CENWS-OD-TS-DMMO

MEMORANDUM FOR: RECORD February 25, 2016

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM PHASE 2 OF THE PORT OF TACOMA'S PIER 4 RECONFIGURATION PROJECT EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT FOR UNCONFINED OPEN-WATER DISPOSAL AT THE COMMENCEMENT BAY DISPOSAL SITE.

1. Introduction. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington State Department of Ecology, Washington State Department of Natural Resources, and the Environmental Protection Agency) regarding the suitability of up to 500,000 cubic yards (cy) of dredged material from the Port of Tacoma's Pier 4 Reconfiguration Phase 2 project for open-water disposal at the Commencement Bay nondispersive disposal site, and for compliance with the State of Washington Antidegradation Policy.

2. Background. In early 2013 the Port of Tacoma (Port) proposed dredging of approximately 560,000 cy of material to cutback and reconfigure Pier 4 to be in alignment with Pier 3 within Husky Container Terminal on the Blair Waterway (see Figure 1 for site vicinity and Figure 2 for project location, extent, and areas). During sediment sampling in April 2013 for characterization of the proposed dredged material, levels of porewater tributyltin (TBT) were found within in-water Area A exceeding the DMMP bioaccumulation trigger (BT) for porewater TBT of 0.15 μg/L. Subsequent sampling events in August and November 2013 to determine the extent of TBT contamination measured TBT in bulk sediments due to holding time constraints, challenges in collecting porewater, and cost. Results of these sampling events revealed very high levels of TBT in bulk sediment analyses, up to 50,000 μg/kg, nearly three orders of magnitude above the DMMP bulk TBT BT of 73 μg/kg, within in-water Areas A and B.

   A fourth sampling event in July 2014 was conducted under an Agreed Order on Consent (AOC; EPA, 2014) between the Environmental Protection Agency CERCLA program (EPA) and the Port of Tacoma to determine the vertical and horizontal extent of TBT contamination at Pier 4. Following review of the preliminary results of the July sampling event, EPA determined that cleanup of the TBT-contaminated sediments was to proceed as a CERCLA Time Critical Removal Action. Therefore, the work occurring at Pier 4 has been divided into two distinct work phases: (1) the Phase 1 Removal Action, which includes an EPA-ordered cleanup of contaminated sediment, and (2) the Phase 2 Reconfiguration Project, which includes cut-back dredging of the remaining sediments and reconfiguration of the pier. A brief description of the work associated with each phase of the project follows:

   Phase 1
   Removal of approximately 70,000 cy of TBT-contaminated sediment has taken place under an AOC between the Port of Tacoma and EPA (EPA, 2015). Prior to removal of the contaminated material along the slope and at the pier face, the clean upper portion of the slope was dredged to maintain slope stability (see Figure 3). A suitability determination for this 11,300 cy of clean Phase 1 top-of-

slope dredged material was issued on January 8, 2015 (DMMP, 2015a). An overlying layer of rip-rap was removed and re-handled upland, and the suitable dredged material was disposed at the Commencement Bay open-water disposal site.

Phase 2

Following completion of Phase 1, the Port will continue to cutback the Pier 4 shoreline and rebuild the pier to be in alignment with Pier 3. This work, which will include dredging of approximately 500,000 cy of material, is the subject of this suitability determination.

Confirmational Sampling Results

Following completion of Phase 1, sediment sampling was required to confirm that the goals of the Phase 1 removal action were met and that the concentrations of TBT in the sediments left behind following Phase 1 dredging met DMMP guidelines for open-water disposal. The details of the confirmational sampling plan are outlined in the Removal Action Work Plan (Floyd|Snider, 2015a), the November 30th Pier 4 Phase 1 – Additional Confirmational Sampling Approach Memo (Floyd|Snider, 2015b) and the January 21st Post Dredge Confirmational Sampling Plan Addendum (Floyd|Snider, 2016a). DMU stations are located in the dredging prism footprint, while PR stations are located in the perimeter areas adjacent to the dredge prism. In addition to the locations outlined in the RAWP, five additional discretionary sample locations were identified and added to the sampling plan. These additional perimeter locations are identified as PR-22 to PR-26 and are shown in Figure 4. The Port also elected to conduct pore water analysis of TBT on a subset of samples from the hot spot, non-hot spot and perimeter areas.

Confirmational samples were collected on January 4-5, 2016 by Marine Sampling Services, Inc. Results of both porewater and bulk TBT concentrations are shown in Table 1 and Figure 5. Exceedances of the bulk TBT bioaccumulation trigger were observed in DMUs 3 and 6, and perimeter samples PR-10, PR-11, PR-12, PR-16, PR-17, PR-18, PR-19, and PR-26. Exceedances of the porewater TBT BT (0.15 ug/L) were observed for at least one depth interval in five of the seventeen DMUs from within the dredging footprint. It was notable that exceedances of the porewater BT did not correlate with those of the bulk BT. For example, the 10-20 cm sample from DMU 6 had a bulk value of 61 μg/kg, below the bulk BT of 73 μg/kg, but the porewater result was 2.2 μg/L, more than ten times the porewater BT of 0.15 μg/L. Similarly, in the 0-10 cm sample from DMU 8 the bulk TBT value was 39 μg/kg, well below the bulk BT of 73 μg/kg, but the porewater TBT value was 0.29 μg/L, almost twice the porewater BT.

Porewater TBT results are considered a better evaluation of the bioavailability of TBT in sediments and thus porewater TBT results trump bulk results (DMMP, 2015b). Considering this, EPA determined, in conjunction with the DMMP, that additional dredging was warranted to remove remaining TBT-contaminated sediments associated with Phase 1. Additional dredging of DMUs 3, 4, 6, 7, and 8 was conducted to remove at least one foot past the Phase 1 design depth. Dredging a minimum 1-ft lift in eleven of the perimeter DMUs was also required by EPA.

Following the first additional round of dredging, a second round of confirmational sampling limited to DMUs 3, 4, 6, 7, and 8 was required by EPA and the DMMP agencies to verify that all the remaining TBT-contaminated sediments had been removed and that the remaining surface of the proposed Phase 2 prism was suitable for open-water disposal during Phase 2. The second round of sampling

included collection of grab samples for analysis of pore water and core samples to bound the vertical extent of bulk TBT contamination, should additional dredging be necessary. In order to expedite decision-making and finish dredging as soon as possible within the fish window, the second round of confirmational sampling was split into two events as described below. Results are summarized in Table 2 and Figure 6.

- The first event involved collection of grab samples and cores immediately following completion of dredging in DMUs 3, 4, 6, 7, and 8, but during dredging in adjacent perimeter DMUs. On January 27th, vibracores and grab samples were collected from DMUs 4 and 6, and cores were collected from DMUs 3, 7, and 8. The goal of grab sampling at that time was to provide an early warning of whether porewater TBT concentrations in the 0-10cm depth interval were still exceeding the DMMP BT. The goal of the coring was to collect sufficient material for porewater TBT analysis from the 10cm - 2ft and 2ft - 4ft intervals. Therefore, multiple cores were collected from each location in order to provide enough sediment for porewater extraction. Despite these efforts, the material consisted of consolidated sands, likely native material, and the laboratory was not able to extract sufficient porewater for TBT analysis from any of the core samples. Therefore, only bulk TBT analysis was conducted for the 10cm - 2 ft, and 2 - 4 ft intervals.
- The second sampling event followed completion of dredging in the second row of perimeter DMUs. Grab samples were collected from DMUs 3, 4, 6, 7 and 8 on February 9th. The porewater collected from these samples was used (in conjunction with the data from the first event) to determine if the 0-10cm depth interval exceeded the TBT BT.

Based on the surface porewater results from the second confirmation sampling event (Table 2), EPA and the DMMP agencies determined that a second additional round of dredging was necessary within DMUs 3, 4, 6, 7, and 8 to remove the surface layer of TBT-contaminated sediment. The results from the core sampling showed that bulk TBT was either non-detect or detected at very low levels in both the 10cm - 2ft and 2 - 4ft intervals. Therefore, it was determined that no additional confirmation sampling was needed.

Prior to the second round of dredging, the existing bathymetric elevations in DMUs 4 and 6 were deep enough that no additional dredging in Phase 2 would be needed. However, in association with the Port's reassessment of the slope stability and the surface porewater results, EPA determined that additional dredging was needed in these two DMUs to remove the remaining surface TBT contamination. During dredging of DMU 4 the slope failed, resulting in slumping of material from the clean upper slope DMU 12 into DMUs 3 and 4. At the time of slope failure, dredging in DMU 4 stopped and EPA and the DMMP agencies determined that no further dredging was warranted due to the slope stability issue, the fact that any remaining contamination within DMU 4 was buried, and that the porewater TBT within DMU 4 was just slightly above the bioaccumulation trigger of 0.15 μg/L. If dredging within DMU 4 becomes necessary in Phase 2 due to the accumulation of slumped material above the project design depth, the accumulated material is considered suitable for open-water disposal.

The second and final round of dredging was performed in DMUs 3, 4, 6, 7, and 8 with dredging completed on February 17, 2016. EPA determined that the tributyltin-contaminated sediment under Pier 4 was completely removed (Parker, 2016). A Time Critical Removal Action Report will be

prepared for EPA and will document the above-described sampling and results in greater detail (Floyd|Snider, 2016b). The final report is expected to be completed by mid-July 2016.

3. Project Summary and Ranking. Table 3 includes project summary and tracking information.

Table 3. Project Summary

Project ranking	Phase 1: Moderate to High Phase 2: Moderate
Proposed dredging volume	500,000 CY
Proposed dredging depth	-53 ft MLLW (including 2 ft overdredge)
Sampling dates	Round 1: April 11-19, 2013
	Round 2: August 8-9, 2013
	Round 3: November 13-16, 2013
	Round 4: June 30 – July 9, 2014
Confirmational sampling dates	Confirmational #1: January 4-5, 2016
	Confirmational #2: January 27th, 2016 and February 9th, 2016
Draft data report received	October 15, 2014
Comments provided on draft report	November 17, 2014
Final data report received	November 24, 2014
EIM Study ID	POTP413
USACE Permit Application Number	NWS-2014-0456
Recency Expiration Dates	High rank = July 2017 Moderate rank = July 2019

This project was originally ranked moderate by the DMMP agencies according to a review of previous testing results and the guidelines set out in the DMMP User Manual for areas on the Blair Waterway (DMMP, 2013). However, as a result of the high levels of TBT contamination found in the sediments along Pier 4, the in-water DMMUs (Areas A and B) are now considered to be high-ranked areas.

Areas C and D maintain the rank of moderate. In a moderate-ranked area the number of samples and analyses are calculated using the following guidelines (DMMP, 2013):

- Maximum volume of sediment represented by each field sample = 4,000 cubic yards
- Maximum volume of sediment represented by each analysis in the upper 4-feet of the dredging prism (surface sediment) = 16,000 cubic yards
- Maximum volume of sediment represented by each analysis in the subsurface portion of the dredging prism = 24,000 cubic yards,

A portion of the upland DMMUs are presumed to be located in native material and therefore don't require testing under DMMP. Sediment cores and upland bores at nearly all locations were collected to depths well into the native layer, and the material was analyzed to a depth that either

reached native or where the results were all non-detects. The volume of non-native material characterized during the first round of sampling was 199,600 cubic yards.

4. Sampling.

Sediment characterization occurred over four sampling events between April 2013 and July 2014 and employed a variety of different sampling techniques designed to address the specific sampling difficulties encountered, including penetrating through the rip-rap armored under-pier slope, sampling though the pier deck, and reaching depths up to 28-ft below mudline. All sampling activities were approved by the DMMP agencies and/or the EPA removal action project manager, and conducted in accordance with the approved SAP, SAP addendum and QAPP (Floyd|Snider, 2013a; Floyd|Snider, 2013b; Kendall, 2013; Floyd|Snider, 2014a). See Figure 2 for area outlines and sampling locations, and Table 4 for sampling location coordinates, sampling dates and methodologies.

Shoreline Cutback DMMUs

Sampling within the shoreline cutback DMMUs in Area C and Area D occurred in April 2013 and August 2014. During the initial sampling event in April 2013, four upland boring locations were occupied and sampled via direct push boring by Cascade Drilling of Woodinville, WA. Two borings from Area C, C1 and C2, and two from Area D, D1 and D2, were advanced from ground surface at +17 ft MLLW to a distance of 10 feet into native material. At each borehole, a discrete sample was collected every 4 feet until native was encountered. The presumed native interface was reached at approximately +5 ft MLLW at stations C1, C2, and D2, and at approximately +6.5 ft MLLW at station D1. Within each area these 4-foot subunits were composited into one sample representing that DMMU, see Table 5 for compositing information for all samples. Once native was reached, discrete samples were collected every 4 feet until reaching the bottom of the planned Z-layer (-55 ft MLLW). The native subunits were composited into one sample representing the native DMMUs across Areas C and D (DMMUs N1and N2).

In-water DMMUs

Sampling within the in-water DMMUs began in April 2013 and continued during sampling in August and November 2013 and July 2014. The original configuration of in-water DMMUs included a single homogeneous DMMU from Area A, and one surface and two subsurface DMMUs from Area B. Sampling within each area is described in detail below.

Area A – Five surface grab samples (0-10cm) were collected with a Power Grab sampler in April 2013 and composited into a single analysis for the full suite of DMMP COCs – DMMU A. Based on the porewater TBT exceedance seen in that sample, individual archives from each of the five grab samples were also analyzed, and the results showed elevated TBT in locations A4 and A5.

Area B – Three sediment cores were collected from locations B1, B2, and B3 by diver assisted MudMole, a submersible pneumatic impact corer owned and operated by AMEC. Diver assistance was performed by Research Support Services. The top 0-4 and 4-8 feet from each core location were composited into samples DMMU B1 and B2, respectively, and sent to the laboratory for analysis.

Three additional locations within Area B (B16, B17, and B18A) were sampled via barge-mounted roto-sonic drilling rig in July 2014 by Holt Services, Inc. of Edgewood, WA. Roto-sonic drilling uses

resonant sonic energy to exploit weaknesses in hard materials. This sampling methodology was chosen in order to sample sediment underneath the rip-rap armored slope.

5. Chemical Analysis. Analysis of conventionals and all standard DMMP COCs was conducted by Analytical Resources, Inc. of Tukwila, Washington. The approved sampling and analysis plan (Floyd|Snider, 2013a) was followed, and quality control guidelines specified by the DMMP program were generally met. All sediment sampling results are documented in the Pier 4 Phase 2 Reconfiguration Project Sediment Characterization Report (Floyd|Snider, 2014b).

   Results from the initial round of sampling in April 2013 showed that the upland cutback DMMUs (Areas C and D) were predominantly sand and gravel, with between 63 and 93% sand. The fines content (silt and clay) ranged from 5 to 17%. Total organic carbon (TOC) was variable, ranging from 0.12% to a high of 2.14%. All DMMP COC's within Areas C and D were less than DMMP screening levels (Table 6). Dioxin results from Areas C and D were all below the DMMP site management objective of 4 pptr TEQ (Table 7).

   Results from the initial round of sampling in April 2013 showed that the in-water DMMUs were predominantly sand, with between 57 - 66% sand. The fines content ranged from 33 - 37%. TOC ranged from 0.56 to 1.2 %. All DMMP COCs in Areas A and B DMMUs were below DMMP screening levels, with the exception of TBT which is described in more detail below. Dieldrin and heptachlor were originally reported as undetected at the reporting limit, which were above DMMP SLs for these compounds. The analytical laboratory determined there was no chance that these compounds were present in these samples down to the method detection limit. Therefore, the results in Table 6 for heptachlor and dieldrin are reported at the method detection limit. TBT results from locations B16, B17 and B18A are shown in Table 8 and discussed below. Dioxin results from Area B are all below the DMMP site management objective of 4 pptr TEQ (Table 7). Dioxin results from Area A are slightly above the site management objective of 4 pptr TEQ, but below the maximum allowed concentration of 10 pptr TEQ. The volume-weighted average dioxin concentration for all DMMUs is 0.989 pptr TEQ, well below the site management objective of 4 pptr TEQ. Considering that a significant volume of material from DMMU A was removed during Phase 1, and that an additional 400,000 cy of native material will also be dredged as part of Phase 2, this volume-weighted average is a worst case estimate of the actual volume-weighted average dioxin concentration that will be disposed at the Commencement Bay disposal site.

   Tributyltin

   As described above, porewater TBT in the composite grab from DMMU A was found at 1.8 μg/L, well above the DMMP BT of 0.15 μg/L. Based on subsequent sampling and analyses it was determined that the extremely high concentrations of TBT observed in DMMUs A and B would be best addressed through an EPA-ordered time critical removal action. Through the EPA process, the vertical and horizontal extent of the TBT contaminated sediments was identified and sediments exceeding the DMMP's bulk TBT BT of 73 μg/kg, or the porewater BT of 0.15 μg/L, were removed as part of the Phase 1 dredging. The results of the second round of confirmational sampling conducted in January and February 2016 and described in the introduction to this suitability determination demonstrated that TBT-contaminated sediments exceeding the DMMP porewater BT were removed and that the post-Phase 1 leave surface is suitable for open-water disposal.

6. Sediment Exposed by Dredging. The sediment to be exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) or the State's Antidegradation standard (Ecology, 2013) as outlined by DMMP guidance (DMMP, 2008).

   Within the in-water DMMUs in Areas A and B, the material that will be exposed at the completion of Phase 2 dredging is native material. The deep native material was not sampled and characterized in Areas A and B because cores were not deep enough, however, shallower samples from those areas that were characterized were compared to DMMP COCs and there were no SL exceedances of DMMP guidelines, other than for TBT. Chemical results from these areas were also compared to SMS criteria, and are shown in Table 9. All results from Areas A and B are below SMS criteria. Extensive testing of TBT occurred during Phase 1 post-dredge confirmational sampling in Areas A and B and results of cores collected during the second round of confirmational sampling showed that TBT was either non-detected or detected at very low levels (3-5 μg/kg TBT).

   Within the shoreline cutback Areas C and D, the native material representing the leave surface, the material that will be exposed by dredging, was characterized and compared to DMMP COCs. There were no SL exceedances of DMMP guidelines. Chemical results from these areas were also compared to SMS criteria, however, due to low TOC values in Area C and a portion of Area D, only two DMMUs were within the range (0.5 – 4%) recommended for carbon normalization (Michelsen 1992). Chemical results compared to SMS criteria are shown in Table 9. All results from Areas C and D are below SMS criteria.

   As demonstrated by the results of the above analysis, the sediment to be exposed by dredging is not considered to be degraded relative to the currently exposed sediment surface. On this basis the DMMP agencies conclude that this project is in compliance with the State of Washington anti-degradation policy.

7. Suitability Determination. This memorandum documents the evaluation of the suitability of sediment proposed for dredging from Phase 2 of the Port of Tacoma's Pier 4 Reconfiguration Project for open-water disposal at the Commencement Bay non-dispersive disposal site. The approved sampling and analysis plans were followed. The data gathered were deemed sufficient and acceptable for regulatory decision-making under the DMMP program.

   In summary, based on the results of the previously described testing, the DMMP agencies conclude that all 500,000 cy of dredged material are suitable for open-water disposal at the Commencement Bay non-dispersive disposal site. See sections 9 and 10 for additional considerations.

   At this time the only disposal option being considered for Phase 2 material is open-water disposal at the Commencement Bay disposal site. Additional coordination may be needed if an alternate disposal method or location is proposed. A determination regarding the suitability of the material for upland disposal must be coordinated with the local Health Department. Use of this material for beneficial use must be approved by the receiving site and coordinated with all applicable Federal and State resource agencies and Tribes.

This suitability determination does ***not*** constitute final agency approval of the project. During the public comment period that follows a public notice, the resource agencies and other stakeholders provide input on the overall project. A final decision will be made after full consideration of agency and stakeholder input, and after an alternatives analysis is done under section 404(b)(1) of the Clean Water Act.

A pre-dredge meeting with DNR, Ecology, EPA, and the Corps of Engineers is required at least 7 days prior to dredging. A dredging quality control plan must be developed and submitted to the Regulatory Branch of the Seattle District Corps of Engineers at least 7 days prior to the pre-dredge meeting. A DNR site use authorization must also be acquired.

8. Bulkhead. During Phase 1 pile removal and dredging a number of additional timber piles were encountered unexpectedly in the Phase 1 dredge prism. The Port of Tacoma reviewed their 1966 design plans from prior to the construction of the existing Pier 4, and discovered plans proposing the construction of a 4-step timber bulkhead within the terminal shoreline. The encountered piling were not from this structure, and no records were found conclusively documenting the construction of the timber bulkhead. However, it's unlikely that the current Pier 4 terminal area could have been hydraulically back-filled without some sort of bulkhead. Figure 7 shows the approximate location of the potential timber bulkhead superimposed over the Phase 1 and Phase 2 footprints and sample locations. Figures 8 and 9 are the original 1966 record drawings of the stepped timber bulkhead, which have been colored in to show the approximate extent of the bulkhead and associated hydraulically placed pad as indicated on Figure 7.

   The DMMP agencies held several meetings and conference calls with the Port of Tacoma to discuss the potential presence of the bulkhead and its impact on the Suitability Determination and overall project. The DMMP agencies carefully reviewed the design plans and sediment sampling activities, and concluded that the existing samples provide adequate characterization of the back fill material as long as the bulkhead was back-filled exclusively with hydraulically placed channel material. However, if the bulkhead was back-filled with material other than that from hydraulic dredging, additional information/data would be needed to determine its suitability.

   The Port of Tacoma has elected to dig several test pits prior to the start of Phase 2 dredging to determine if the bulkhead exists, and if so, to determine whether material other than hydraulically dredged material was used as back fill. If this investigation reveals evidence that any material other than hydraulically dredged material was placed within the timber bulkhead, the DMMP agencies must be contacted immediately. Additional sampling may be required to determine if the material is suitable for open-water disposal.

9. Debris Management. No debris is allowed to be disposed of at the Commencement Bay disposal site. A 1' x 1' debris screen must be on site and available for use as necessary during the entire project. In addition, a place to store debris (such as a debris barge) and the necessary equipment to separate and move any debris encountered must be available. Confirmation of removal of rip-rap and documentation/coordination of the lack of debris on the grid should be discussed in project planning documents, and will be discussed at the pre-dredge meeting.

   The DMMP agencies implemented a debris screening requirement following the 2015 SMARM in

order to prevent the disposal of solid waste and large debris at the open-water disposal sites (DMMP, 2015c). The proposed clarification states that "all projects must use a screen to remove debris unless it can be demonstrated that debris is unlikely to be present or that the debris present is large woody debris that can be easily observed and removed by other means during dredging." For the purposes of debris management, the Phase 2 dredge prism is divided into three areas with different debris screening requirements, as follows:

Area 1. This is the in-water portion of the project on the southern end of the former pier where no dredging during Phase 1 occurred. This area is currently covered by a rip-rap armored slope. The rip-rap must be removed prior to dredging in this area. In addition, a 1' x 1' mesh grid must be used during the first pass of dredging in this area, and until no debris is retained on the grid.

Area 2. This is the in-water portion of the project that was dredged during Phase 1. A debris screen will be required to be used until the dredging shows that no more debris is present under any of the following situations:

1) Demolition and dredging of the four-step timber bulkhead (if present),
2) An unexpected structure or debris such as piling are encountered,
3) Dredging in areas, including adjacent downslope areas, where rip-rap or other materials remain or were placed to stabilize the slope prior to Phase 2 dredging,
4) Dredging in areas, including adjacent downslope areas, that have experienced slope instability and collapse at any time prior to the beginning of Phase 2.

Dredged material from any remaining portions of Area 2 that do not meet any of the above conditions will not require screening.

Area 3. This is the upland portion of the project. No debris screening is needed in this portion of the project. However, if an unexpected structure or debris is encountered, the debris screen must be used until no further debris is retained on the screen.

10. References.

DMMP, 2013. *Dredged Material Evaluation and Disposal Procedures (Users Manual)*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, July 2013.

DMMP, 2008. *Quality of Post-Dredge Sediment Surfaces (Updated).* A Clarification Paper Prepared by David Fox (USACE), Erika Hoffman (EPA) and Tom Gries (Ecology) for the Dredged Material Management Program, June 2008.

DMMP, 2015a. Determination Regarding the Suitability of Proposed Dredged Material from Phase 1 of the Port of Tacoma Pier 4 Cleanup and Reconfiguration Project Evaluated for Unconfined Open-water Disposal at the Commencement Bay Disposal Site or For Beneficial Use. January 8, 2015.

DMMP, 2015b. Final DMMP Clarification paper. Tributyltin (TBT) Measurement Basis. September 30, 2015.

DMMP, 2015c. Final DMMP Clarification Paper: Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites. October 2, 2015.

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

EPA, 2014. Administrative Settlement Agreement and Order on Consent for Removal Investigation in the Matter of: Blair Waterway TBT Site, Tacoma, Pierce County, Washington; Port of Tacoma, Respondent. June 13, 2014.

EPA, 2015. Administrative Settlement Agreement and Order on Consent for Time Critical Removal Action in the Matter of: Blair Waterway TBT Site, Tacoma, Pierce County, Washington; Port of Tacoma, Respondent. February 6, 2015

Floyd|Snider, 2013a. *Pier 4 Reconfiguration Project, Blair Waterway, Tacoma, WA Dredge Material Characterization Sampling and Analysis Plan*. Prepared by Floyd|Snider for the Port of Tacoma. April 10, 2013.

Floyd|Snider, 2013b. Pier 4 Reconfiguration Project Sampling and Analysis Plan Addendum. Prepared by Floyd|Snider for the Port of Tacoma. October 31, 2013.

Floyd|Snider, 2014a. Pier 4 Removal and Dredging Remediation Project - Additional Sediment Characterization Quality Assurance Project Plan. Prepared by Floyd|Snider for the Port of Tacoma. June 27, 2014

Floyd|Snider, 2014b. Pier 4 Phase 2 Reconfiguration Project Sediment Characterization Report. Prepared by Floyd|Snider for the Port of Tacoma. November 24, 2014.

Floyd|Snider, 2015a. Pier 4 Phase 1 Removal Action Project, Removal Action Work Plan, Prepared by Floyd|Snider for the Port of Tacoma. January 27, 2015

Floyd|Snider, 2015b. Pier 4 Phase 1 - Additional Confirmational Sampling Approach Memo. Prepared by Floyd|Snider for the Port of Tacoma. November 30, 2015

Floyd|Snider, 2016a. Post Dredge Confirmational Sampling Plan Addendum Pier 4 Phase 1 Removal Action Project. Prepared by Floyd|Snider for the Port of Tacoma. January 21, 2016.

Floyd|Snider, 2016b. Pier 4 Phase 1 Time Critical Removal Action Report. Prepared by Floyd|Snider for the Port of Tacoma. In preparation.

Kendall, 2013. Email from David Kendall to Jessi Massingale, David Fox, Celia Barton, Laura Inouye, and Justine Barton, Re: Pier 4 TBT Discrete Results and New Steps. July 16, 2013.

Michelsen, T. C. (1992). *Organic carbon normalization of sediment data.* Technical Information Memorandum. Washington Department of Ecology, Olympia, WA

Parker, 2016. Letter from Kathy Parker to Port of Tacoma. EPA Region 10, Seattle WA. February 18, 2016.

11. Agency Signatures.

The signed copy is on file in the Dredged Material Management Office

Concur:

_____	_____
Date	Kelsey van der Elst - Seattle District Corps of Engineers
_____	_____
Date	Justine Barton - Environmental Protection Agency
_____	_____
Date	Erika Hoffman - Environmental Protection Agency
_____	_____
Date	Laura Inouye, Ph.D. - Washington Department of Ecology
_____	_____
Date	Celia Barton - Washington Department of Natural Resources

Copies furnished:

DMMP signatories

Scott Hooton, Port of Tacoma

Mark Rettman, Port of Tacoma

Jessi Massingale, Floyd|Snider

Erin Murray, Floyd|Snider

Olivia Romano, USACE Regulatory Project Manager

Table 1. First Round Post-Dredge Confirmational and Perimeter TBT Bulk and Porewater and TOC Sample Results

				Tributyltin Bulk Sediment	Tributyltin Porewater	Total Organic Carbon
			DMMP Screening Level	73	0.15	--
Area	Sample ID	Sample Date	Depth	µg/kg	µg/L	%
Post-Dredge Confirmational Samples						
DMU-1	DMU1-0-10	01/04/2016	0–10 cm	36	0.029	0.503
	DMU1-10-20	01/04/2016	10–20 cm	7.9 J	NA	NA
	DMU1-0-1'	01/04/2016	0–1 ft	16	NA	NA
DMU-2	DMU2-0-10	01/04/2016	0–10 cm	8.9	0.15	0.315
	DMU2-10-20	01/04/2016	10–20 cm	2.6 U	NA	NA
DMU-3	DMU3-0-10	01/04/2016	0–10 cm	**120**	**0.56**	NA
	DMU3-10-20	01/04/2016	10–20 cm	**320**	NA	NA
	DMU3-0-1'	01/04/2016	0–1 ft	44 J	NA	0.689
DMU-4	DMU4-0-10	01/04/2016	0–10 cm	33	**0.64**	0.534
	DMU4-10-20	01/04/2016	10–20 cm	42	**0.32**	0.384
DMU-5	DMU5-0-10	01/04/2016	0–10 cm	1.1 JQ	NA	0.132
	DMU5-10-20	01/04/2016	10–20 cm	2.6 U	NA	NA
DMU-6	DMU6-0-10	01/04/2016	0–10 cm	**120**	**0.56**	0.63
	DMU6-10-20	01/04/2016	10–20 cm	61	**2.2**	0.33
DMU-7	DMU7-0-10	01/04/2016	0–10 cm	41	**0.63**	0.241
	DMU7-10-20	01/04/2016	10–20 cm	24	NA	NA
DMU-8	DMU8-0-10	01/04/2016	0–10 cm	39	**0.29**	0.442
	DMU8-10-20	01/04/2016	10–20 cm	27	NA	NA
DMU-9	DMU-43:619	01/04/2016	0–10 cm	16	0.14	0.763
	DMU9-10-20	01/04/2016	10–20 cm	2.1 JQ	NA	NA
DMU-10	DMU10-0-10	01/04/2016	0–10 cm	1.8 JQ	NA	0.29
	DMU10-10-20	01/04/2016	10–20 cm	4	NA	0.122
DMU-11	DMU11-0-10	01/05/2016	0–10 cm	3.7 U	0.006 UJ	0.229
	DMU11-10-20	01/05/2016	10–20 cm	3.6 U	NA	NA
DMU-12	DMU12-0-10	01/05/2016	0–10 cm	2.9 JQ	NA	0.062
	DMU12-10-20	01/05/2016	10–20 cm	3.4 U	NA	NA
DMU-13	DMU13-0-10	01/05/2016	0–10 cm	3.7 U	NA	0.098
	DMU13-10-20	01/05/2016	10–20 cm	3.7 U	NA	NA
DMU-14	DMU14-0-10	01/05/2016	0–10 cm	3.6 U	NA	0.044
	DMU14-10-20	01/05/2016	10–20 cm	3.8 U	NA	NA
DMU-15	DMU15-0-10	01/05/2016	0–10 cm	3.6 U	NA	0.063
	DMU15-10-20	01/05/2016	10–20 cm	3.4 U	NA	NA
	DMU15-10-20-D	01/05/2016	10–20 cm	3.4 U	NA	NA
DMU-16	DMU16-0-10	01/05/2016	0–10 cm	3.4 U	NA	0.052
	DMU16-10-20	01/05/2016	10–20 cm	3.4 U	NA	NA
DMU-17	DMU17-0-10	01/05/2016	0–10 cm	3.6 U	NA	0.054
	DMU17-10-20	01/05/2016	10–20 cm	3.5 U	NA	NA
Perimeter Samples[4]						
PR-01	PR1-0-10	01/05/2016	0–10 cm	4.2	NA	NA
PR-02	PR2-0-10	01/05/2016	0–10 cm	4	NA	NA
PR-03	PR3-0-10	01/05/2016	0–10 cm	7.7	NA	NA
PR-04	PR4-0-10	01/05/2016	0–10 cm	49	NA	NA
PR-05	PR5-0-10	01/05/2016	0–10 cm	18	NA	NA
PR-06	PR6-0-10	01/05/2016	0–10 cm	70	NA	NA

Table 1. First Round Post-Dredge Confirmational and Perimeter TBT Bulk and Porewater and TOC Sample Results

				Tributyltin Bulk Sediment	Tributyltin Porewater	Total Organic Carbon
			DMMP Screening Level	73	0.15	--
Area	Sample ID	Sample Date	Depth	µg/kg	µg/L	%
Perimeter Samples (Cont.)[4]						
PR-07	PR7-0-10	01/05/2016	0–10 cm	33	NA	NA
PR-08	PR8-0-10	01/05/2016	0–10 cm	44	NA	NA
PR-09	PR9-0-10	01/05/2016	0–10 cm	52	NA	NA
PR-10	PR10-0-10	01/05/2016	0–10 cm	**130**	NA	NA
PR-11	PR11-0-10	01/05/2016	0–10 cm	**170**	NA	NA
PR-12	PR12-0-10	01/05/2016	0–10 cm	**160**	NA	NA
PR-13	PR13-0-10	01/05/2016	0–10 cm	62	NA	NA
PR-14	PR14-0-10	01/04/2016	0–10 cm	46	NA	NA
PR-15	PR15-0-10	01/04/2016	0–10 cm	7	**0.16**	0.527
PR-16	PR16-0-10	01/04/2016	0–10 cm	**97**	**1.4**	0.57
PR-17	PR17-0-10	01/04/2016	0–10 cm	**120**	**1.7**	0.392
PR-18	PR18-0-10	01/04/2016	0–10 cm	**93**	**0.32**	0.245
PR-19	PR19-0-10	01/05/2016	0–10 cm	**160**	NA	NA
PR-20	PR20-0-10	01/04/2016	0–10 cm	5.5	NA	NA
PR-21	PR21-0-10	01/04/2016	0–10 cm	22	**0.31**	0.371
	PR21-0-10-D	01/04/2016	0–10 cm	25	**0.23**	0.315
PR-22	PR22-0-10	01/04/2016	0–10 cm	14	NA	NA
	PR22-0-10-D	01/04/2016	0–10 cm	13	NA	NA
PR-23	PR23-0-10	01/04/2016	0–10 cm	67	NA	NA
PR-24	PR24-0-10	01/05/2016	0–10 cm	21	NA	NA
PR-25	PR25-0-10	01/05/2016	0–10 cm	23	NA	NA
PR-26	PR26-0-10	01/05/2016	0–10 cm	77	NA	NA
OF-1[5]	OF-1-0-10	01/05/2016	0–10 cm	4.2	NA	NA

Notes:

-- Not applicable.

BOLD Concentration exceeds the DMMP Screening Level.

1 Although the surface 0- to 10-cm water porewater result exceeds the DMMP Screening Level of 0.15 µg/L, the subsurface bulk TBT result was less than the DMMP Screening Level of 73 µg/kg; therefore, an additional dredge pass was conducted and no additional sampling was

2 For the second sampling event, sample DMU104-0-10 was a field duplicate of sample DMU4-0-10.

3 For the final sampling event, sample DMU104-0-10 was a field duplicate of sample DMU4-0-10.

4 Due to exceedances of bulk TBT concentrations in some perimeter grid cells and a lack of porewater data in any of the perimeter grid cells, as required by the USEPA/DMMP, all the perimeter grid cells were dredged 1 to 2 feet and no additional samples were collected or required.

5 The surface sediment sample was collected approximately 12 feet off the APM Terminal outfall associated with the dredged material water treatment system, as required by USEPA.

Abbreviations:

cm Centimeters
ft Feet
µg/kg Micrograms per kilogram
µg/L Micrograms per liter
NA Sample for respective analysis not collected or analyzed.
TBT Tributyltin
USEPA U.S. Environmental Protection Agency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the reporting limit and method detection limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit, which is considered to be an estimate.

Table 2. Second and Final Round Post-Dredge Confirmational TBT Bulk and Porewater Sample Results

					Tributyltin Bulk Sediment	Tributyltin Porewater	Total Organic Carbon
				DMMP Screening Level	73	0.15	--
Area	Sampling Event	Sample ID	Sample Date	Depth	µg/kg	µg/L	%
Post-Dredge Confirmational Samples							
DMU-3	2nd	DMU3-10cm-2'	01/29/2016	10 cm–2 ft	3.4 U	NA	NA
		DMU3-2-4	01/29/2016	2–4 ft	3.5 U	NA	NA
	Final	DMU3-0-10	02/09/2016	0–10 cm	NA	**0.24**[1]	NA
DMU-4	2nd	DMU4-0-10	01/30/2016	0–10 cm	NA	**0.23**	NA
		DMU104-0-10[2]	01/30/2016	0–10 cm	NA	**0.43**	NA
		DMU4-10cm-2'	01/29/2016	10 cm–2 ft	3.3 JQ	NA	NA
		DMU4-2-4	01/29/2016	2–4 ft	3.4 U	NA	NA
	Final	DMU4-0-10	02/09/2016	0–10 cm	NA	**0.19**[1]	NA
		DMU104-0-10[3]	02/09/2016	0–10 cm	NA	**0.16**[1]	NA
DMU-6	2nd	DMU6-0-10	01/30/2016	0–10 cm	NA	**1.4**	NA
		DMU6-10cm-2	01/30/2016	10 cm–2 ft	3.8 U	NA	NA
		DMU6-2-4	01/30/2016	2–4 ft	3.8 U	NA	NA
	Final	DMU6-0-10	02/09/2016	0–10 cm	NA	**0.61**[1]	NA
DMU-7	2nd	DMU7-10cm-2'	01/30/2016	10 cm–2 ft	3.4 U	NA	NA
		DMU7-2-4	01/30/2016	2–4 ft	3.8 U	NA	NA
	Final	DMU7-0-10	02/09/2016	0–10 cm	NA	**0.24**[1]	NA
DMU-8	2nd	DMU8-10cm-2'	01/29/2016	10 cm–2 ft	5.2	NA	NA
		DMU8-2-4	01/29/2016	2–4 ft	3.5 U	NA	NA
	Final	DMU8-0-10	02/09/2016	0–10 cm	NA	**0.35**[1]	NA

Notes:

BOLD Concentration exceeds the DMMP Screening Level.

1 Although the surface 0- to 10-cm water porewater result exceeds the DMMP Screening Level of 0.15 µg/L, the subsurface bulk TBT result was less than the DMMP Screening Level of 73 µg/kg; therefore, an additional dredge pass was conducted and no additional sampling was performed or required.

2 For the second sampling event, sample DMU104-0-10 was a field duplicate of sample DMU4-0-10.

3 For the final sampling event, sample DMU104-0-10 was a field duplicate of sample DMU4-0-10.

Abbreviations:

cm Centimeters
DMMP Dredged Material Management Program
ft Feet
µg/kg Micrograms per kilogram
µg/L Micrograms per liter
NA Sample for respective analysis not collected or analyzed.
TBT Tributyltin
USEPA U.S. Environmental Protection Agency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the reporting limit and method detection limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table 4. Sampling Coordinates, Date and Methodology

		Coordinates (NAD83)		Sampling Date	Sampling Methodology
		Northing (ft)	Easting (ft)		
Station	A1	713672.9	1166340.0	April 2013	Power Grab
	A2	713528.6	1166500.1		
	A3	713394.5	1166636.7		
	A4	713265.0	1166794.0		
	A5	713140.0	1166998.0		
	B1	712836.7	1167529.6	April 2013	MudMole Core
	B2	712667.6	1167685.3		
	B3	712524.2	1167839.9		
	B16	712803.1	1167530.7	July 2014	Roto-sonic Boring
	B17	712728.2	1167601.6		
	B18A	712753.7	1167519.1		
	C1	712933.8	1166950.1	April 2013	Direct-push Boring
	C2	712728.3	1167258.7		
	D1	712532.2	1167465.0	April 2013	Direct-push Boring
	D2	712400.4	1167646.8		

Table 5. Sampling and Compositing. Depths in ft MLLW

		DMMU A	DMMU B1	DMMU B2	DMMU C1	DMMU C2	DMMU C3	DMMU D1	DMMU D2	DMMU D3	DMMU N1	DMMU N2	B16	B17	B18A	Total
	SAP volume (CY):	16,100	14,400	15,200	16,500	13,500	13,300	16,200	14,400	13,900	24,600	24,800				89,000
Station	A1	-58.7	---	---	---	---	---	---	---	---	---		---	---	---	
	A2	-55.4	---	---	---	---	---	---	---	---	---		---	---	---	
	A3	-57.4	---	---	---	---	---	---	---	---	---		---	---	---	
	A4	-47.8	---	---	---	---	---	---	---	---	---		---	---	---	
	A5	-43.0	---	---	---	---	---	---	---	---	---		---	---	---	
	B1	---	-51.7 to -47.7	---	---	---	---	---	---	---	---		---	---	---	
	B2	---	-47.5 to -43.5	-43.5 to -39.5	---	---	---	---	---	---	---		---	---	---	
	B3	---	-47.0 to -43.0	-43.0 to -41.0	---	---	---	---	---	---	---		---	---	---	
	B16	---	---	---	---	---	---	---	---	---	---		-48.2 to -50.2 -50.2 to -52.2 -52.2 to -54.2	---	---	
	B17	---	---	---	---	---	---	---	---	---	---		---	-45.7 to -47.7	---	
	B18A	---	---	---	---	---	---	---	---	---	---		---	---	-23.9 to -25.9 -29.4 to -30.4 -30.4 to -32.4	
	C1	---	---	---	17 to 13	13 to 9	9 to 5	---	---	---	5 to 1.2	1.2 to -3	---	---	---	
	C2	---	---	---	17 to 13	13 to 9	9 to 5	---	---	---	5 to 1.2	1.2 to -3	---	---	---	
	D1	---	---	---	---	---	---	17 to 13	13 to 9	9 to 6.5	6.5 to 2.5	2.5 to -1.5	---	---	---	
	D2	---	---	---	---	---	---	17 to 13	13 to 9	9 to 5	5 to 1.2	1.2 to -3	---	---	---	

Table 6. Chemical results compared to DMMP regulatory guidelines.

CHEMICAL	DMMP Guidelines			DMMU A		DMMU A Duplicate		DMMU A2		DMMU B1		DMMU B2		DMMU C1		DMMU C2		DMMU C3		DMMU D1		DMMU D2		DMMU D3		DMMU N1		DMMU N1 Duplicate		DMMU N2	
	SL	BT	ML	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ
CONVENTIONALS																															
Gravel, %				8		5.2		---		1.4		0.4		18.8		1.6		1.6		31.5		1.7		0.4		0.9		---		2.5	
Sand, %				57.2		58.2		---		65.5		65.4		64.4		89.9		93.3		62.7		92.1		86.1		81.9		---		87.9	
Silt, %				25.1		26.1		---		26.3		29.2		14.2		7.9		4.2		4.5		5.1		11.9		14.1		---		8.2	
Clay, %				9.6		10.5		---		6.9		4.9		2.6		0.4		1		1.3		1.2		1.6		3.1		---		1.6	
Fines (Silt + Clay), %				34.8		36.6		---		33.2		34.2		16.8		8.4		5.1		5.9		6.2		13.6		17.1		---		9.7	
Total Solids, %				68.09		66.31		---		78.09		76.72		92.43		94.55		86.8		96.62		94.88		79.71		82.37		81.89		83.29	
Volatile Soilids, %				2.49		2.72		---		1.44		2.32		1.18		0.88		0.84		1.87		1		1.25		0.91		0.9		0.88	
Total Organic Carbon, %				1.11		1.14		---		0.557		0.556		0.285		0.136		0.12		2.14		1.28		0.357		0.333		0.404		0.363	
Total Sulfides, mg/kg				150	J	217	J	---		12.4	J	43	J	1.53	J	2.17	J	1.08	UJ	1	UJ			1.39	J	1.8	J	---		3.37	J
Total Ammonia, mg N/kg				4.35		5.96		---		4.1		12.1		0.1	U	0.1	U	0.11	U	0.09	U			0.35		0.76		0.94		1.94	
METALS (mg/kg dry)																															
Antimony	150	---	200	7	UJ	7	UJ	---		6	UJ	7	UJ	5	UJ	5	UJ	6	UJ	5	UJ	5	UJ	6	UJ	6	UJ	6	UJ	6	UJ
Arsenic	57	507	700	7	U	8		---		6	U	7	U	5	U	5	U	6	U	5	U	5	U	6	U	6	U	6	U	6	U
Cadmium	5.1	11.3	14.0	0.4		0.4		---		0.4		0.3		0.4		0.3		0.3		0.4		0.3		0.3		0.3		0.3		0.4	
Chromium	260	260	---	16		15.4		---		14.5		14.3		15.7		12.2		11.2		12				11.5		12.1		12.6		13.8	
Copper	390	1,027	1,300	30.5	J	213	J	---		18.8		18		13.4		10.9		9.8		11.3		12		10.5		11.1		11.1		11.4	
Lead	450	975	1,200	5		6		---		3		3	U	4		2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
Mercury	0.41	1.5	2.3	0.04		0.04		---		0.03	U	0.03	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.03	U	0.03	U	0.02	U
Selenium	---	3	---	0.7	U	0.7	U	---		0.6	U	0.6	U	0.5	U	0.5	U	0.6	U	0.5	U	0.5	U	0.6	U	0.6	U	0.6	U	0.6	U
Silver	6.1	6.1	8.4	0.4	U	0.4	U	---		0.4	U	0.4	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.4	U	0.4	U	0.4	U	0.4	U
Zinc	410	2,783	3,800	43		58		---		30		24		22		20		18		27		17		17		19		20		21	
ORGANOMETALLIC COMPOUNDS																															
Tributyltin (porewater; µg/L)	0.15	0.15	---	**1.8**		**1.2**		---		0.084		---		---		---		---		---		---		---		---		---		---	
Tributyltin (bulk; µg/kg)	73	73	---	**1,000**		---		**690**		---		---		3.4	U	3	U	3.2	U	3.3	U	3	U	2.9	U	3.1	U	3.2	U	3.2	U
PAHs (ug/kg dry)																															
Total LPAH	5,200	---	29,000	1,000	J	400	J	---		28	J	22		19	U	19	U	18	U	28	U	18	U	19	U	18	U	10	J	9.8	J
Naphthalene	2,100	---	2,400	690	J	34	J	---		12	JQ	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Acenaphthylene	560	---	1,300	16	JQ	13	JQ	---		19	U	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Acenaphthene	500	---	2,000	46		55		---		19	U	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Fluorene	540	---	3,600	36		45		---		19	U	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Phenanthrene	1,500	---	21,000	170		200		---		16	JQ	22		19	U	19	U	18	U	28	U	18	U	19	U	18	U	10	JQ	9.8	JQ
Anthracene	960	---	13,000	55		51		---		19	U	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
2-Methylnaphthalene	670	---	1,900	35		28		---		19	U	16	JQ	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Total HPAH	12,000	---	69,000	2,400	J	1,900		---		180	J	38	U	21	J	37	U	36	U	56	U	37	U	37	U	37	U	37	U	36	U
Fluoranthene	1,700	4,600	30,000	550		650		---		28		19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Pyrene	2,600	11,980	16,000	830	J	590		---		64		19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Benzo(a)anthracene	1,300	---	5,100	220		140		---		14	JQ	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Chrysene	1,400	---	21,000	250		160		---		18	JQ	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Total benzofluoranthenes	3,200	---	9,900	310		200		---		31	JQ	38	U	11	JQ	37	U	36	U	56	U	37	U	37	U	37	U	37	U	36	U
Benzo[a]pyrene	1,600	---	3,600	130		88		---		14	JQ	19	U	9.7	JQ	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Indeno(1,2,3-c,d)pyrene	600	---	4,400	44		34		---		19	U	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U
Dibenzo(a,h)anthracene	230	---	1,900	17		16	JQ	---		3	JQ	4.8	U	4.8	U	4.6	U	4.5	U	7	U	4.6	U	4.6	U	4.6	U	4.6	U	4.4	U
Benzo(g,h,i)perylene	670	---	3,200	44		35		---		9.7	JQ	19	U	19	U	19	U	18	U	28	U	18	U	19	U	18	U	18	U	18	U

Table 6. Chemical results compared to DMMP regulatory guidelines.

CHEMICAL	DMMP Guidelines			DMMU A	DMMU A Duplicate	DMMU A2	DMMU B1	DMMU B2	DMMU C1	DMMU C2	DMMU C3	DMMU D1	DMMU D2	DMMU D3	DMMU N1	DMMU N1 Duplicate	DMMU N2
	SL	BT	ML														
CHLORINATED BENZENES (ug/kg dry)																	
1,2-Dichlorobenzene	35	---	110	3.2 JQ	4.8 U	---	4.8 U	4.8 U	4.8 U	4.6 U	4.5 U	7 U	4.6 U	4.6 U	4.6 U	4.6 U	4.4 U
1,4-Dichlorobenzene	110	---	120	2.7 JQ	4.8 U	---	4.8 U	4.8 U	4.8 U	4.6 U	4.5 U	7 U	4.6 U	4.6 U	4.6 U	4.6 U	4.4 U
1,2,4-Trichlorobenzene	31	---	64	4.8 U	4.8 U	---	4.8 U	4.8 U	4.8 U	4.6 U	4.5 U	7 U	4.6 U	4.6 U	4.6 U	4.6 U	4.4 U
Hexachlorobenzene	22	168	230	4.8 U	4.8 U	---	4.8 U	4.8 U	0.92 U	0.94 U	0.95 U	0.98 U	0.9 U	0.91 U	0.93 U	0.93 U	0.93 U
PHTHALATE ESTERS (ug/kg dry)																	
Dimethyl phthalate	71	---	1,400	4.8 U	4.8 U	---	4.8 U	4.8 U	4.8 U	4.6 U	4.5 U	7 U	4.6 U	4.6 U	4.6 U	4.6 U	4.4 U
Diethyl phthalate	200	---	1,200	170 J	48 UJ	---	48 U	48 U	48 U	46 U	45 U	70 U	46 U	46 U	46 U	46 U	44 U
Di-n-butyl phthalate	1,400	---	5,100	19 U	19 U	---	19 U	19 U	19 U	19 U	18 U	28 U	18 U	19 U	18 U	18 U	18 U
Butyl benzyl phthalate	63	---	970	5.3	6.2	---	4.8 U	4.8 U	4.8 U	4.6 U	4.5 U	7 U	20	4.6 U	4.6 U	4.6 U	4.4 U
Bis(2-ethylhexyl)phthalate	1,300	---	8,300	310 J	380	---	31 U	24 U	24 U	14 JQ	22 U	35 U	23 U	25	23 U	23 U	22 U
Di-n-octyl phthalate	6,200	---	6,200	19 U	19 U	---	19 U	19 U	19 U	19 U	18 U	28 U	18 U	19 U	18 U	18 U	18 U
PHENOLS (ug/kg dry)																	
Phenol	420	---	1,200	19	74	---	14 JQ	19 U	19 U	19 U	18 UJ	28 U	18 U	19 U	18 U	18 U	18 U
2 Methylphenol	63	---	77	2.4 JQ	3.6 JQ	---	4.8 U	4.8 U	4.8 U	4.6 U	4.5 UJ	7 U	4.6 U	4.6 U	4.6 U	4.6 U	4.4 U
4 Methylphenol	670	---	3,600	19 U	19 U	---	19 U	19 U	19 U	19 U	18 UJ	28 U	18 U	19 U	18 U	18 U	18 U
2,4-Dimethylphenol	29	---	210	3.4 JQ	2.8 JQ	---	19 U	19 U	19 U	19 U	18 UJ	28 U	18 U	19 U	18 U	18 U	2.8 JQ
Pentachlorophenol	400	504	690	48 U	48 U	---	48 U	48 U	48 UJ	46 UJ	45 UJ	70 UJ	190 J	14 JQ	46 UJ	46 UJ	44 UJ
MISCELLANEOUS EXTRACTABLES (ug/kg dry)																	
Benzoic acid	650	---	760	380 UJ	380 U	---	390 U	380 U	390 U	370 U	360 UJ	560 U	370 U	370 U	370 U	370 U	360 UJ
Benzyl alcohol	57	---	870	26	31	---	19 U	19 U	19 U	19 U	18 U	28 U	18 U	19 U	18 U	18 U	18 UJ
Dibenzofuran	540	---	1,700	60	41	---	19 U	19 U	19 U	19 U	18 U	28 U	18 U	19 U	18 U	18 U	18 U
Hexachlorobutadiene	11	---	270	4.8 U	4.8 U	---	4.8 U	4.8 U	0.92 U	0.94 U	0.95 U	0.98 U	0.9 U	0.91 U	0.93 U	0.93 U	0.93 U
N-Nitrosodiphenylamine	28	---	130	2.8 JQ	4.1 JQ	---	19 U	19 U	19 U	19 U	18 U	28 U	18 U	19 U	18 U	18 U	18 U
PESTICIDES (ug/kg dry)																	
Aldrin	9.5	---	---	2.5 U	2.5 U	---	2.4 U	2.4 U	0.46 U	0.47 U	0.47 U	0.49 U	0.45 U	0.46 U	0.46 U	0.46 U	0.46 U
Total Chlordane	2.8	37	---	2.5 U	2.5 U	---	2.4 U	2.4 U	0.46 U	0.47 U	0.47 U	0.49 U	1.8 UY	0.46 U	0.46 U	0.46 U	0.46 U
Dieldrin	1.9	---	---	0.5 U^{MDL}	0.5 U^{MDL}	---	0.49 U^{MDL}	0.49 U^{MDL}	0.92 U	0.94 U	0.95 U	0.98 U	0.9 U	0.91 U	0.93 U	0.93 U	0.93 U
Heptachlor	1.5	---	---	0.65 U^{MDL}	0.65 U^{MDL}	---	0.65 U^{MDL}	0.65 U^{MDL}	0.46 U	0.47 U	0.47 U	0.49 U	0.45 U	0.46 U	0.46 U	0.46 U	0.46 U
p,p'-DDE	9	---	---	5 U	5 U	---	4.9 U	4.9 U	0.92 U	0.94 U	0.95 U	0.98 U	0.9 U	0.91 U	0.93 U	0.93 U	0.93 UJ
p,p'-DDD	16	---	---	5 U	5 U	---	4.9 U	4.9 U	0.92 U	0.94 U	0.95 U	0.98 U	0.9 U	0.91 U	0.93 U	0.93 U	0.93 UJ
p,p'-DDT	12	---	---	5 U	5 U	---	4.9 U	4.9 U	0.92 U	0.94 U	0.95 U	1.2 UY	1.2 UY	0.91 U	0.93 U	0.93 U	0.93 UJ
Total DDT		50	69	5 U	5 U	---	4.9 U	4.9 U	0.92 U	0.94 U	0.95 U	1.2 UY	1.2 UY	0.91 U	0.93 U	0.93 U	0.93 UJ
PCBs (ug/kg dry)																	
Total PCBs	130	---	3,100	7.4 J	7.8 J	---	3.8 U	3.8 U	3.8 U	3.7 U	3.7 U	3.9 U	3.7 U	3.7 U	3.8 U	3.8 U	3.7 U
Total PCBs (mg/kg OC)	---	38	---	0.67 J	0.68 J	---	0.68 U	0.68 U	---	---	---	0.18 U	0.2891 U	---	---	---	---

J = estimated concentration
JQ = detected between the MDL and MRL, concentration is an estimate
U = undetected
U^{MDL} = not detected, reported by lab at the method detection limit
UJ = not detected, estimated at the reporting limit
UY = not detected, estimated at the reporting limit which is raised due to chromatographic interference

LQ = laboratory qualifier
OC = organic carbon
SL = screening level
BT = bioaccumulation trigger
ML = maximum level
bioaccumulation trigger exceedance

Table 7. Dioxin/Furan TEQ calculations

CHEMICAL	TEF	DMMU A				DMMU A Duplicate				DMMU B1				DMMU B2			
DIOXINS/FURANS		conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)
2,3,7,8-TCDD	1	0.258	U	0	0.129	0.219	U	0	0.1095	0.228	U	0	0.114	0.0516	U	0	0.0258
1,2,3,7,8-PeCDD	1	0.664	J	0.664	0.664	0.705	J	0.705	0.705	0.328	J	0.328	0.328	0.0357	U	0	0.01785
1,2,3,4,7,8-HxCDD	0.1	0.793	J	0.0793	0.0793	0.959	J	0.0959	0.0959	0.298	J	0.0298	0.0298	0.0516	U	0	0.00258
1,2,3,6,7,8-HxCDD	0.1	4.02		0.402	0.402	4.84		0.484	0.484	1.37	U	0	0.0685	0.0536	U	0	0.00268
1,2,3,7,8,9-HxCDD	0.1	1.99		0.199	0.199	2.3		0.23	0.23	0.797	U	0	0.03985	0.0536	U	0	0.00268
1,2,3,4,6,7,8-HpCDD	0.01	113		1.13	1.13	159		1.59	1.59	31.8		0.318	0.318	0.973	J	0.00973	0.00973
OCDD	0.0003	1,270		0.381	0.381	1,850		0.555	0.555	318		0.0954	0.0954	7.37	U	0	0.0011055
2,3,7,8-TCDF	0.1	1.3		0.13	0.13	1.21		0.121	0.121	0.434	U	0	0.0217	0.0397	U	0	0.001985
1,2,3,7,8-PeCDF	0.03	1.8	J	0.054	0.054	1.24	J	0.0372	0.0372	0.422	U	0	0.00633	0.0437	U	0	0.0006555
2,3,4,7,8-PeCDF	0.3	1.13		0.339	0.339	0.866	J	0.2598	0.2598	0.272	J	0.0816	0.0816	0.0357	J	0.01071	0.01071
1,2,3,4,7,8-HxCDF	0.1	4.26		0.426	0.426	3.3		0.33	0.33	0.843	J	0.0843	0.0843	0.0338	U	0	0.00169
1,2,3,6,7,8-HxCDF	0.1	1.24		0.124	0.124	1.05		0.105	0.105	0.42	J	0.042	0.042	0.0318	U	0	0.00159
1,2,3,7,8,9-HxCDF	0.1	0.957	J	0.0957	0.0957	0.907	J	0.0907	0.0907	0.266	J	0.0266	0.0266	0.0437	U	0	0.002185
2,3,4,6,7,8-HxCDF	0.1	0.527		0.0527	0.0527	0.598	J	0.0598	0.0598	0.45	U	0	0.0225	0.0357	U	0	0.001785
1,2,3,4,6,7,8-HpCDF	0.01	17.9		0.179	0.179	18.9		0.189	0.189	6.44		0.0644	0.0644	0.373	J	0.00373	0.00373
1,2,3,4,7,8,9-HpCDF	0.01	1.75		0.0175	0.0175	1.74	U	0	0.0087	0.474	J	0.00474	0.00474	0.0338	U	0	0.000169
OCDF	0.0003	55.6		0.01668	0.01668	51.9		0.01557	0.01557	12.6		0.00378	0.00378	0.929	J	0.0002787	0.0002787
TOTAL TEQ				4.290	4.419			4.868	4.986			1.079	1.352			0.024	0.087

CHEMICAL	TEF	DMMU C1				DMMU C2				DMMU C3				DMMU D1				DMMU D2			
DIOXINS/FURANS		conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)
2,3,7,8-TCDD	1	0.168	U	0	0.084	0.152	U	0	0.076	0.0279	U	0	0.01395	0.207	U	0	0.1035	0.028	U	0	0.014
1,2,3,7,8-PeCDD	1	0.737	J	0.737	0.737	0.0819	U	0	0.04095	0.0739	U	0	0.03695	0.561	J	0.561	0.561	0.032	U	0	0.016
1,2,3,4,7,8-HxCDD	0.1	0.707	J	0.0707	0.0707	0.0899	J	0.00899	0.00899	0.0439	U	0	0.002195	0.308	J	0.0308	0.0308	0.044	U	0	0.0022
1,2,3,6,7,8-HxCDD	0.1	1.88		0.188	0.188	0.244	J	0.0244	0.0244	0.194	U	0	0.0097	1.31		0.131	0.131	0.038	U	0	0.0019
1,2,3,7,8,9-HxCDD	0.1	1.32		0.132	0.132	0.174	J	0.0174	0.0174	0.0699	U	0	0.003495	0.647	J	0.0647	0.0647	0.048	U	0	0.0024
1,2,3,4,6,7,8-HpCDD	0.01	35.2		0.352	0.352	4.26	U	0	0.0213	3.79	U	0	0.01895	25.3		0.253	0.253	8.03	U	0	0.04015
OCDD	0.0003	321		0.0963	0.0963	42.5	U	0	0.006375	41.9	U	0	0.006285	469		0.1407	0.1407	3370		1.011	1.011
2,3,7,8-TCDF	0.1	0.42	U	0	0.021	0.0779	U	0	0.003895	0.0659	U	0	0.003295	0.107	J	0.0107	0.0107	0.028	U	0	0.0014
1,2,3,7,8-PeCDF	0.03	0.402	U	0	0.00603	0.0819	U	0	0.0012285	0.0559	J	0.001677	0.001677	0.0915	U	0	0.0013725	0.02	J	0.0006	0.0006
2,3,4,7,8-PeCDF	0.3	0.384	J	0.1152	0.1152	0.0639	U	0	0.009585	0.0339	U	0	0.005085	0.0517	J	0.01551	0.01551	0.032	U	0	0.0048
1,2,3,4,7,8-HxCDF	0.1	1.01		0.101	0.101	0.176	J	0.0176	0.0176	0.12	J	0.012	0.012	0.217	U	0	0.01085	0.034	J	0.0034	0.0034
1,2,3,6,7,8-HxCDF	0.1	0.503	J	0.0503	0.0503	0.0779	U	0	0.003895	0.0419	U	0	0.002095	0.141	J	0.0141	0.0141	0.032	U	0	0.0016
1,2,3,7,8,9-HxCDF	0.1	0.332	U	0	0.0166	0.0579	U	0	0.002895	0.0619	U	0	0.003095	0.0517	U	0	0.002585	0.04	U	0	0.002
2,3,4,6,7,8-HxCDF	0.1	0.763	J	0.0763	0.0763	0.0619	U	0	0.003095	0.0499	U	0	0.002495	0.131	U	0	0.00655	0.036	U	0	0.0018
1,2,3,4,6,7,8-HpCDF	0.01	7.5		0.075	0.075	0.977	J	0.00977	0.00977	1.27		0.0127	0.0127	9.08		0.0908	0.0908	0.0859		0.000859	0.000859
1,2,3,4,7,8,9-HpCDF	0.01	0.681	U	0	0.003405	0.0799	U	0	0.0003995	0.0818	U	0	0.000409	0.484	U	0	0.00242	0.0519	U	0	0.0002595
OCDF	0.0003	17	U	0	0.00255	2.33	U	0	0.0003495	2.78	U	0	0.000417	28.1		0.00843	0.00843	5.23	U	0	0.0007845
TOTAL TEQ				1.994	2.127			0.078	0.248			0.026	0.135			1.321	1.448			1.016	1.105

Table 7. Dioxin/Furan TEQ calculations

CHEMICAL	TEF	DMMU D3				DMMU N1				DMMU N1 Duplicate				DMMU N2			
DIOXINS/FURANS		conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)
2,3,7,8-TCDD	1	0.024	U	0	0.012	0.108	U	0	0.054	0.0279	U	0	0.01395	0.0276	U	0	0.0138
1,2,3,7,8-PeCDD	1	0.036	U	0	0.018	0.0539	U	0	0.02695	0.0577	U	0	0.02885	0.0434	U	0	0.0217
1,2,3,4,7,8-HxCDD	0.1	0.048	U	0	0.0024	0.0858	U	0	0.00429	0.0716	U	0	0.00358	0.0573	U	0	0.002865
1,2,3,6,7,8-HxCDD	0.1	0.05	U	0	0.0025	0.21	U	0	0.0105	0.161	J	0.0161	0.0161	0.142	U	0	0.0071
1,2,3,7,8,9-HxCDD	0.1	0.0519	U	0	0.002595	0.0898	U	0	0.00449	0.0756	U	0	0.00378	0.111	U	0	0.00555
1,2,3,4,6,7,8-HpCDD	0.01	1.06	U	0	0.0053	5.3	U	0	0.0265	3.95	U	0	0.01975	5.54	U	0	0.0277
OCDD	0.0003	228		0.0684	0.0684	62	U	0	0.0093	48.2	U	0	0.00723	65.7	U	0	0.009855
2,3,7,8-TCDF	0.1	0.014	U	0	0.0007	0.0319	U	0	0.001595	0.0458	U	0	0.00229	0.0336	U	0	0.00168
1,2,3,7,8-PeCDF	0.03	0.036	U	0	0.00054	0.0419	U	0	0.0006285	0.0617	J	0.001851	0.001851	0.0612	J	0.001836	0.001836
2,3,4,7,8-PeCDF	0.3	0.032	U	0	0.0048	0.0459	U	0	0.006885	0.0378	U	0	0.00567	0.0257	J	0.00771	0.00771
1,2,3,4,7,8-HxCDF	0.1	0.03	U	0	0.0015	0.124	J	0.0124	0.0124	0.0896	U	0	0.00448	0.109	J	0.0109	0.0109
1,2,3,6,7,8-HxCDF	0.1	0.028	U	0	0.0014	0.0579	U	0	0.002895	0.0378	U	0	0.00189	0.0671	J	0.00671	0.00671
1,2,3,7,8,9-HxCDF	0.1	0.036	U	0	0.0018	0.0719	U	0	0.003595	0.0478	U	0	0.00239	0.0296	U	0	0.00148
2,3,4,6,7,8-HxCDF	0.1	0.032	U	0	0.0016	0.0619	U	0.00619	0.00619	0.0418	U	0	0.00209	0.0257	U	0	0.001285
1,2,3,4,6,7,8-HpCDF	0.01	0.042	U	0	0.00021	1.42		0	0.0071	1.24		0.0124	0.0124	1.02		0.0102	0.0102
1,2,3,4,7,8,9-HpCDF	0.01	0.0579	U	0	0.0002895	0.0699	U	0	0.0003495	0.109	U	0	0.000545	0.079	U	0	0.000395
OCDF	0.0003	0.394	U	0	0.0000591	4.6	U	0	0.00069	3.09	U	0	0.0004635	3.04	U	0	0.000456
TOTAL TEQ				0.068	0.124			0.019	0.178			0.030	0.127			0.037	0.131

Project Volume-Weighted Average
0.989 pptr TEQ

Table 8. Tributyltin results from rotosonic drilling in Area B.

CHEMICAL	DMMP Guidelines			B16						B17		B18A					
	SL	BT	ML	-48.2 to -50.2		-50.2 to -52.02		-52.2 to -54.2		-45.7 to -47.7		-23.9 to -25.9		29.4 to -30.4		-30.4 to -32.4	
CONVENTIONALS				conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ	conc	LQ
Gravel, %				---		5.1		---		---		11.9		---		2	
Sand, %				---		76.5		---		---		49.9		---		89.1	
Silt, %				---		15.1		---		---		29		---		5.8	
Clay, %				---		3.4		---		---		9.1		---		3.1	
Fines (Silt + Clay), %				---		18.5		---		---		38.2		---		8.9	
Total Organic Carbon , %				0.216		1.13		---		---		0.862		---		0.114	
ORGANOMETALLIC COMPOUNDS																	
Tributyltin (bulk; µg/kg)	73	73	---	11		3.5	U	3.5	U	3.6	UJ	3.6	U	3.8	U	3.4	U

Table 9. Chemical results compared to SMS regulatory guidelines.

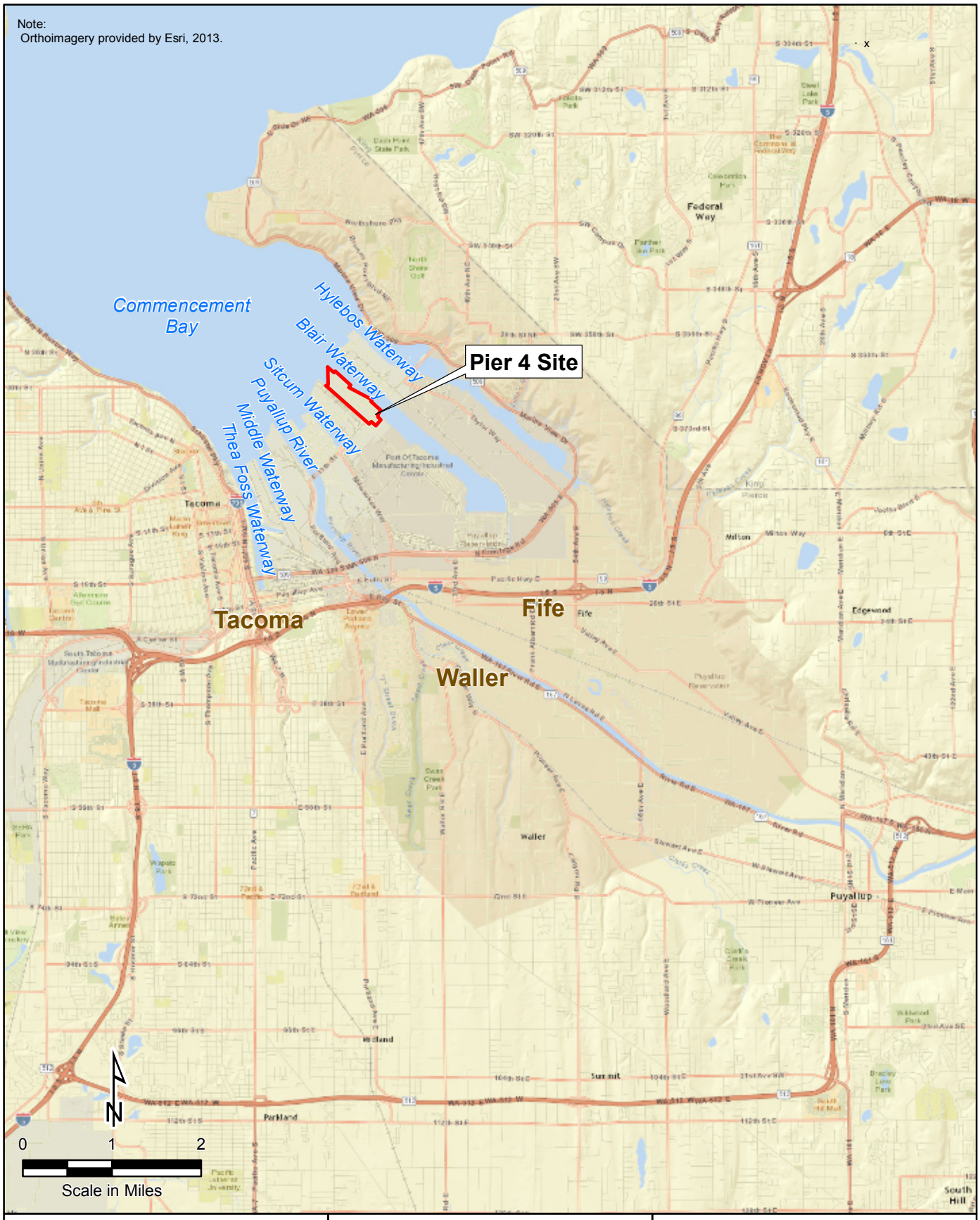
CHEMICAL	SMS Guidelines		DMMU A		DMMU A Duplicate		DMMU B1		DMMU B2		DMMU C1		DMMU C2		DMMU C3		DMMU D1		DMMU D2		DMMU D3		DMMU N1		DMMU N1 Duplicate		DMMU N2	
	SQS	CSL																										
Total Organic Carbon, %			1.11		1.14		0.557		0.556		0.285		0.136		0.12		2.14		1.28		0.357		0.333		0.404		0.363	
METALS (mg/kg dry)																												
Arsenic	57	93	7	U	8		6	U	7	U	5	U	5	U	6	U	6	U	5	U	6	U	6	U	6	U	6	U
Cadmium	5.1	6.7	0.4		0.4		0.4		0.3		0.4		0.3		0.3		0.3		0.4		0.3		0.3		0.3		0.4	
Chromium	260	270	16		15.4		14.5		14.3		15.7		12.2		11.2		14.9		12		11.5		12.1		12.6		13.8	
Copper	390	390	30.5	J	213	J	18.8		18		13.4		10.9		9.8		9.8		11.3		10.5		11.1		11.1		11.4	
Lead	450	530	5		6		3		3	U	4		2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
Mercury	0.41	0.59	0.04		0.04		0.03	U	0.03	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.02	U	0.03	U	0.03	U	0.02	U
Silver	6.1	6.1	0.4	U	0.4	U	0.4	U	0.4	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.4	U	0.4	U	0.4	U	0.4	U
Zinc	410	960	43		58		30		24		22		20		18		18		27		17		19		20		21	
PAHs (mg/kg OC)																												
Total LPAH	370	780	91	J	35	J	5	J	4		---		---		---		1.3	U	1.8	U	---		---		---		---	
Naphthalene	99	170	62	J	3	J	2.2	J	3.4	U	---		---		---		1.3	U	1.8	U	---		---		---		---	
Acenaphthylene	66	66	1.4	J	1.1	J	3.4	U	3.4	U	---		---		---		1.3	U	1.8	U	---		---		---		---	
Acenaphthene	16	57	4.1		4.8		3.4	U	3.4	U	---		---		---		1.3	U	1.8	U	---		---		---		---	
Fluorene	23	79	3.2		3.9		3.4	U	3.4	U	---		---		---		1.3	U	1.8	U	---		---		---		---	
Phenanthrene	100	480	15		18		2.9	J	4		---		---		---		1.3	U	1.8	U	---		---		---		---	
Anthracene	220	1200	5		4.5		3.4	U	3.4	U	---		---		---		1.3	U	1.8	U	---		---		---		---	
2-Methylnaphthalene	38	64	3.2		2.5		3.4	U	2.9	J	---		---		---		1.3	U	1.8	U	---		---		---		---	
Total HPAH	960	5300	220	J	170		33	J	6.8	U	---		---		---		2.6		3.7	U	---		---		---		---	
Fluoranthene	160	1200	50		57		5		3.4	U	---		---		---		1.3		1.8	U	---		---		---		---	
Pyrene	1000	1400	75	J	52		11		3.4	U	---		---		---		1.3		1.8	U	---		---		---		---	
Benzo(a)anthracene	110	270	20		12		2.5	J	3.4	U	---		---		---		1.3		1.8	U	---		---		---		---	
Chrysene	110	460	23		14		3.2	J	3.4	U	---		---		---		1.3		1.8	U	---		---		---		---	
Benzofluoranthenes	230	450	28		18		5.6	J	6.8	U	---		---		---		2.6		3.7	U	---		---		---		---	
Benzo(a)pyrene	99	210	12		8		2.5	J	3.4	U	---		---		---		1.3		1.8	U	---		---		---		---	
Indeno(1,2,3-c,d)pyrene	34	88	4		3		3.4	U	3.4	U	---		---		---		1.3		1.8	U	---		---		---		---	
Dibenzo(a,h)anthracene	12	33	2		1	J	0.54	J	0.86	U	---		---		---		0.33		0.5	U	---		---		---		---	
Benzo(g,h,i)perylene	34	88	4		3		1.7	J	3.4	U	---		---		---		1.3		1.8	U	---		---		---		---	
CHLORINATED BENZENES (mg/kg OC)																												
1,2-Dichlorobenzene	2.3	2.3	0.29	J	0.42	U	0.86	U	0.86	U	---		---		---		---		0.33	U	---		---		---		---	
1,4-Dichlorobenzene	3.1	9	0.24	J	0.42	U	0.86	U	0.86	U	---		---		---		---		0.33	U	---		---		---		---	
1,2,4-Trichlorobenzene	0.81	1.8	0.43	U	0.42	U	0.86	U	0.86	U	---		---		---		---		0.33	U	---		---		---		---	
Hexachlorobenzene	0.38	2.3	0.43	U	0.42	U	0.86	U	0.86	U	---		---		---		---		0.046	U	---		---		---		---	

Table 9. Chemical results compared to SMS regulatory guidelines.

CHEMICAL	SMS Guidelines		DMMU A		DMMU A Duplicate		DMMU B1		DMMU B2		DMMU C1		DMMU C2		DMMU C3		DMMU D1		DMMU D2		DMMU D3		DMMU N1		DMMU N1 Duplicate		DMMU N2	
	SQS	CSL																										
PHTHALATE ESTERS (mg/kg OC)																												
Dimethyl phthalate	53	53	0.43	U	0.42	U	0.86	U	0.86	U	---		---		---		---		0.33	U	---		---		---		---	
Diethyl phthalate	61	110	15	J	4.2	UJ	8.6	U	8.6	U	---		---		---		---		3.3	U	---		---		---		---	
Di-n-butyl phthalate	220	1700	1.7	U	1.7	U	3.4	U	3.4	U	---		---		---		---		1.3	U	---		---		---		---	
Butyl benzyl phthalate	4.9	64	0.48		0.54		0.86	U	0.86	U	---		---		---		---		0.33	U	---		---		---		---	
Bis(2-ethylhexyl)phthalate	47	78	28	J	33		5.6	U	4.3	U	---		---		---		---		1.6	U	---		---		---		---	
Di-n-octyl phthalate	58	4500	1.7	U	1.7	U	3.4	U	3.4	U	---		---		---		---		1.3	U	---		---		---		---	
PHENOLS (ug/kg dry)																												
Phenol	420	1200	19		74		14	JQ	19	U	19	U	19	U	18	UJ	18	UJ	28	U	19	U	18	U	18	U	18	U
2 Methylphenol	63	63	2.4	JQ	3.6	JQ	4.8	U	4.8	U	4.8	U	4.6	U	4.5	UJ	4.5	UJ	7	U	4.6	U	4.6	U	4.6	U	4.4	U
4 Methylphenol	670	670	19	U	19	U	19	U	19	U	19	U	19	U	18	UJ	18	UJ	28	U	19	U	18	U	18	U	18	U
2,4-Dimethylphenol	29	29	3.4	JQ	2.8	JQ	19	U	19	U	19	U	19	U	18	UJ	18	UJ	28	U	19	U	18	U	18	U	2.8	JQ
Pentachlorophenol	360	690	48	U	48	U	48	U	48	U	48	UJ	46	UJ	45	UJ	45	UJ	70	UJ	14	JQ	46	UJ	46	UJ	44	UJ
MISCELLANEOUS EXTRACTABLES (mg/kg OC)																												
Dibenzofuran	15	58	5.4		3.6		3.4	U	3.4	U	---		---		---		---		1.3	U	---		---		---		---	
Hexachlorobutadiene	3.9	6.2	0.43	U	0.42	U	0.86	U	0.86	U	---		---		---		---		0.046	U	---		---		---		---	
N-Nitrosodiphenylamine	11	11	0.25	J	0.36	J	3.4	U	3.4	U	---		---		---		---		1.3	U	---		---		---		---	
PCBs (mg/kg OC)																												
Total PCBs (mg/kg carbon)	12	65	0.67	J	0.68	J	0.68	U	0.68	U	---		---		---		---		0.18	U	---		---		---		---	
MISCELLANEOUS EXTRACTABLES (ug/kg dry)																												
Benzyl alcohol	57	73	26		31		19	U	19	U	19	U	19	U	18	U	18	U	28	U	19	U	18	U	18	U	18	UJ
Benzoic acid	650	650	380	UJ	380	U	390	U	380	U	390	U	370	U	360	UJ	360	UJ	560	U	370	U	370	U	370	U	360	UJ

J = estimated concentration
JQ = detected between the MDL and MRL, concentration is an estimate
U = undetected
UJ = not detected, estimated at the reporting limit
UY = not detected, estimated at the reporting limit which is raised due to chromatographic interference

QL = laboratory qualifier
OC = organic carbon
SMS = Sediment Management Standards
SQS = sediment quality standard
CSL = cleanup screening level

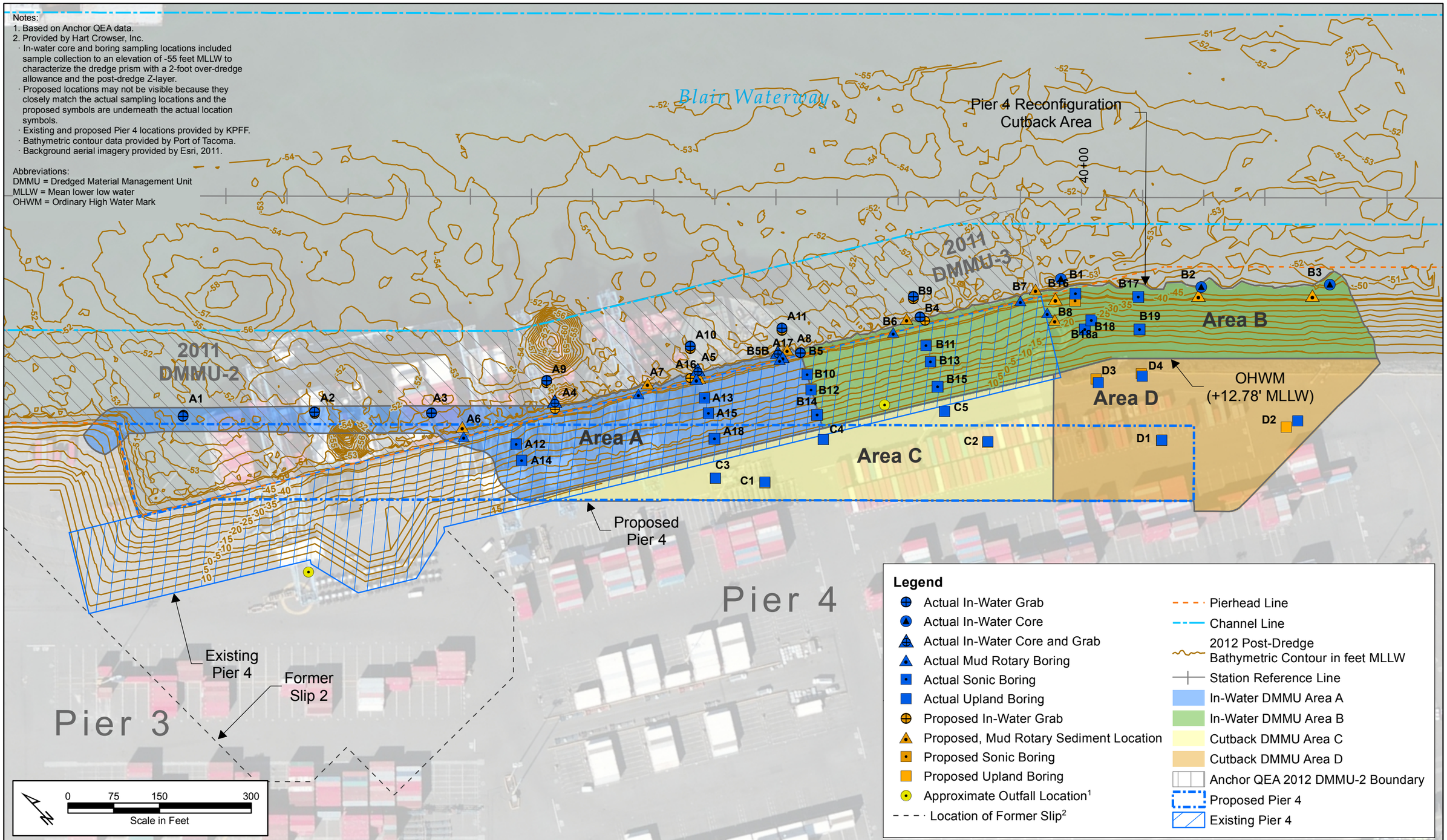


Port of Tacoma | FLOYD | SNIDER strategy • science • engineering

Sediment Characterization Report
Pier 4 Phase 2
Reconfiguration Project
Tacoma, Washington

Figure 1.1
Site Vicinity Map

I:\GIS\Projects\POT_Pier_4\MXD\Task 3030\Characterization Report\Figure 1.1 Site Vicinity Map.mxd
10/8/2014



Port of Tacoma

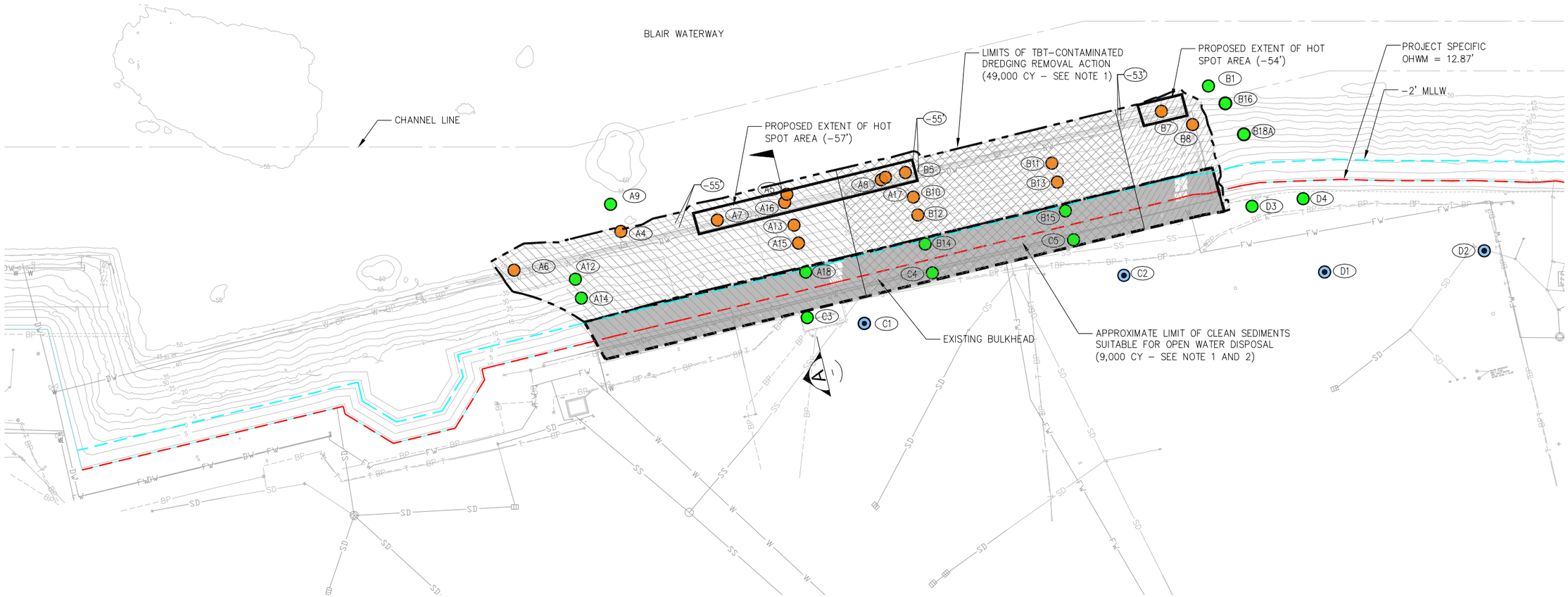
FLOYD | SNIDER
strategy • science • engineering

Sediment Characterization Report
Pier 4 Phase 2 Reconfiguration Project
Tacoma, Washington

Figure 2

Pier 4 DMMU Areas and Targeted and Actual Sampling Locations

I:\GIS\Projects\POT_Pier_4\MXD\Task 3030\Characterization Report\Figure 1.3 Pier 4 DMMU Areas and Sample Locations.mxd 10/8/2014



PHASE 1 DREDGE PLAN

SCALE: 1"=150'

LEGEND

- EXISTING CONTOUR
- (-51') TOE OF DREDGE, SEE NOTE 3
- (XX) SAMPLE LOCATION
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -55' MLLW AND UPPER 9FT OF SLOPE, SEE NOTE 3
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -55' MLLW AND UPPER 11FT OF SLOPE, SEE NOTE 3
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -53' MLLW AND UPPER 8FT OF SLOPE, SEE NOTE 3
- (A) CROSS SECTION LOCATION
- SAMPLE LOCATIONS WITH SEDIMENT SAMPLES CONTAINING TBT CONCENTRATIONS GREATER THAN THE DMMP SCREENING LEVEL OF 73 UG/KG
- SAMPLE LOCATIONS WHERE THERE ARE NO TBT EXCEEDANCES OF THE DMMP TBT SCREENING LEVEL (73 UG/KG) (SAMPLES ANALYZED FOR TBT ONLY)
- SAMPLE LOCATIONS WHERE THERE ARE NO CHEMICAL EXCEEDANCES OF THE DMMP SCREENING LEVELS FOR THE DMMP SUITE OF CHEMICALS OF CONCERN

NOTES

1. VOLUME IS APPROXIMATE AND INCLUDES THE 1-FOOT OVERDREDGE ALLOWANCE.
2. THE 2-FOOT RIP RAP ARMORED SLOPE MATERIAL (APPROXIMATELY 2,3000 CY) HAS BEEN DEDUCTED FROM THE VOLUME.
3. DREDGE DEPTHS DO NOT INCLUDE THE 1-FOOT OVERDREDGE ALLOWANCE.

PROJECT NORTH

kpff Consulting Engineers
101 Stewart Street, Suite 400
Seattle, Washington 98101
(206) 382-0600 Fax (206) 382-0500

PROPOSED SUITABILITY OF PHASE 1 PROJECT CLEAN MATERIAL
TACOMA, WASHINGTON

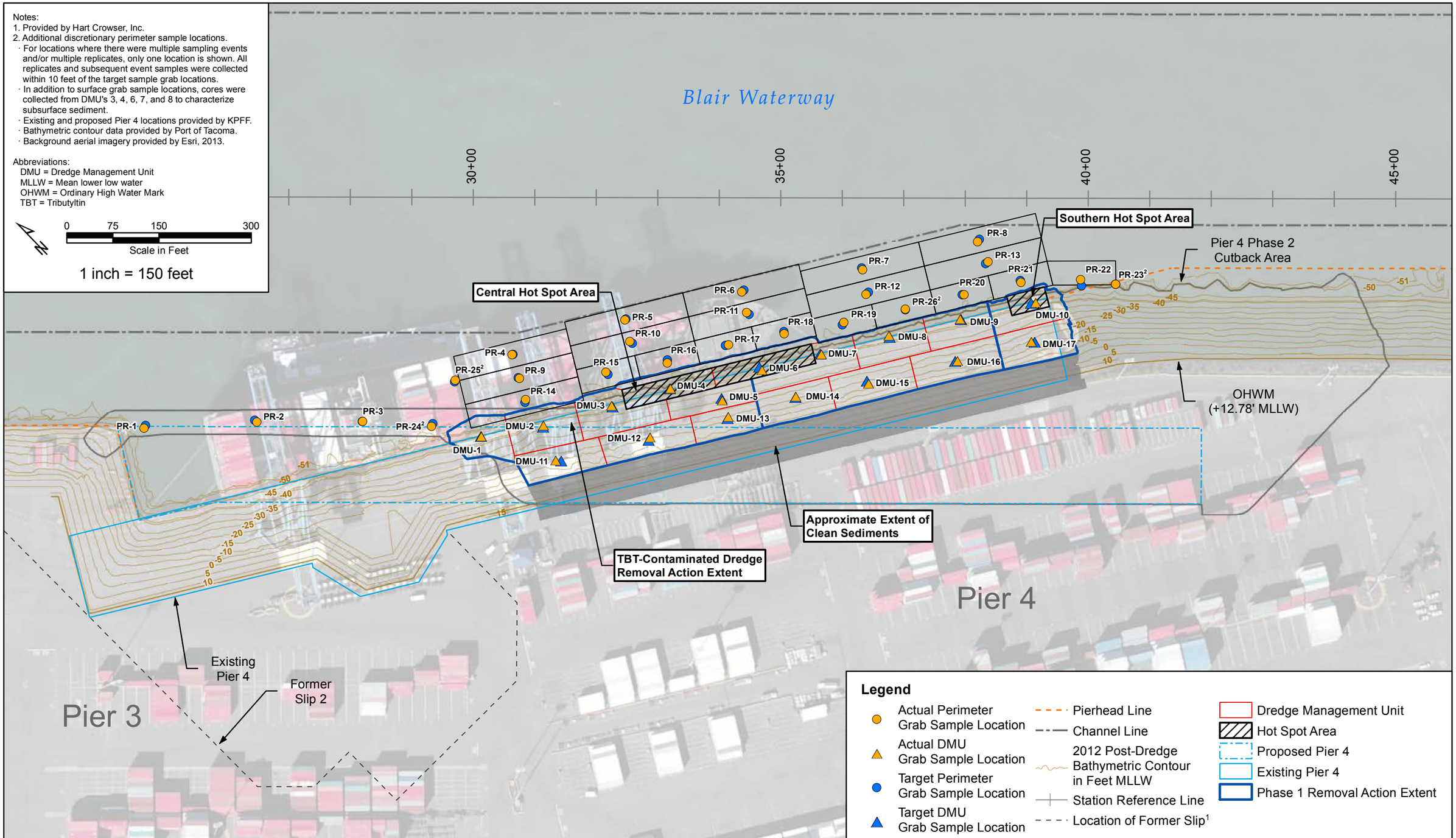
Figure 3 PHASE 1 DREDGE PLAN

DATE: DECEMBER 2014 | SCALE: 1" = 150'-0"

Notes:
1. Provided by Hart Crowser, Inc.
2. Additional discretionary perimeter sample locations.
   · For locations where there were multiple sampling events and/or multiple replicates, only one location is shown. All replicates and subsequent event samples were collected within 10 feet of the target sample grab locations.
   · In addition to surface grab sample locations, cores were collected from DMU's 3, 4, 6, 7, and 8 to characterize subsurface sediment.
   · Existing and proposed Pier 4 locations provided by KPFF.
   · Bathymetric contour data provided by Port of Tacoma.
   · Background aerial imagery provided by Esri, 2013.

Abbreviations:
DMU = Dredge Management Unit
MLLW = Mean lower low water
OHWM = Ordinary High Water Mark
TBT = Tributyltin

0 75 150 300
Scale in Feet
1 inch = 150 feet

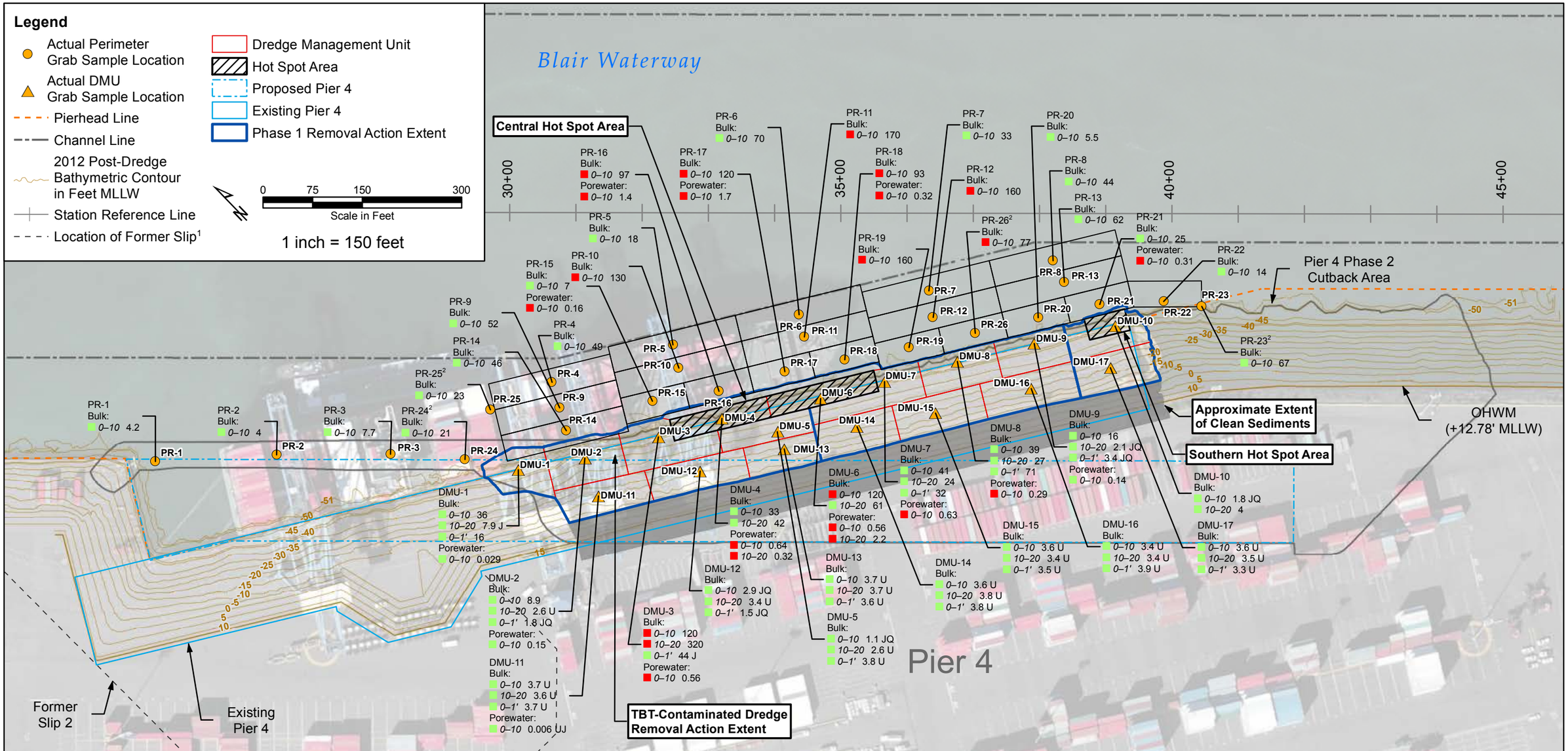


Port of Tacoma | FLOYD | SNIDER strategy • science • engineering

Pier 4 Phase 1 Removal Action Project
Tacoma, Washington

Figure 4.
Post-Dredge Confirmational and Perimeter Target and Actual Grab Sample Locations

I:\GIS\Projects\POT_Pier_4\MXD\Task 8040\Post-Dredge Confirmation Plan\Figure 1 Post-Dredge Confirmational and Perimeter Targeted and Actual Sample Locations.mxd 2/25/2016



Label Key

- Less than either the DMMP Bulk TBT Screening Level of 73 µg/kg or the Porewater TBT Screening Level of 0.15 µg/L
- Greater than DMMP Bulk TBT Screening Level of 73 µg/kg

DMU-2 — Location name
Bulk:
- *0–10* 8.9
- *10–20* 2.6 U
- *0–1'* 1.8 JQ

} Depth in centimeters and result in µg/kg; *0–1'* 1.8 JQ — Depth in feet and result in µg/kg

Porewater:
- *0–10* 0.15 — Result in µg/L

Notes:
1. Provided by Hart Crowser, Inc.
2. Additional discretionary perimeter sample locations.

- Existing and proposed Pier 4 locations provided by KPFF.
- Bathymetric contour data provided by Port of Tacoma.
- Background aerial imagery provided by Esri, 2013.

Abbreviations:
DMMP = Dredged Material Management Program
DMU = Dredge Management Unit
µg/kg = Micrograms per kilogram
µg/L = Micrograms per liter
MLLW = Mean lower low water
OHWM = Ordinary High Water Mark
TBT = Tributyltin

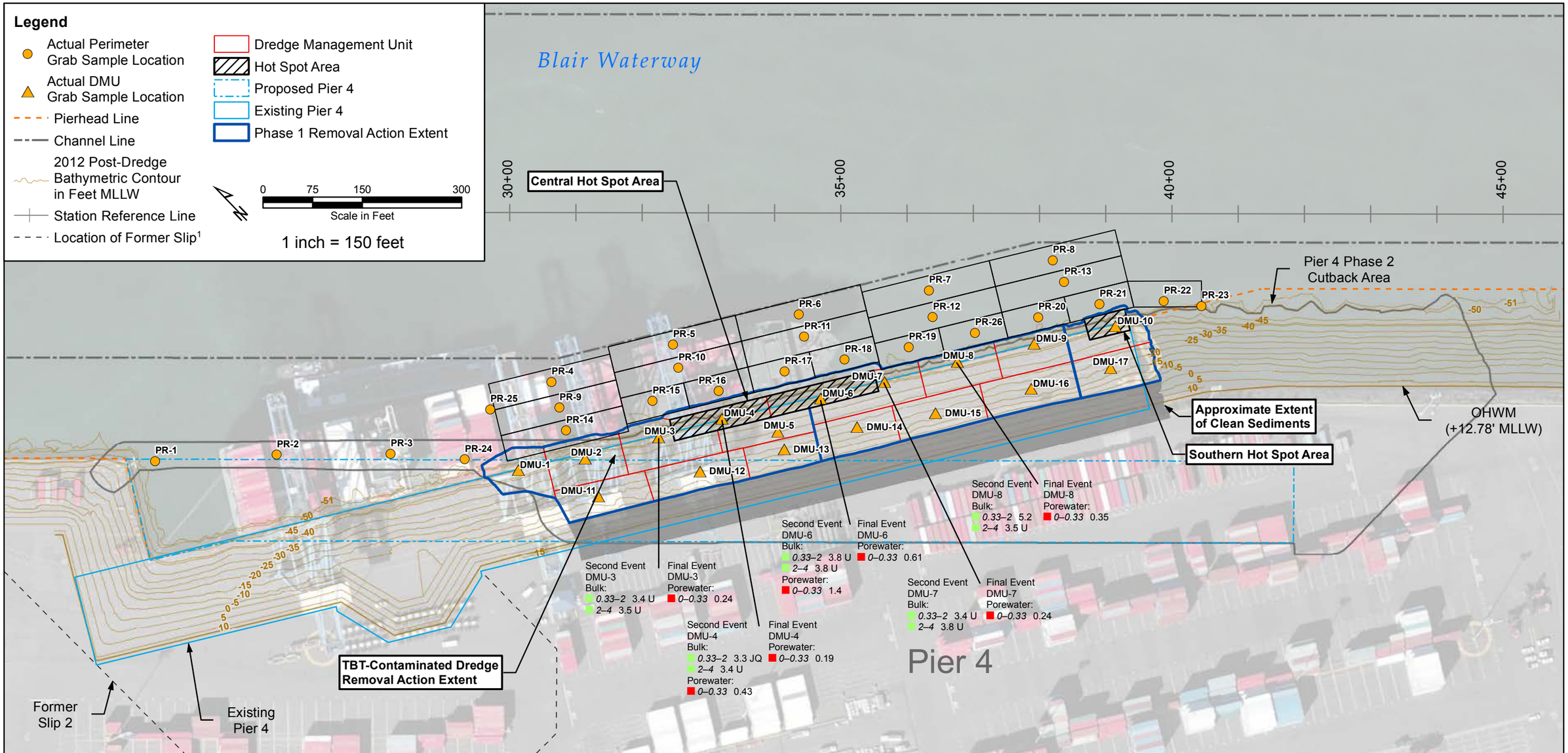
Qualifiers:
J = Analyte was detected, concentration is considered to be an estimate.
JQ = Analyte was detected between the reporting limit and method detection limit, concentration is considered to be an estimate.
U = Analyte was not detected, concentration given is the reporting limit.
UJ = Analyte was not detected, concentration given is the reporting limit, which is considered to be an estimate.

Port of Tacoma
FLOYD | SNIDER
strategy • science • engineering

Pier 4 Phase 1 Removal Action Project
Tacoma, Washington

Figure 5.
Post-Dredge Confirmational Sediment and Porewater TBT Results from First Sampling Event

I:\GIS\Projects\POT_Pier_4\MXD\Task 8040\Post-Dredge Confirmation Plan\Figure 2 Post-Dredge Confirmational Sediment and Porewater TBT Results from First Sampling Event.mxd 2/23/2016



Label Key

- Less than either the DMMP Bulk TBT Screening Level of 73 µg/kg or the Porewater TBT Screening Level of 0.15 µg/L
- Greater than DMMP Bulk TBT Screening Level of 73 µg/kg

Second Event — Sampling Event
DMU-4 — Location name
Bulk:
0.33–2 3.3 JQ
2–4 3.4 U
— Depth in feet and result in µg/kg
Porewater:
0–0.33 0.43 — Depth in feet and result in µg/L

Notes:
1. Provided by Hart Crowser, Inc.
2. Additional discretionary perimeter sample locations.
- Existing and proposed Pier 4 locations provided by KPFF.
- Bathymetric contour data provided by Port of Tacoma.
- Background aerial imagery provided by Esri, 2013.

Abbreviations:
DMMP = Dredged Material Management Program
DMU = Dredge Management Unit
µg/kg = Micrograms per kilogram
µg/L = Micrograms per liter
MLLW = Mean lower low water
OHWM = Ordinary High Water Mark
TBT = Tributyltin

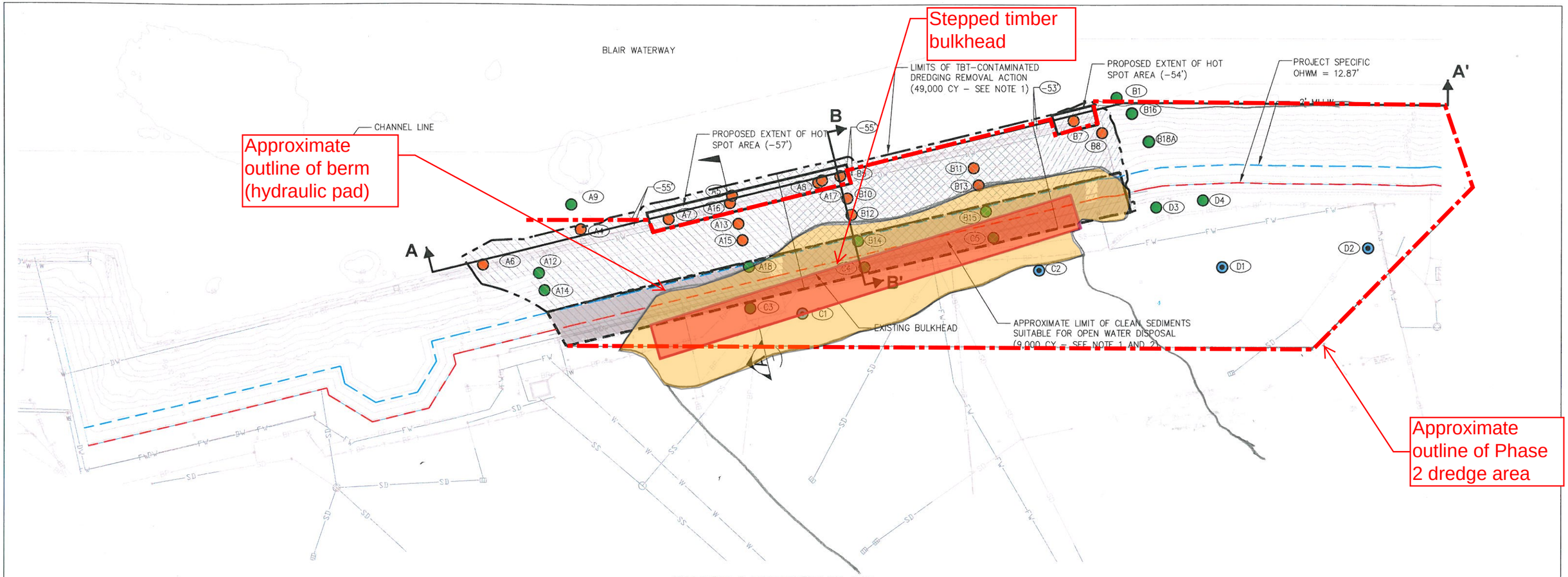
Qualifiers:
JQ = Analyte was detected between the reporting limit and method detection limit, concentration is considered to be an estimate.
U = Analyte was not detected, concentration given is the reporting limit.

Port of Tacoma
FLOYD | SNIDER
strategy • science • engineering

Pier 4 Phase 1 Removal Action Project
Tacoma, Washington

Figure 6.
Post-Dredge Confirmational Sediment and Porewater TBT Results from Second and Final Sampling Event

I:\GIS\Projects\POT_Pier_4\MXD\Task 8040\Post-Dredge Confirmation Plan\Figure 3 Post-Dredge Confirmational Sediment and Porewater TBT Results from Second and Final Sampling Event.mxd 2/23/2016



PHASE 1 DREDGE PLAN

SCALE: 1"=150'

LEGEND

- EXISTING CONTOUR
- (-51') TOE OF DREDGE, SEE NOTE 3
- (XX) SAMPLE LOCATION
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -55' MLLW AND UPPER 9FT OF SLOPE, SEE NOTE 3
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -55' MLLW AND UPPER 11FT OF SLOPE, SEE NOTE 3
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -53' MLLW AND UPPER 8FT OF SLOPE, SEE NOTE 3
- (A) CROSS SECTION LOCATION
- SAMPLE LOCATIONS WITH SEDIMENT SAMPLES CONTAINING TBT CONCENTRATIONS GREATER THAN THE DMMP SCREENING LEVEL OF 73 UG/KG
- SAMPLE LOCATIONS WHERE THERE ARE NO TBT EXCEEDANCES OF THE DMMP TBT SCREENING LEVEL (73 UG/KG) (SAMPLES ANALYZED FOR TBT ONLY)
- SAMPLE LOCATIONS WHERE THERE ARE NO CHEMICAL EXCEEDANCES OF THE DMMP SCREENING LEVELS FOR THE DMMP SUITE OF CHEMICALS OF CONCERN
- Cross Section Designation and Location
- Potential Timber Bulkhead Extent

NOTES

1. VOLUME IS APPROXIMATE AND INCLUDES THE 1-FOOT OVERDREDGE ALLOWANCE.
2. THE 2-FOOT RIP RAP ARMORED SLOPE MATERIAL (APPROXIMATELY 2,3000 CY) HAS BEEN DEDUCTED FROM THE VOLUME.
3. DREDGE DEPTHS DO NOT INCLUDE THE 1-FOOT OVERDREDGE ALLOWANCE.

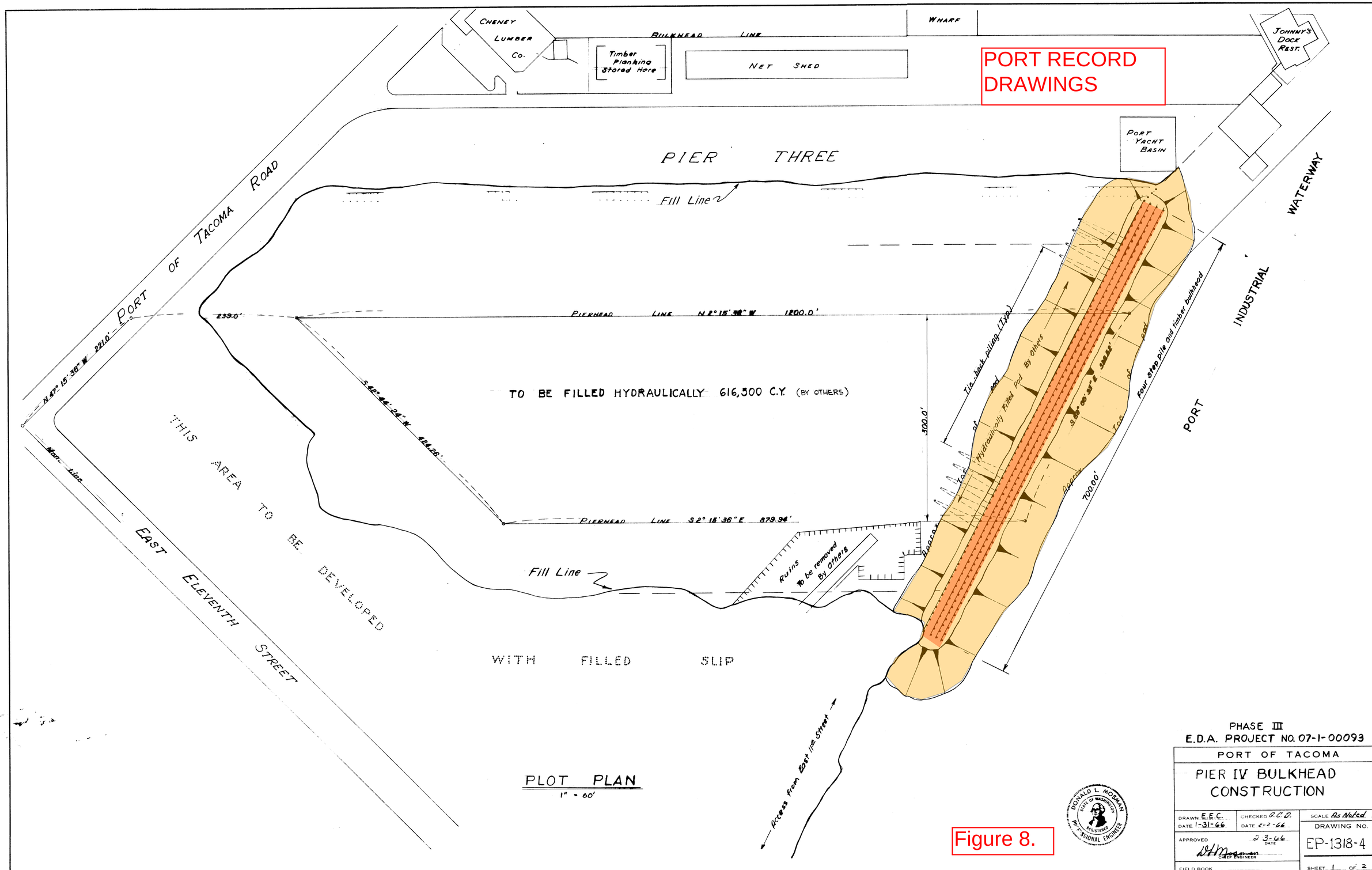
PROJECT NORTH

kpff Consulting Engineers
101 Stewart Street, Suite 400
Seattle, Washington 98101
(206) 382-0600 Fax (206) 382-0500

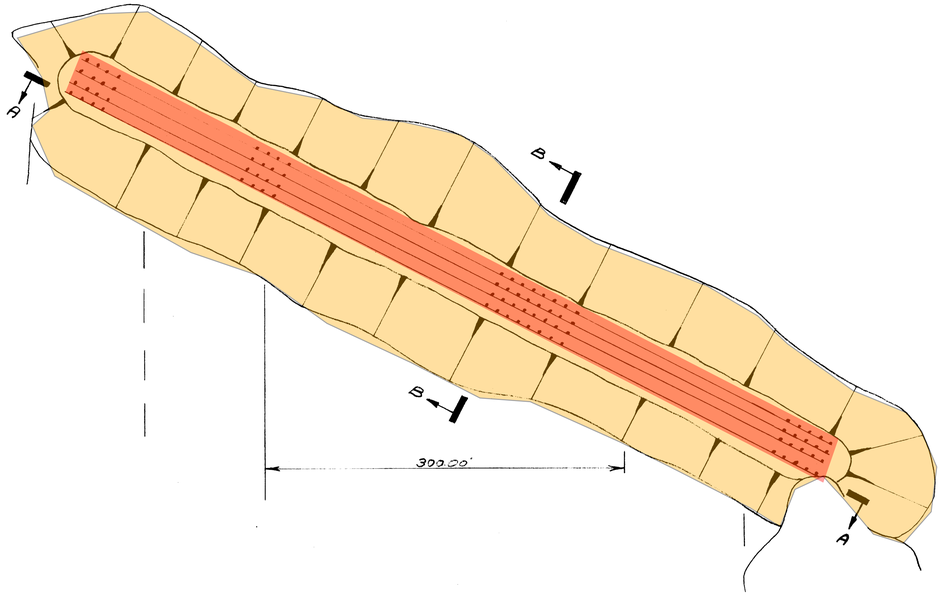
PROPOSED SUITABILITY OF PHASE 1 PROJECT
CLEAN MATERIAL
TACOMA, WASHINGTON

Figure 7.

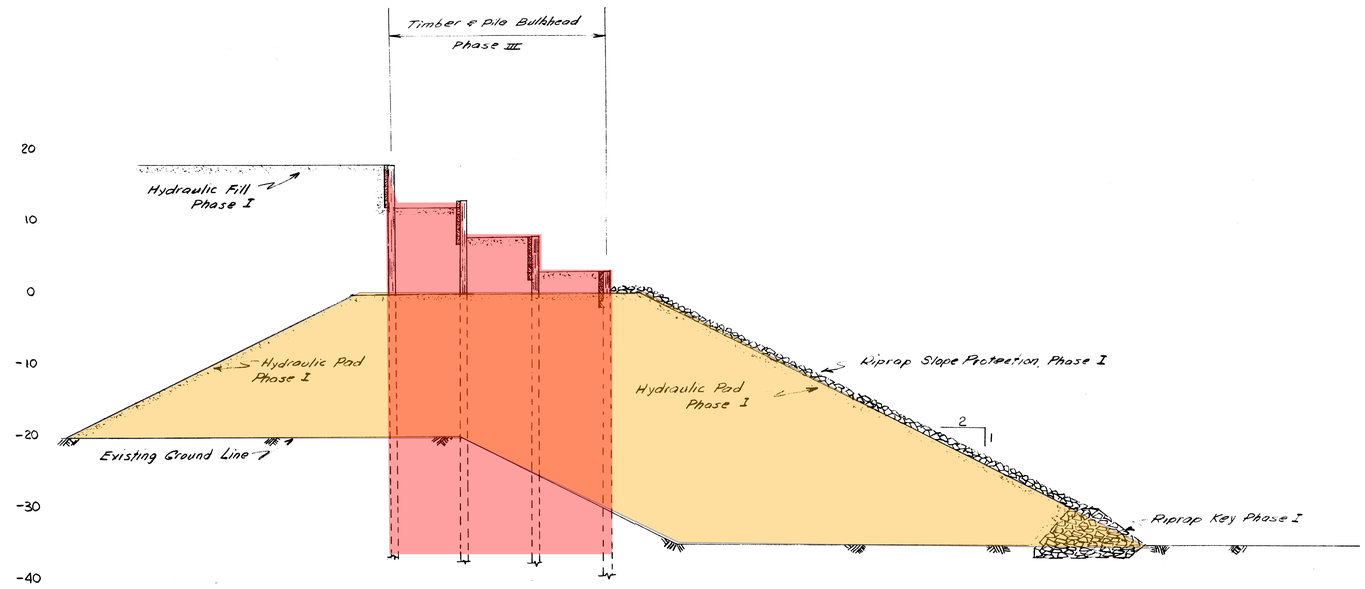
DATE: DECEMBER 2014 | SCALE: 1" = 150'-0"


PORT RECORD DRAWINGS
CHENEY LUMBER CO.
Timber Planking Stored Here
BULKHEAD LINE
WHARF
NET SHED
JOHNNY'S DOCK REST.
PORT YACHT BASIN
PIER THREE
Fill Line
PORT OF TACOMA ROAD
WATERWAY
INDUSTRIAL
PORT
239.0'
PIERHEAD LINE N 2° 15' 36" W 1200.0'
N 47° 15' 36" W 221.0'
S 42° 44' 24" W 484.26'
TO BE FILLED HYDRAULICALLY 616,500 C.Y. (BY OTHERS)
Tie back piling (TYP.)
Hydraulically Filled Pad By Others
Four step pile and timber bulkhead
S 85° 00' 55" E 388.88'
Top of pad
Approx. 700.00'
100.0'
Approx.
Mon. Line
AREA TO BE DEVELOPED WITH FILLED SLIP
PIERHEAD LINE S 2° 15' 36" E 879.94'
Fill Line
Ruins To be removed By Others
EAST ELEVENTH STREET
Access from East 11th Street
PLOT PLAN
1" = 60'
DONALD L. MOSMAN STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER
Figure 8.
PHASE III
E.D.A. PROJECT NO. 07-1-00093
PORT OF TACOMA
PIER IV BULKHEAD CONSTRUCTION
DRAWN E.E.C. DATE 1-31-66
CHECKED G.C.D. DATE 2-2-66
SCALE As Noted
DRAWING NO. EP-1318-4
APPROVED D.L. Mosman CHIEF ENGINEER DATE 2-3-66
FIELD BOOK
SHEET 1 OF 2

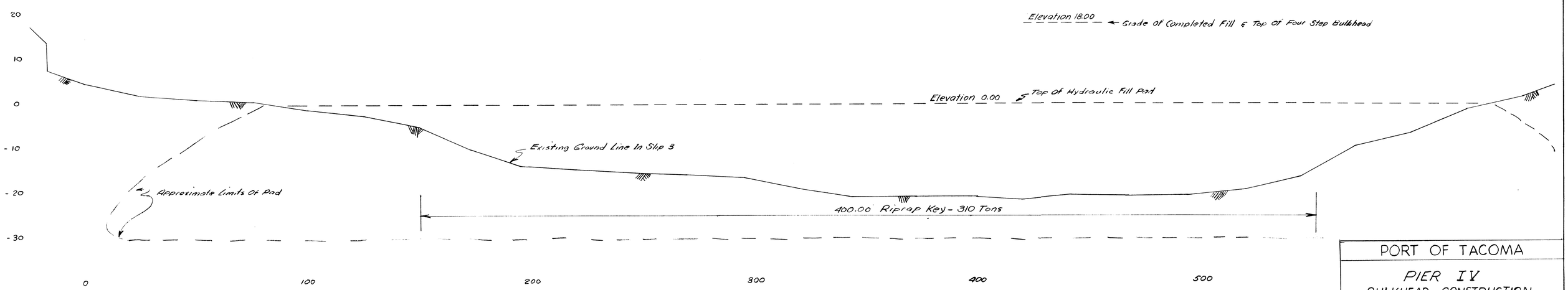
PORT RECORD DRAWINGS



PLAN VIEW
1" = 60'



SECTION "B"-"B"
1" = 10'



SECTION "A"-"A"
1" = 10' VERT.
1" = 20' HORIZ.

Figure 9.

PORT OF TACOMA	
PIER IV BULKHEAD CONSTRUCTION	
DRAWN E.E.C. DATE 10-31-66 / CHECKED ____ DATE ____	SCALE As Noted DRAWING NO.
APPROVED ____ CHIEF ENGINEER FIELD BOOK ____	EP-1318-4 SHEET 3 OF 3