performance criteria; the test may be considered a valid test. The laboratory report and data validation report may be found in Appendix L1.

Mortality in the test sediment ranged from 10 to 33.8% mortality. The absolute test mortality observed in all but the KEN02Z sample was less than 15% of that observed in the Beaver Creek control sediment. For KEN02Z the observed mortality was 19.5% greater than the Beaver Creek control sediment. As required by the DMMU User Manual (USACE, 2014) and the SAP, the DMMP-developed statistical program BioStat was used to statistically compare the mortality results. Using an arcsin transformation to normalize the percent mortality data, KEN02Z was determined to be statistically different from the Beaver Creek sediment (p=0.05). Comparing to the interpretive guidelines in Table 5-2, KEN02Z failed the two hit guideline; mortality > 15% over control and statistically different from the control sediment (p = 0.05).

5.4 *CHIRONOMUS DILUTUS 20-DAY GROWTH TEST*

The results of the 20-day freshwater midge growth test may be seen in Table 5-5. The mean individual growth rate (MIG), expressed as the ash free dry weight (AFDW) exceeded the relevant performance criteria for the control and reference sediments. The test may be considered a valid test.

All tested DMMU-composite sediments had MIG that was at least 90% of that observed in the Beaver Creek control sediment. All test sediments were well below the one and two-hit criteria, and are considered to have passed relative to these guidelines.

5.5 SUMMARY OF BIOLOGICAL TESTING

The cumulative biological testing results are presented in Table 5-6. With the exception of KEN02Z, all test stations passed the three biological tests, and may be considered to have passed the DMMP guidelines. In the absence of a second corroborative second hit, KEN02Z may be interpreted as having passed the freshwater biological guidelines.

Table 5-1 Comparison of Beaver Creek and Kenmore Test Sediment Conventional Results

Chemical	Beaver Creek Sediment		Z-Layer Composite															
			KEN01		KEN02		KEN03		KEN04		KEN05		KEN06		KEN07		KEN08	
	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ	Value	VQ
Conventionals																		
Gravel (%)	0.3		11.5		1.3		0.7		1.7		0.1		0.9		0.4		0.7	
Sand (%)	52.4		45.9		42		47.9		26.6		44.2		53.4		48.2		52.0	
Silt (%)	43.9		29.8		43.5		39.5		54.1		40.4		36.1		38.7		35.7	
Clay (%)	3.5		12.9		13.1		11.9		17.6		15.4		9.7		12.9		11.6	
Total Fines (%) [1]	47.4		42.7		56.6		51.4		71.7		55.8		45.8		51.6		47.3	
Total Solids (%)	30.90		61.74		41.00		42.75		49.74		51.48		48.88		45.07		48.25	
TOC (%)	4.30		6.12		11.39		12.77		8.35		7.10		9.92		10.50		10.41	
Ammonia (bulk) (mg/kg)	34.1		1.75		2.41		2.66		2.7		1.8		3.12		1.49		2.36	
Sulfide (bulk - single core) (mg/kg)	77.4		75.75		162.5		165.5		164.5		211		118		262.5		199	

Note:
1. Percent fines are the sum of the percent silt and percent clay.

Table 5-2 Freshwater Bioassay QA/QC Performance Standards and Interpretive Criteria

Toxicity Test	**Negative Control Performance Standard**	**Reference Sediment Performance Standard** [1]	**1-Hit Criteria**	**2-Hit Criteria**
Hyalella azteca 10-day mortality	Mortality ≤ 20%	Mortality ≤ 25%	Mortality > 25% over control	Mortality > 15% over control
			Statistically different from control sediment (p = 0.05)	Statistically different from control sediment (p = 0.05)
Chironomus dilutus 20-day mortality	Mortality ≤ 32%	Mortality ≤ 35%	Mortality > 25% over control	Mortality > 15% over control
			Statistically different from control sediment (p = 0.05)	Statistically different from control sediment (p = 0.05)
Chironomus dilutus 20-day growth	Mean individual growth/day ≥ 0.6 mg/day	Mean individual growth rate	Mean growth rate < 60% control	Mean growth rate < 75% control
		≥ 80 percent of the control sediment	Statistically different from control sediment (p = 0.05)	Statistically different from control sediment (p = 0.05)

Notes:

1. Test sediment results will be compared quantitatively and statistically directly against the control sediment results.

Table 5-3 *Hyalella azteca* 10-day mortality results.

Sample	Mean mortality (%)	MT - MC [1,2]	MT - MC > 25%?	MT - MC [3]	MT - MC > 15%?	Statistically greater than control?	Trans-formation	1-Hit Criteria: MT-MC >25% and MT vs. MC SS (p = 0.05)	2-Hit Criteria: MT-MC >15% and MT vs. MC SS (p = 0.05)	Interpretation
Control	0.0	Negative Control Mortality ≤ 20%. Acceptable Test		Control Mortality ≤ 25%. Acceptable Test		---	---	---	---	---
KEN01Z 07102014	0.0	0.0	no	0.0	no	no	---	no	no	no hit
KEN02Z 07102014	2.5	2.5	no	2.5	no	no	---	no	no	no hit
KEN03Z 07122014	1.3	1.3	no	1.3	no	no	---	no	no	no hit
KEN04Z 07122014 *	1.7	1.7	no	1.7	no	no	---	no	no	no hit
KEN05Z 07122014	1.3	1.3	no	1.3	no	no	---	no	no	no hit
KEN06Z 07112014	0.0	0	no	0	no	no	---	no	no	no hit
KEN07Z 07112014	1.3	1.3	no	1.3	no	no	---	no	no	no hit
KEN08Z 07112014	1.3	1.25	no	1.25	no	no	---	no	no	no hit

Notes:

1. M_C = Mean Control Mortality
2. M_T = Mean Test Station Mortality

3.Test Sediments compared with the Beaver Creek Control Sediment

* Due to insufficient sediment sample volume, only six replicates were used.

Table 5-4 *Chironomus dilutus* 20-day mortality results.

Sample	Mean mortality (%)	MT - MC [1,2]	MT - MC > 25%?	MT - MC [3]	MT - MC > 15%?	Statistically greater than control?	Trans-formation	1-Hit Criteria: MT-MC >25% and MT vs. MC SS (p = 0.05)	2-Hit Criteria: MT-MC >15% and MT vs. MC SS (p = 0.05)	Interpretation
Control	14.3	Negative Control Mortality ≤ 32%. Acceptable Test		Control Mortality ≤ 35%. Acceptable Test		---	---	---	---	---
KEN01 Z07102014	26.3	12.0	no	12.0	no	no	---	no	no	no hit
KEN02 Z07102014	33.8	19.5	no	19.5	yes	yes	arcsin	no	yes	hit
KEN03 Z07122014	13.8	-0.5	no	-0.5	no	no	---	no	no	no hit
KEN04 Z07122014	23.8	9.5	no	9.5	no	no	---	no	no	no hit
KEN05 Z07122014	21.3	7.0	no	7.0	no	no	---	no	no	no hit
KEN06 Z07112014	21.3	7.0	no	7.0	no	no	---	no	no	no hit
KEN07 Z07112014	10.0	-4.3	no	-4.3	no	no	---	no	no	no hit
KEN08 Z07112014	13.8	-0.5	no	-0.5	no	no	---	no	no	no hit

1. M_C = Mean Control Mortality
2. M_T = Mean Test Station Mortality
3. Test Sediments compared with the Beaver Creek Control Sediment

Table 5-5 *Chironomus dilutus* 20-day growth test results.

Sample	Growth - mean Individual AFDW (mg) [1]	Control Performance MIGC > 0.60 mg/individual [2]	Reference Performance MIGC / MIGC ≥ 0.8 [3]	MIGT/MIGC [4]	MIGT SS < MIGC (p = 0.05)	Transformation	1-Hit Criteria: MIGT/MIGC < 0.6 and MIGT SS < MIGC (p = 0.05)	2-Hit Criteria: MIGT/MIGC < 0.75 and MIGT SS < MIGC (p = 0.05)	Interpretation
Control	1.43	1.40	1.00			---	---	---	---
KEN01Z07102014	1.39	---	---	0.97	no	---	no	no	no hit
KEN02Z07102014	1.47	---	---	1.03	no	---	no	no	no hit
KEN03Z07122014	1.35	---	---	0.94	no	---	no	no	no hit
KEN04Z07122014	1.43	---	---	1.00	no	---	no	no	no hit
KEN05Z07122014	1.37	---	---	0.96	no	---	no	no	no hit
KEN06Z07112014	1.58	---	---	1.11	no	---	no	no	no hit
KEN07Z07112014	1.31	---	---	0.92	no	---	no	no	no hit
KEN08Z07112014	1.44	---	---	1.01	no	---	no	no	no hit

Notes:
1. AFDW = Ash Free Dry Weight at the conclusion of the test
2. MIGC = Mean Individual Growth Control
3. Test Sediments compared with the Beaver Creek Control Sediment
4. MIGT = Mean Individual Growth Test

Table 5-6 Summary of Results relative to the Freshwater Bioassay Guidelines

Station	*Hyallela* Survival	*Chironomus* survival	*Chironomus* Growth	Summary Interpretation
KEN01Z07102014	no hit	no hit	no hit	no hit
KEN02Z07102014	no hit	X	no hit	no hit
KEN03Z07122014	no hit	no hit	no hit	no hit
KEN04Z07122014	no hit	no hit	no hit	no hit
KEN05Z07122014	no hit	no hit	no hit	no hit
KEN06Z07112014	no hit	no hit	no hit	no hit
KEN07Z07112014	no hit	no hit	no hit	no hit
KEN08Z07112014	no hit	no hit	no hit	no hit

Notes:
"no hit" = passes DMMP Guideline
X = hit under the 2-hit rule (minor hit)
XX = hit under the 1-hit rule (major hit)

6 REFERENCES

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Contact the Dredged Material Management Office for copies of any of the appendices.

Appendix A

Sampling and Analysis Plan

Appendix B

Daily Report Logs

Appendix C

Sediment Drive Logs

Appendix D

Field and Lab Notebook

Appendix E

Sediment Core Logs

Appendix F

Sediment Core Photographs

(on DVD only)

Appendix G

Chain-of-Custody Forms

Appendix H

ARI Data Reports

(on DVD only)

Appendix I

Data Validation Report

(on DVD only)

Appendix J

Validated Analytical Data

(on DVD only)

Appendix K

EIM Deliverable

(on DVD only)

Appendix L

Puget Sound Standard Reference Material Report

(on DVD only)

Appendix M

Bioassay Reports

(on DVD only)