Prepared by:
The Dredged Material Management Office
Seattle District, U.S. Army Corps of Engineers

MEMORANDUM FOR RECORD **September 4, 2019**

SUBJECT: CHARACTERIZATION OF THE POST-DREDGE SEDIMENT SURFACE AT EVERETT MARINA AND POST-DISPOSAL SEDIMENT SURFACE AT THE PORT GARDNER DISPOSAL SITE FOLLOWING OVERDREDGING IN THE MARINA

1. **Introduction**. This memorandum documents the results of sediment characterization conducted for the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) to assess post-dredge conditions at Everett Marina and post-disposal conditions at the Port Gardner disposal site following overdredging in the marina that occurred between December 6, 2018 and January 20, 2019.

   DMMP (2017) describes dioxin/furan testing conducted at Everett Marina between 2010 and 2016. Elevated dioxin/furan concentrations (22.3 and 23.1 nanograms per kilogram toxicity equivalence [ng/kg TEQ]) were documented in two Z-samples collected in dredged material management unit (DMMU) 9 in 2010 from -14 to -16 ft MLLW. The DMMP agencies restricted dredging in this area to a maximum depth of -13 ft MLLW, including overdepth, so as to avoid exposing sediment with elevated dioxin/furan concentrations.

   The dredging and disposal work plan (American, 2018) called for dredging to -12 ft MLLW plus one foot of overdepth within the boundaries of DMMU 9 and 9A, which conformed to the restrictions established by the DMMP agencies for this area.

   Marina dredging was conducted between November 27, 2018 and February 12, 2019 (Windward, 2019c). The Port of Everett notified USACE on February 13, 2019 that the dredging contractor had over-dredged (i.e. dredged too deeply) in DMMU 9/9a and DMMU 7 (Figure 1). Dredging also took place outside the northern boundaries of DMMUs 5 and 8 (Figure 1), including minor incursions into a residuals cover layer in the Everett Shipyard (ESY) cleanup area (Figure 2).

   The DMMP agencies reviewed the dredging records from the marina and the disposal records for both the marina and from USACE maintenance dredging of the Snohomish River federal navigation project, which was dredged contemporaneously. The agencies were concerned that the overdredging could have left a degraded sediment surface within the marina. There was also concern that material placed at the Port Gardner disposal site from the overdredge might have resulted in a post-disposal surface with unacceptable levels of dioxins/furans. This concern was mitigated by the fact that the disposal tracks from disposal of the Snohomish River material overlapped with the disposal coordinates reported for the marina dredging. However, some of the marina disposal events had sparser coverage of Snohomish River material than others.

   In response to the overdredge and concern about the potential for elevated dioxin/furan concentrations in exposed sediment within the marina and at the disposal site, the DMMP agencies required the Port

of Everett to characterize conditions at both locations. In addition, staff from Ecology's Toxics Cleanup Program (TCP) required the Port to assess the condition of the ESY residuals cover layer. This memorandum documents the results of the sediment characterization effort.

2. **Sediment Characterization Summary**. Table 1 includes summary and tracking information.

Table 1. Project Summary

Overdredge volume	9,703 cy
Draft marina SAP received	March 29, 2019
Draft SAP returned for revisions	April 2, 2019
Revised SAP received	April 9, 2019
Revised SAP returned for revisions	April 11, 2019
Final SAP received	April 11, 2019
Final SAP approved	April 12, 2019
Marina sampling dates	April 17-18, 2019
Draft disposal site SAP addendum received	May 2, 2019
Draft SAP addendum returned for revisions	May 9, 2019
Final SAP addendum received	May 15, 2019
Final SAP addendum approved	May 16, 2019
Disposal site sampling date	May 20, 2019
Draft data report received	August 2, 2019
Draft report returned for revisions	August 16, 2019
Final data report received	September 3, 2019
DMMO Tracking numbers	POEMA-2-A-O-405 (marina) MONPG-4-A-O-406 (PG disposal site)
EIM Study ID	POEMA19 (marina) MONPG19 (PG disposal site)
USACE Permit Number	NWS-2017-744

3. **Sediment Characterization Objectives**. The DMMP agencies and TCP established sampling and testing requirements to meet the following objectives, as documented in Windward (2019c):

- Objective 1: Characterize the surface sediment dioxin/furan TEQs in the areas within DMMUs 7 and 9 where the dredge depth exceeded the design depth to evaluate compliance with anti-degradation guidelines provided in DMMP (2008).

- Objective 2: Estimate dioxin/furan TEQs in the unauthorized material that was transported to the Port Gardner open-water disposal facility.

- Objective 3: Characterize surface sediment dioxin/furan TEQs in areas outside of the DMMUs where lateral over-dredging occurred to evaluate compliance with antidegradation guidelines.

- Objective 4: Characterize sediment semivolatile organic compound (SVOC) concentrations in locations within the ESY site where incursions into the residuals cover layer occurred, as requested by TCP.

- Objective 5: Characterize the surface sediment dioxin/furan TEQs in those areas of the Port Gardner disposal site where disposal of USACE maintenance dredged material from the Snohomish River might not have covered material disposed from the marina.

4. **Study Design**. To meet the sediment characterization objectives, the study design included collection of a total of twenty-three surface sediment samples from the marina and nine surface sediment samples from the disposal site.

   Seventeen of the samples from the marina were placed in DMMUs 7 and 9. These samples – identified as EM-SS04 to EM-SS20 – were designed to address Objectives 1 and 2 (Windward, 2019a). Post-dredge bathymetry had shown overdredge depths greater than four feet beyond the allowable overdepth in places (Figure 1). Target sampling locations were distributed so as to sample sediment over the full range of overdredge depths (Figure 3).

   The other six surface sediment samples from the marina were placed outside of the DMMU boundaries to characterize the lateral overdredging (Figure 3). Two samples (EM-SS01 and EM-SS03) were placed in over-dredged areas north of DMMU 5 to address Objective 3. One sample (EM-SS02) was placed in an undredged area between EM-SS01 and EM-SS03 to estimate the dioxin/furan concentration in the dredged material that was taken to the disposal site from the lateral over-dredge areas (Objective 2). Three samples (ESY-1, ESY-2 and ESY-3) were placed in the ESY residual cover layer where the dredging incursions occurred (Objective 4). These samples were to be analyzed for SVOCs, including polycyclic aromatic hydrocarbons (PAHs), dibenzofuran and 2,4-dimethyl phenol, all of which were chemicals of concern (COCs) for that area (Windward, 2019a).

   At the Port Gardner disposal site, seven samples (PG19-SS01 to PG19-SS07) were placed in that part of the disposal site that received sediment from the over-dredged areas and where relatively little Snohomish River material was placed (Figure 4). Two on-site reference samples were also included in the study design. Sample PG19-SS-OSR1 was located outside of the area influenced by disposal of both marina and Snohomish River dredged material, while PG19-SS-OSR2 was placed in an area influenced by the disposal of Snohomish River dredged material, but not material from the marina (Windward, 2019b).

5. **Sampling**. Sampling in the marina took place April 18-19, 2019 using a pneumatic power grab sampler (Windward, 2019c). Samples were collected from the top ten cm to represent the biologically active zone. Target and actual sampling location coordinates are provided in Table 2 and shown in Figure 5. Acceptance criteria included a penetration depth of at least eleven cm, sample collection within ten feet of the target coordinates, and a mudline elevation within one foot (vertical) of the mudline elevation at the target coordinates. Several deviations from these acceptance criteria occurred, as documented in Windward (2019c). The DMMP agencies evaluated these deviations and concluded that they were minor in nature and did not compromise the ability of the data to address the objectives of the study.

Sampling at the Port Gardner disposal site occurred May 20, 2019 (Windward, 2019c) using a power grab sampler. Samples were collected from the top ten cm. Acceptance criteria included a penetration depth of at least eleven cm and sample collection within ten feet of the target coordinates. There were two minor deviations. Target and actual sampling location coordinates are provided in Table 2 and shown in Figure 6.

6. **Chemical Analysis**. The dioxin/furan results for samples collected from the marina are presented in Table 3 and Figure 7. Chemistry results for the ESY samples from the marina are provided in Table 4. Dioxin/furan results for samples collected from the Port Gardner disposal site are presented in Table 5 and Figure 8.

   Dioxin/furan TEQs in the marina samples ranged from 3.7 to 17.3 ng/kg. Dioxin/furan TEQs at the Port Gardner disposal site ranged from 0.5 to 6.2 ng/kg.

   COC concentrations in the ESY samples were all below the sediment cleanup objectives found in the State of Washington's Sediment Management Standards (Ecology, 2013).

   Independent data validation was performed on all results by Laboratory Data Consultants, Inc. All data were determined to be acceptable for use. No data were rejected (Windward, 2019c).

7. **Biological Testing**. Biological testing was not required for this study.

8. **Discussion**. Section 3 listed five objectives of the sediment characterization, which are discussed objective-by-objective below.

   Objective 1. Antidegradation in DMMUs 7 and 9.
   Bioaccumulation testing for dioxins/furans was conducted for sediment from the marina in 2016. Sediment samples from seven DMMUs were composited to represent three management areas for testing. Management Area 4 (M4) had the highest dioxin/furan concentration and was represented by a composite created out of sediment from DMMU 10 (13.0 ng/kg TEQ) and DMMU 12 (14.4 ng/kg TEQ). Analysis of the composite yielded a concentration of only 11.7 ng/kg TEQ. All tested sediment – including M4 – passed bioaccumulation testing and was found suitable for open-water disposal (DMMP, 2017).

   As can be seen in Table 3 and Figure 7, fifteen of the seventeen post-dredge samples from DMMUs 7 and 9 had dioxin/furan concentrations less than the highest concentration subjected to and passing bioaccumulation testing (i.e. 11.7 ng/kg TEQ). The only sampling stations exceeding 11.7 ng/kg TEQ were EM-SS05 and EM-SS12, with concentrations of 15.9 and 14.1 ng/kg TEQ respectively. The mean concentration of the 17 samples was 8.2 ng/kg TEQ. Dioxins/furans are not acutely toxic to benthic organisms at these concentrations. It is through bioaccumulation that chronic sublethal effects occur. Bioaccumulation occurs over the life of the organism and, therefore, DMMP treats bioaccumulation as an area-weighted phenomenon, which is best addressed by looking at the mean concentration of the area in question. Because the mean post-dredge concentration in the marina was well below the highest concentration tested for and passing bioaccumulation testing, the DMMP agencies do not consider the two individual locations with somewhat higher concentrations to be in need of removal and/or cover.

Objective 2. Estimate dioxin/furan TEQs in unauthorized material taken to the Port Gardner open-water disposal site.

As discussed previously, the only post-dredge sampling stations within DMMUs 7 and 9 that exceeded 11.7 ng/kg TEQ (the highest concentration passing bioaccumulation testing) were EM-SS05 and EM-SS12, with concentrations of 15.9 and 14.1 ng/kg TEQ respectively. Regarding the lateral over-dredge areas, undredged station EM-SS02 served as a proxy for sediment taken to the Port Gardner disposal site. This station had the highest dioxin/furan concentration (17.3 ng/kg TEQ) of all of the samples collected from the marina following dredging. The data from these three stations indicate that the dioxin/furan concentration in at least some of the unauthorized material taken to the disposal site was above the concentrations that passed bioaccumulation testing. However, these concentrations were all less than the maximum pre-dredge concentration of 23.1 pptr TEQ.

Objective 3. Antidegradation in the areas where lateral overdredging occurred.

The dioxin/furan concentration at undredged station EM-SS02 (17.3 ng/kg TEQ) provides an indication of the pre-dredge quality of surface sediment outside the DMMU boundaries. The dioxin/furan concentrations at the two locations in the lateral overdredge area (EM-SS01 and EM-SS03) were 11.1 and 8.4 ng/kg TEQ respectively, which are well below the concentration at EM-SS02. This provides evidence that the post-dredge surface sediment in the lateral over-dredged areas is not degraded compared to the pre-dredge condition. The dioxin/furan concentrations at EM-SS01 and EM-SS03 are also below the highest concentration that passed bioaccumulation testing.

Objective 4. Characterize SVOCs in areas where there were incursions into the ESY residuals cover layer.

Regarding SVOCs tested at ESY-1, ESY-2 and ESY-3, since all concentrations were below the sediment cleanup objectives, TCP staff concluded that no harm had been done by the incursions into the residuals cover layer at ESY.

Objective 5. Post-Disposal Conditions at the Port Gardner Disposal Site.

Dioxin/furan concentrations at the seven stations within the area receiving dredged material from the marina and with the smallest apparent cover of Snohomish River dredged material (i.e. PG19-SS01 to PG19-SS07) ranged from 0.5 to 6.2 ng/kg TEQ. The mean dioxin/furan concentration at these seven stations was 2.3 ng/kg TEQ. This concentration is well below the DMMP disposal site management objective of 4.0 ng/kg TEQ and far below the highest concentration subjected to and passing bioaccumulation testing (i.e. 11.7 ng/kg TEQ). The on-site reference stations had low dioxin/furan concentrations as well, with concentrations of 0.8 and 2.3 ng/kg TEQ at stations PG19-SS-OSR1 and PG19-SS-OSR2 respectively.

As mentioned in the Objective 2 discussion, there was evidence that material with dioxin/furan TEQs greater than the highest concentration passing bioaccumulation testing was taken to the disposal site. However, the elevated dioxin/furan concentrations found at stations EM-SS02, EM-SS05 and EM-SS12 (17.3, 15.9 and 14.1 ng/kg TEQ respectively) were not reflected in the samples collected from the disposal site. Possible explanations include the relatively small volume dredged from the lateral over-dredge areas compared to the volume from the rest of the marina, or burial by or mixing with other dredged material with lower dioxin/furan concentrations.

9. Conclusions. The DMMP agencies reviewed the post-dredge data from the marina and post-disposal data from the Port Gardner disposal site and concluded that no further action is needed on the part of the Port of Everett. The dioxin/furan concentrations in both the marina and at the disposal site are considered acceptable.

10. References.

American, 2018. *Port of Everett Central Marina Improvements – Phase 3 Project; Dredging and Disposal Work Plan, Revision 6.* American Construction Company, November 14, 2018.

DMMP, 2008. *Quality of Post-Dredge Sediment Surfaces (Updated).* A DMMP clarification paper prepared by David Fox (U.S. Army Corps of Engineers), Erika Hoffman (U.S. Environmental Protection Agency) and Tom Gries (Washington Department of Ecology) for the DMMP agencies, June 10, 2008.

DMMP, 2017. *Determination Regarding the Suitability of Proposed Dredged Material from the Port of Everett Marina, Evaluated under Section 404 of the Clean Water Act, for Placement at the Dredged Material Management Program's Unconfined Open-Water Disposal Site in Port Gardner.* Memorandum of Record prepared by the Dredged Material Management Office for the Dredged Material Management Program, March 30, 2017.

Ecology, 2013. *Sediment Management Standards – Chapter 173-204 WAC*. Washington State Department of Ecology, Revised February 2013.

Windward, 2019a. Port of Everett: *Post-Dredge Surface Sediment Characterization* [Marina Sampling and Analysis Plan]. Prepared by Windward Environmental LLC for the Port of Everett, April 11, 2019.

Windward, 2019b. Port of Everett: *Post-Dredge Surface Sediment Characterization – Disposal Site Addendum*. Prepared by Windward Environmental LLC for the Port of Everett, May 14, 2019.

Windward, 2019c. Port of Everett: Post-Dredge Surface Sediment Characterization Data Report. Prepared by Windward Environmental LLC for the Port of Everett, August 27, 2019.

11. Agency Signatures.

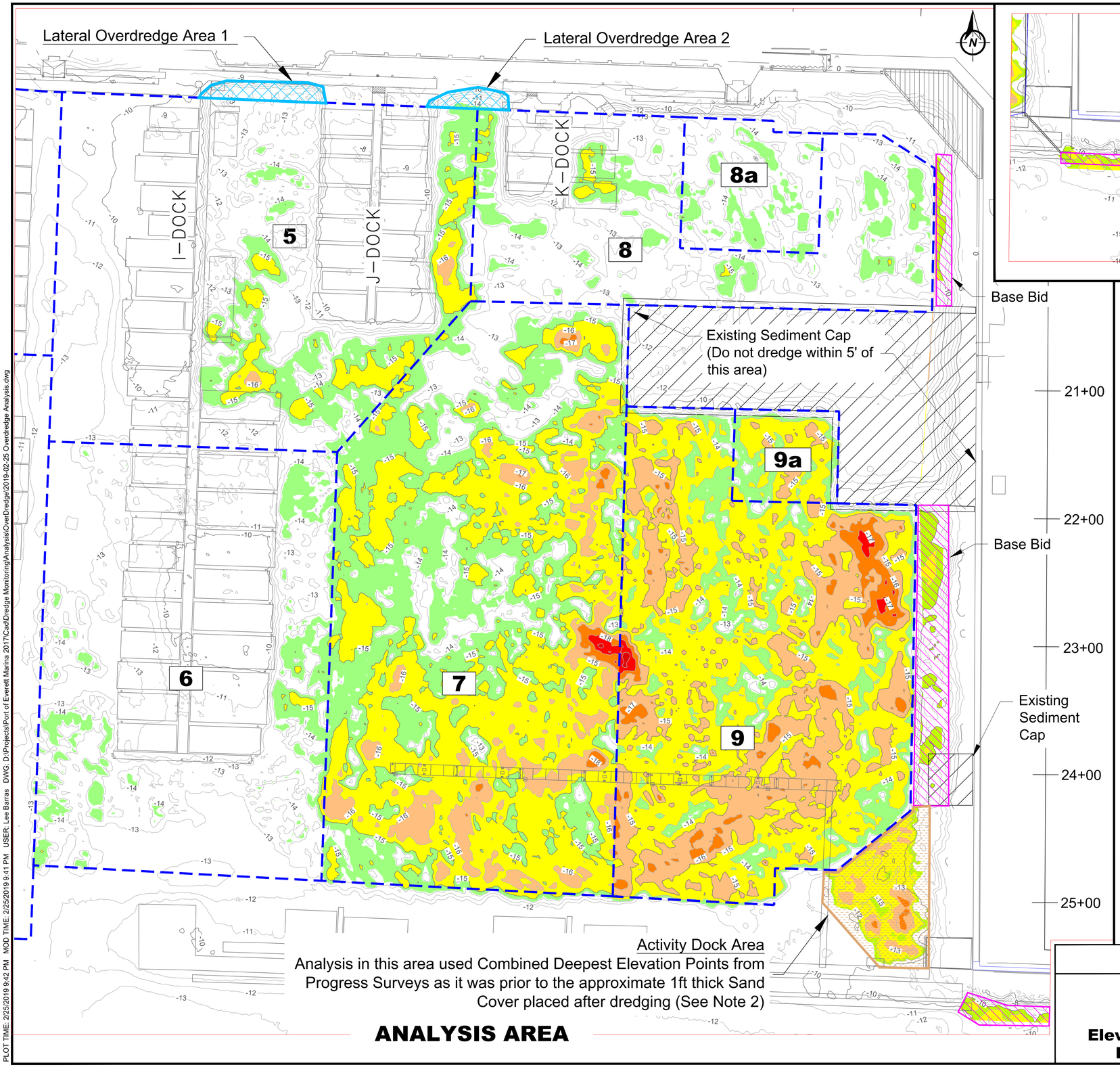
Concur:

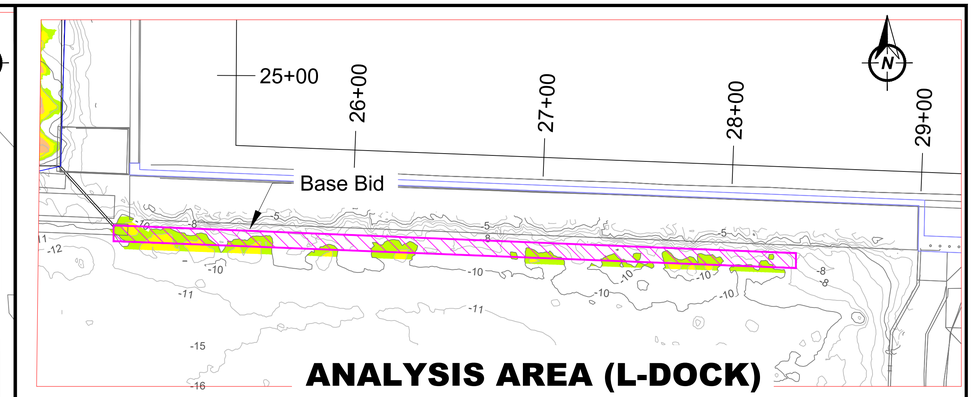
_____	_____
Date	David Fox - Seattle District Corps of Engineers
_____	_____
Date	Erika Hoffman - Environmental Protection Agency
_____	_____
Date	Laura Inouye, Ph.D. - Washington Department of Ecology
_____	_____
Date	Shannon Soto - Washington Department of Natural Resources

Copies furnished:

DMMP signatories
Katie Heard – Seattle District Regulatory
Susie McGroddy – Windward Environmental
Kathy Godtfredsen – Windward Environmental
Laura Gurley – Port of Everett
Erik Gerking – Port of Everett

Figure 1





LEGEND

- DMMU Boundary
- 9a — DMMU ID
- Base Bid Area
- Lateral OverDredge Area
- Activity Dock Area with Sand Cover
- -10 — Contour Index (5') (Post-Dredge February 19, 2019)
- -13 — Contour Intermediate (1') (Post-Dredge February 19, 2019)

0 80
Scale in Feet

OVERDREDGE ANALYSIS	
Elevation in Feet Below Allowable Overdepth*	**Color**
0.25 to 1	
1 to 2	
2 to 3	
3 to 4	
4 to 5	
< 5	

* Allowable Overdepth varies per location
DMMU 5, 6, 7, 8, 8a = Elev. -14
DMMU 9, 9a = Elev. -13
Activity Dock = Elev. -11
Base Bid (Guest 5 Dock and L- Dock) = Elev. -10
** Data range starts at 0.25' to compensate for survey accuracy.

NOTES

1. Pre-dredge survey date: Nov. 5, 2018. Post-Dredge survey date: February 19, 2019. Surveys performed by PGS, Inc.
2. Analysis in Activity Dock area compares the November 5, 2018 Pre-Dredge survey vs the Combined Deepest Dredge Point Surface as the area had 1ft of sand placed over it prior to the Post-Dredge survey.

Port of Everett

CMI Phase 3 Dredging

Overdredge Analysis
Elevation Below Allowable Overdepth
Pre-Dredge versus Post-Dredge

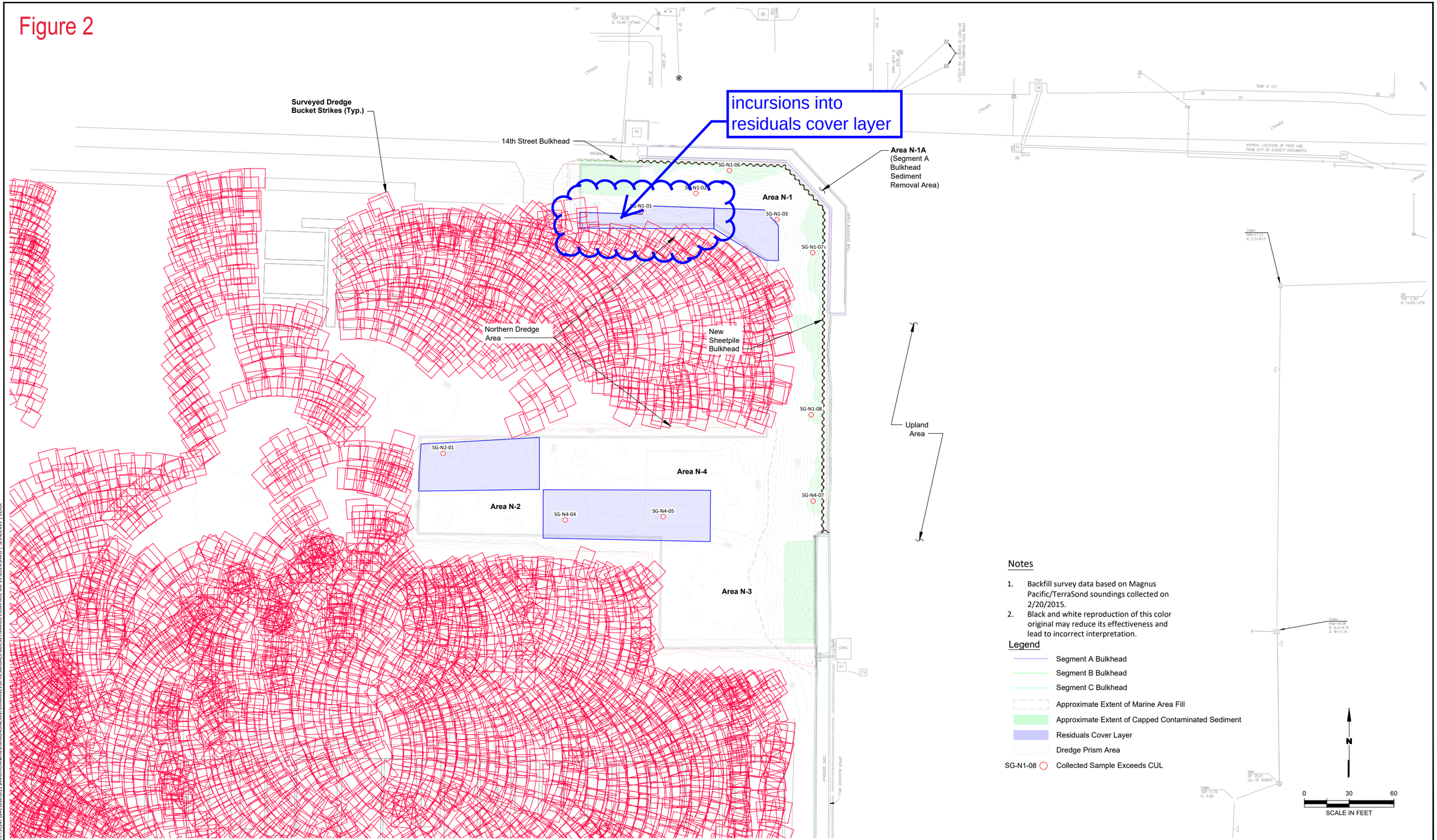
DOF DALTON OLMSTED FUGLEVAND

FIGURE 1

February 25, 2019

PLOT TIME: 2/25/2019 9:42 PM MOD TIME: 2/25/2019 9:41 PM USER: Lee Barras DWG: D:\Projects\Port of Everett Marina 2017\Cad\Dredge Monitoring\Analysis\OverDredge\2019-02-25 Overdredge Analysis.dwg

Figure 2



Sources: Magnus Pacific/TerraSond Surveys 2014 & 2015

PRELIMINARY

NO.	DATE	REVISIONS	DESIGNED	REVIEWED	APPROVED

DRAFTED BY:	X. DRAFTER	XXX	.-.-.
DESIGNED BY:	Y. DESIGNER	YYY	.-.-.
REVIEWED BY:	Z. REVIEWER	ZZZ	.-.-.
APPROVED BY:			
STATUS:	X% Submittal	INITIAL	DATE

LANDAU ASSOCIATES
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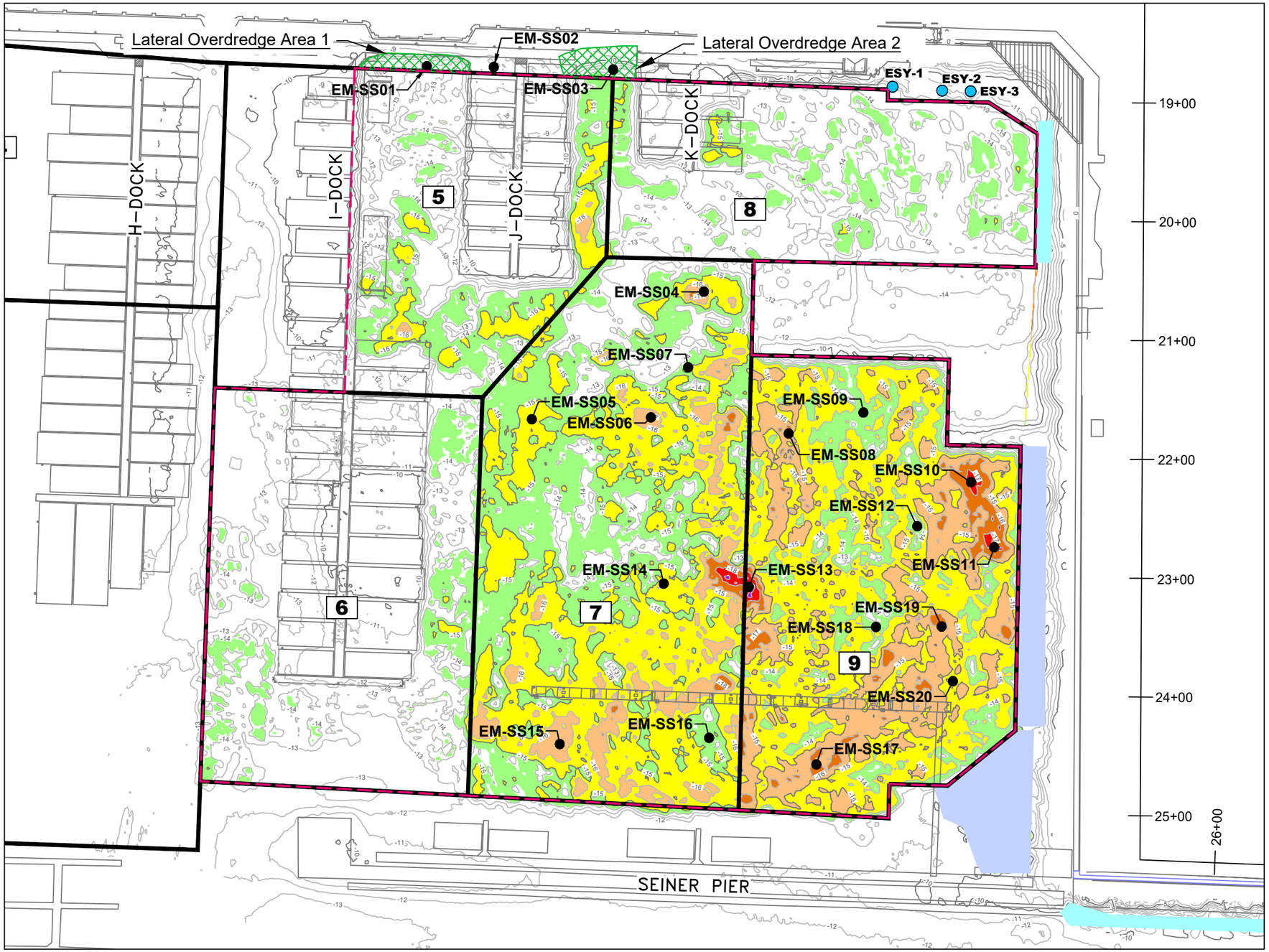
<PROJECT TITLE>

<TITLE>

PROJECT NO.	.
DATE	.-.-.
SHEET	1 OF X
DRAWING NO.	NO

LANDAU ASSOCIATES INC. | G:\PROJECTS\147\041\010\011\AMERICANDREDGINGNONCONFORMANCE\ARESIDUALS-BUCKETMARKS COMPARE LAI 19-0314.DWG | 3/14/2019 | EZICK

Figure 3



LEGEND

- Proposed Sample Location
- ESY Sample Location
- Phase 2A Boundary
- DMMU Boundary
- 9 DMMU ID
- Dredged for Upland Disposal - No Sand Cover
- Dredged for Upland Disposal - Sand Cover
- Lateral Overdredge Area
- Contour Index (5') (Post-Dredge February 19, 2019)
- Contour Intermediate (1') (Post-Dredge February 19, 2019)

OVERDREDGE ANALYSIS	
Elevation in Feet Below Allowable Overdepth*	**Color**
0.25 to 1	
1 to 2	
2 to 3	
3 to 4	
4 to 5	
> 5	

* Allowable Overdepth varies per location
DMMU 5, 6, 7, 8, 8a = Elev. -14
DMMU 9, 9a = Elev. -13
** Data range starts at 0.25' to compensate for survey accuracy.

NOTES

1. Pre-dredge survey date: Nov. 5, 2018. Post-Dredge survey date: February 19, 2019. Surveys performed by PGS, Inc.

Wind Ward environmental LLC

Date created: 3/20/2019
Date last revised: 3/21/2019
Original data content provided by DOF

N
0 100 200 Feet

Port of Everett

Map 3. Post-dredge surface sediment sampling locations

FINAL

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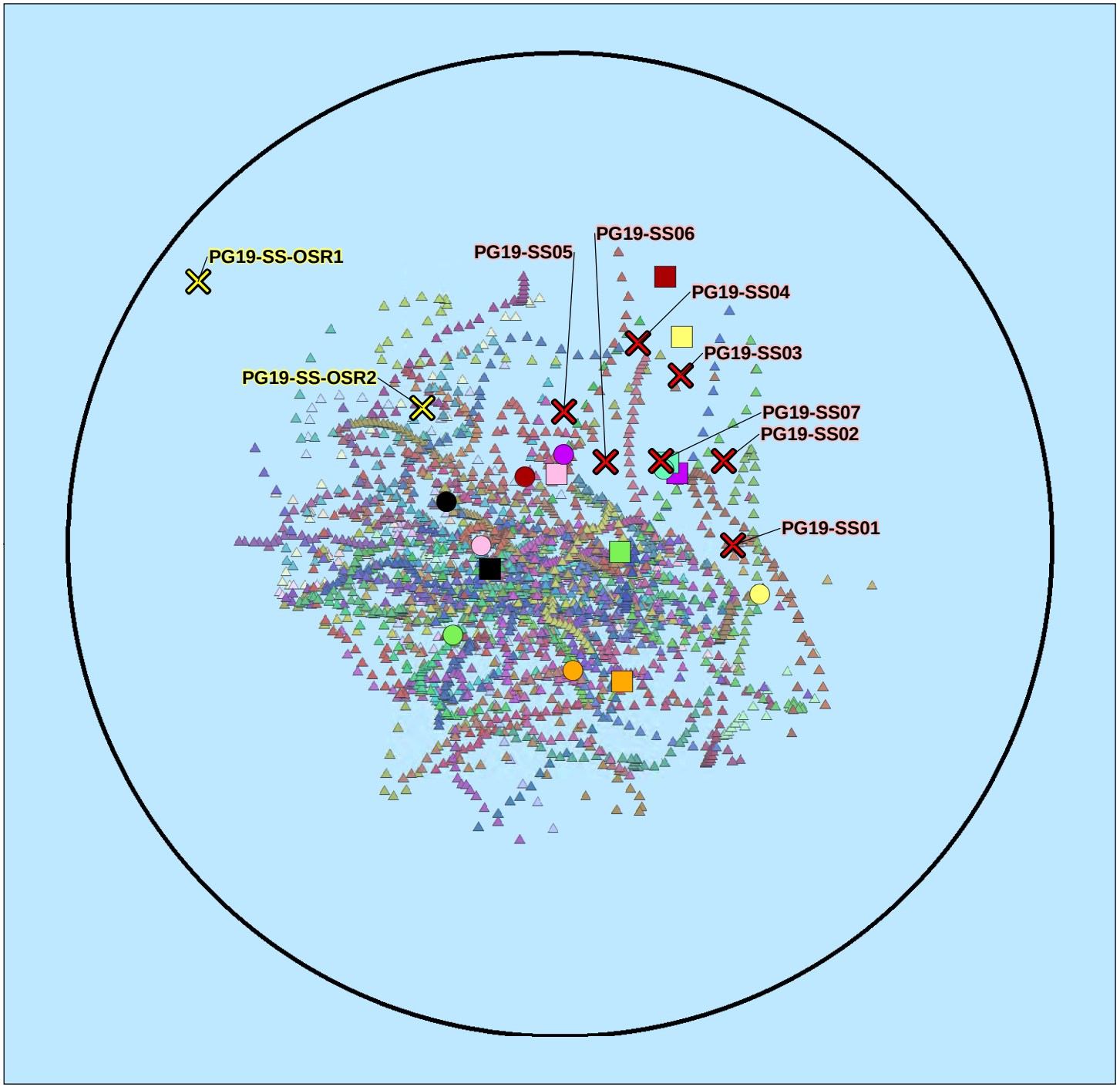
Figure 4



Grab sample within potential Port material influence area

Reference sample outside potential Port material influence area

Port disposal locations

Open	Closed
4	4
5	5
6	6
7	7
9	9
10	10
11	11
12	12

USACE disposal - open

Disposal zone

N

0 0.02 0.04 Miles

0 0.04 0.08 Kilometers

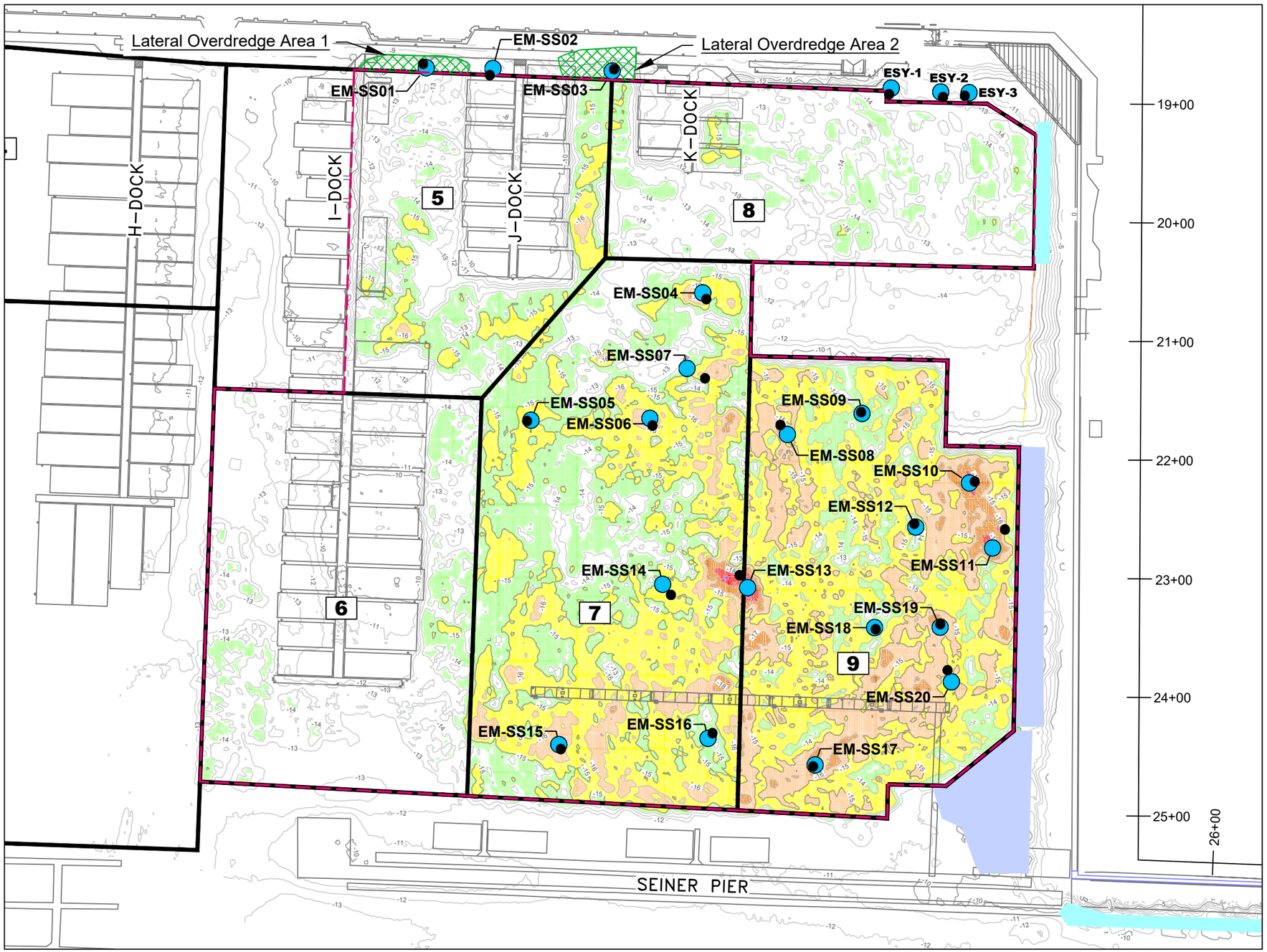
Scale is the same for each map frame

Map 1. Port Gardner disposal site proposed sampling locations

Windward environmental LLC

Prepared by mikey, 5/14/2019, W:\Projects\Port of Everett\Data\GIS\Maps_and_Analyses\Marina Dredge Support\Overdredge_Analysis\7044_Port Gardner offshore disposal locations.mxd

Figure 5



LEGEND

- Actual Sample Location
- Target Sample Location
- Phase 2A Boundary
- DMMU Boundary
- 9 DMMU ID
- Dredged for Upland Disposal - No Sand Cover
- Dredged for Upland Disposal - Sand Cover
- Lateral Overdredge Area
- -10 Contour Index (5') (Post-Dredge February 19, 2019)
- -13 Contour Intermediate (1') (Post-Dredge February 19, 2019)

OVERDREDGE ANALYSIS	
Elevation in Feet Below Allowable Overdepth*	**Color**
0.25 to 1	
1 to 2	
2 to 3	
3 to 4	
4 to 5	
> 5	

* Allowable Overdepth varies per location
DMMU 5, 6, 7, 8, 8a = Elev. -14
DMMU 9, 9a = Elev. -13
** Data range starts at 0.25' to compensate for survey accuracy.

NOTES

1. Pre-dredge survey date: Nov. 5, 2018. Post-Dredge survey date: February 19, 2019. Surveys performed by PGS, Inc.

Wind Ward environmental LLC

Date created: 7/24/2019
Date last revised: 7/25/2019
Original data content provided by DOF

N
0 100 200 Feet

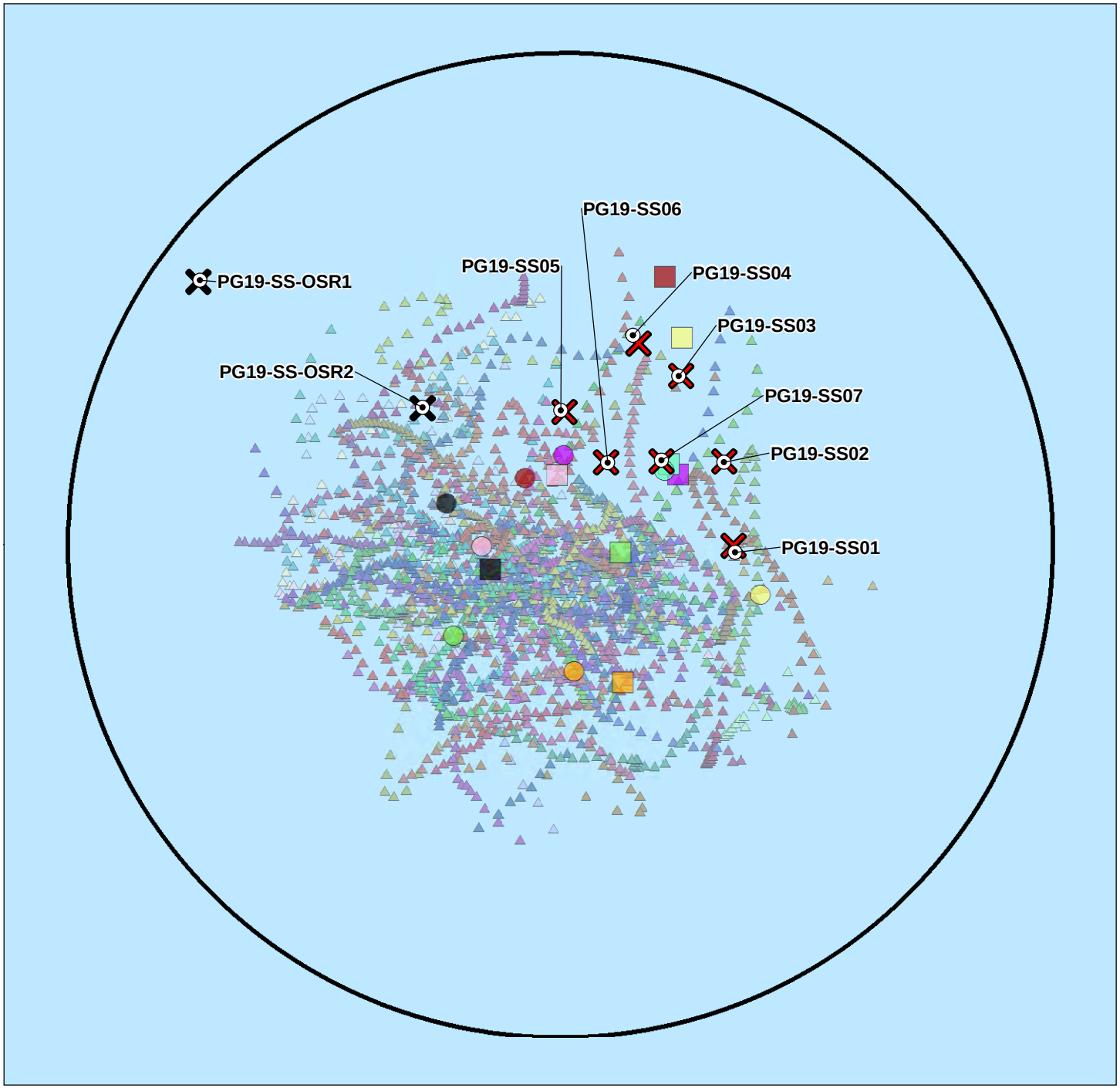
Port of Everett

Map 1. Post-dredge surface sediment sampling locations

FINAL

W:\Projects\Port of Everett\Data\CAD\Marina Dredging\Production Drawings\Non Compliance Overdredge Analysis\Data Report\Map 2. Post-dredge surface sediment

Figure 6



Sample locations within potential Port material influence area

Actual

Target

Reference sample outside potential Port material influence area

Actual

Target

Port disposal locations

Open	Closed
4	4
5	5
6	6
7	7
9	9
10	10
11	11
12	12

ACE disposal - open

Disposal zone

N

0 0.02 0.04 Miles

0 0.04 0.08 Kilometers

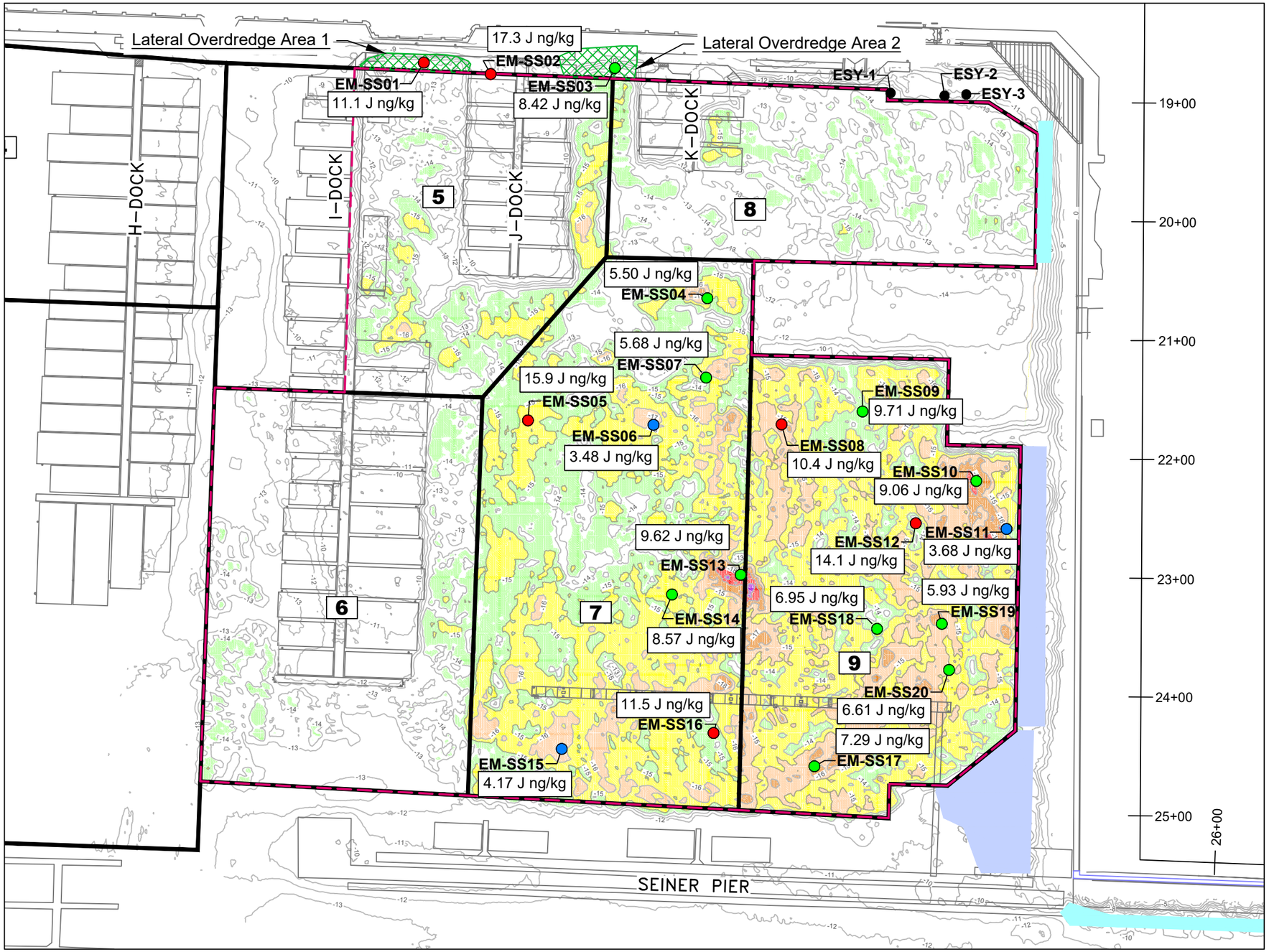
Map 2. Port Gardner disposal site sampling locations

FINAL

Windward environmental LLC

Prepared by mikey, 8/27/2019, W:\Projects\Port of Everett\Data\GIS\Maps_and_Analyses\Marina Dredge Support\Overdredge_Analysis\Data_Report\7044a_Port Gardner offshore disposal locations w sample locations.mxd

Figure 7



LEGEND

Dioxin/furan TEQ (ng/kg)

- > 10
- > 5 and ≤ 10
- ≤ 5
- No dioxin/furan results
- Phase 2A Boundary
- DMMU Boundary
- 9 DMMU ID
- Dredged for Upland Disposal - No Sand Cover
- Dredged for Upland Disposal - Sand Cover
- Lateral Overdredge Area
- Contour Index (5') (Post-Dredge February 19, 2019)
- Contour Intermediate (1') (Post-Dredge February 19, 2019)

OVERDREDGE ANALYSIS	
Elevation in Feet Below Allowable Overdepth*	**Color**
0.25 to 1	
1 to 2	
2 to 3	
3 to 4	
4 to 5	
> 5	

* Allowable Overdepth varies per location
DMMU 5, 6, 7, 8, 8a = Elev. -14
DMMU 9, 9a = Elev. -13
** Data range starts at 0.25' to compensate for survey accuracy.

NOTES

1. Pre-dredge survey date: Nov. 5, 2018. Post-Dredge survey date: February 19, 2019. Surveys performed by PGS, Inc.

Windward environmental LLC

Date created: 8/20/2019
Date last revised: 8/20/2019
Original data content provided by DOF

N
0 100 200 Feet

Port of Everett

Map 3. Post-dredge Marina dioxin/furan results

FINAL

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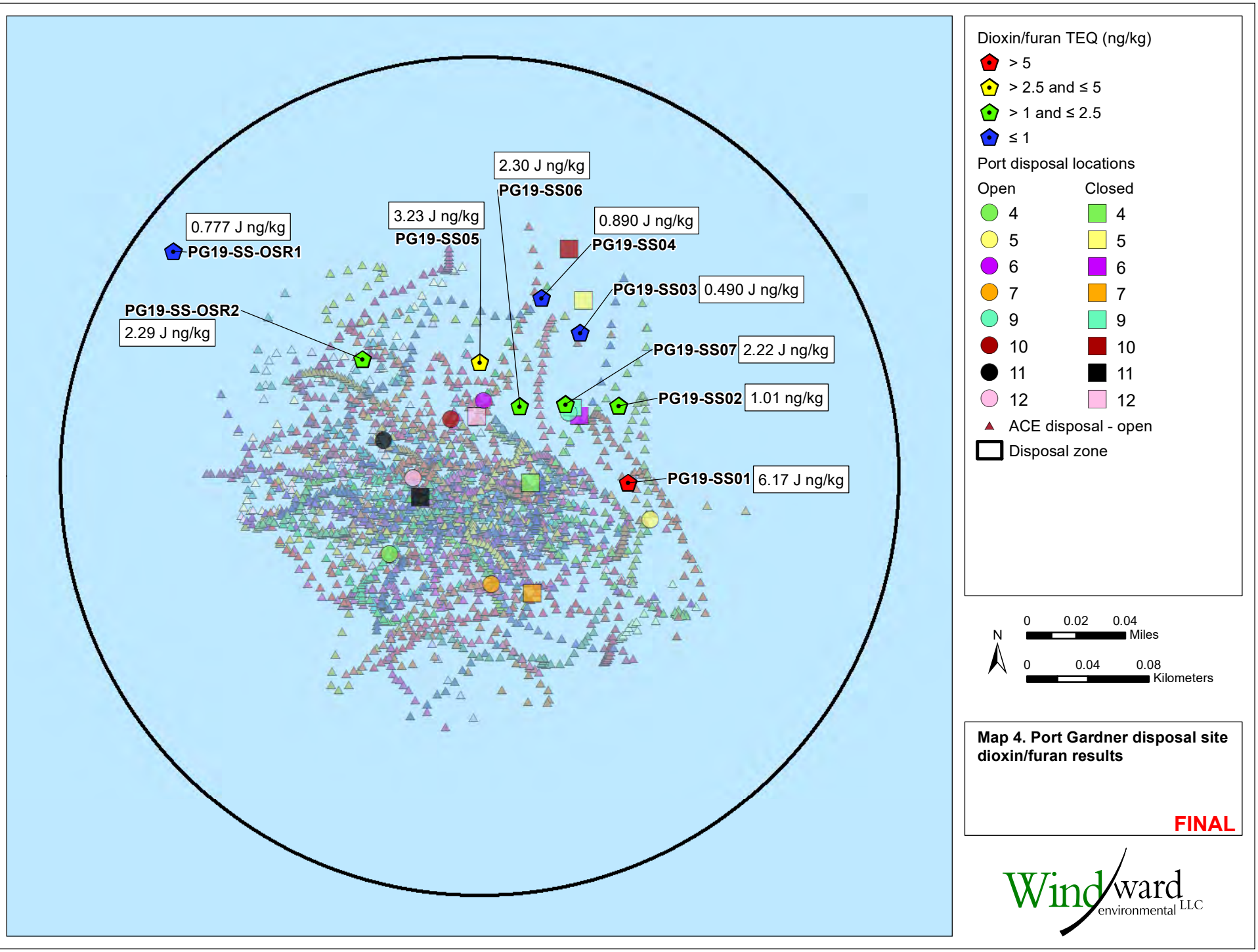
Figure 8



Map 4. Port Gardner disposal site dioxin/furan results

FINAL

Windward environmental LLC

Prepared by mikey, 8/21/2019; W:\Projects\Port of Everett\Data\GIS\Maps_and_Analyses\Marina Dredge Support\Overdredge_Analysis\Data_Report\7044c_Port Gardner offshore disposal locations w sample locations and DF TEQ values.mxd

Table 2. Target and actual coordinates and mudline elevations for sampling locations

Location ID	Target Coordinates		Actual Coordinates		Distance from Target (ft)	Mudline Elevation (ft MLLW)	
	Easting (ft)[a]	Northing (ft)[a]	Easting (ft)[a]	Northing (ft)[a]		Estimated	Actual
EM-19-SS01	1301423	367474	1301420	367477	4.1	-13.3	-13.4
EM-19-SS02	1301479	367473	1301477	367467	6.4	-8.8	-9.5
EM-19-SS03	1301580	367471	1301581	367472	4.9	-13.5	-13.4
EM-19-SS04	1301656	367284	1301659	367279	6.2	-17.2	-16.2
EM-19-SS05	1301511	367177	1301508	367176	5.3	-15.2	-14.5
EM-19-SS06	1301611	367178	1301614	367172	8.5	-17.1	-16.2
EM-19-SS07	1301643	367220	1301658	367212	16.9	-14.7	-14.8
EM-19-SS08	1301727	367165	1301721	367173	7.5	-15.7	-14.8
EM-19-SS09	1301790	367182	1301790	367183	1.6	-12.6	-12.2
EM-19-SS10	1301881	367124	1301885	367125	9.5	-17.2	-16.8
EM-19-SS11	1301900	367069	1301911	367085	20.2	-17.1	-16.7
EM-19-SS12	1301836	367087	1301834	367089	3.3	-13.9	-13.4
EM-19-SS13	1301694	367036	1301687	367046	10.1	-18.3	-17.4
EM-19-SS14	1301622	367038	1301629	367029	11.7	-15.4	-15.5
EM-19-SS15	1301535	366903	1301536	366899	8.8	-16.7	-16.4
EM-19-SS16	1301660	366909	1301664	366913	2.6	-14.7	-14.0
EM-19-SS17	1301751	366886	1301749	366885	2.9	-16.1	-15.7
EM-19-SS18	1301801	367002	1301802	367000	8.9	-14.4	-13.6
EM-19-SS19	1301856	367002	1301856	367005	5.9	-16.1	-16.1
EM-19-SS20	1301866	366956	1301862	366966	9.3	-14.5	-14.1
ESY-1	1301815	367457	1301813	367451	5.6	-13.1	-12.5
ESY-2	1301857	367453	1301859	367449	4.8	-11.2	-8.9
ESY-3	1301880	367453	1301877	367450	4.6	-10.8	-11.7
PG19-SS01	1286695	361101	1286698	361089	12.6	na	na
PG19-SS02	1286678	361255	1286678	361254	1.6	na	na
PG19-SS03	1286600	361412	1286595	361411	4.8	na	na
PG19-SS04	1286522	361471	1286512	361486	17.9	na	na
PG19-SS05	1286386	361346	1286380	361349	7.0	na	na
PG19-SS06	1286463	361254	1286465	361253	3.0	na	na
PG19-SS07	1286563	361256	1286564	361257	1.9	na	na
PG19-SS-OSR1	1285718	361584	1285721	361586	4.1	na	na
PG19-SS-OSR2	1286128	361353	1286128	361354	1.2	na	na

[a] Washington North Zone, NAD83 state plane coordinates – US survey feet.

ID – identification
MLLW – mean lower low water
na – not applicable
NAD83 – North American Datum of 1983

Source: Table 1 from Windward (2019c)

Table 3. Marina dioxin/furan TEQs

Sample	Dioxin/Furan TEQ (ng/kg)
EM-19-SS01	11.1 J
EM-19-SS02	17.3 J
EM-19-SS03	8.42 J
EM-19-SS04	5.50 J
EM-19-SS05	15.9 J
EM-19-SS06	3.48 J
EM-19-SS07	5.68 J
EM-19-SS08	10.4 J
EM-19-SS09	9.71 J
EM-19-SS10	9.06 J
EM-19-SS10-FD	7.48 J
EM-19-SS11	3.68 J
EM-19-SS12	14.1 J
EM-19-SS13	9.62 J
EM-19-SS14	8.57 J
EM-19-SS15	4.17 J
EM-19-SS16	11.5 J
EM-19-SS17	7.29 J
EM-19-SS18	6.95 J
EM-19-SS19	5.93 J
EM-19-SS20	6.61 J

J – estimated concentration
TEQ – toxic equivalent
FD – field duplicate

Table 4. ESY sediment concentrations compared to SMS criteria

Chemical	SMS Criteria		ESY-1		ESY-2	ESY-3
	SCO	CSL	ESY-1	ESY-1-FD		
Carbon-Normalized SVOCs (mg/kg OC)						
2-Methylnaphthalene	38	64	2.63	1.92	0.740	1.45
Acenaphthene	16	57	7.83	6.15	0.680	1.24
Acenaphthylene	66	66	1.14	0.908	0.419	0.834
Anthracene	220	1,200	4.78	3.47	1.53	3.55
Benzo(a)anthracene	110	270	10.3	7.47	2.48	6.56
Benzo(a)pyrene	99	210	5.74	4.13	2.02	3.97
Benzo(g,h,i)perylene	31	78	2.78	1.79	1.10	1.89
Total benzofluoranthenes	230	450	19.8	14.2	3.43	13.2
Chrysene	110	460	12.5	8.79	3.53	9.62
Dibenzo(a,h)anthracene	12	33	0.836	0.534	0.322	0.576
Fluoranthene	160	1200	51.1	32.0	7.07	13.4
Fluorene	23	79	4.46	3.36	1.00	2.10
Indeno(1,2,3-cd)pyrene	34	88	2.49	1.83	0.978	1.87
Naphthalene	99	170	6.64 J	4.81 J	1.87 J	3.31 J
Phenanthrene	100	480	11.3	7.64	3.01	6.11
Pyrene	1,000	1,400	41.6	25.6	8.84	16.7
Total HPAHs	960	5,300	127	82.1	26.4	54.6
Total LPAHs	370	780	36.2 J	26.3 J	8.51 J	17.1 J
Dibenzofuran	15	58	4.09	2.83	0.978	1.87
Dry-Weight-Normalized SVOCs (µg/kg dw)						
2,4-Dimethylphenol	29	29	12.9 J	10.5 J	5.90 J	5.40 J
Conventionals (%)						
TOC	-	-	1.52	1.74	1.81	1.57

CSL – cleanup screening level
dw – dry weight
ESY – Everett Shipyard
FD – field duplicate
J – estimated concentration
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
OC – organic carbon
PAH – polycyclic aromatic hydrocarbon
SCO – sediment cleanup objective
SMS – Washington State Sediment Management Standards
SVOC – semivolatile organic compound
TOC – total organic carbon

Table 5. Port Gardner dioxin/furan TEQs

Sample	Dioxin/Furan TEQ (ng/kg)
PG19-SS01	6.17 J
PG19-SS02	1.01
PG19-SS02-FD	1.08
PG19-SS03	0.490 J
PG19-SS04	0.890 J
PG19-SS05	3.23 J
PG19-SS06	2.30 J
PG19-SS07	2.22 J
PG19-SS-OSR1	0.777 J
PG19-SS-OSR2	2.29 J

J – estimated concentration
TEQ – toxic equivalent
FD – field duplicate