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MEMORANDUM

To:	Rebecca Lawson, Washington State Department of Ecology Olivia Romano, U.S. Army Corps of Engineers	**Date:**	September 8, 2010
From:	Dan Berlin, Anchor QEA, LLC Tom Wang, Anchor QEA, LLC	**Project:**	080166-01
Cc:	Joanne Snarski, Port of Olympia		
Re:	15-Month Monitoring Results - Berths 2 and 3 Interim Cleanup Action Pilot Study		

This memorandum summarizes the results of sediment chemistry monitoring and a bathymetric conditions survey performed by the Port of Olympia (Port) as part of the Berths 2 and 3 Interim Cleanup Action Pilot Study (Interim Action) in West Bay in Olympia, Washington. This monitoring and survey work was conducted 15 months following completion of the Interim Action, as required in the Water Quality Monitoring and Sediment Sampling Plan (Sampling Plan; Anchor Environmental 2009). This memorandum includes sediment chemistry, sediment profile imaging (SPI), and bathymetry results. Previous sampling was conducted 3 months and 9 months following completion of the Interim Action (Anchor QEA 2009a and 2010, respectively). Sampling conducted as part of the Interim Action is documented in the Completion Report – Berths 2 and 3 Interim Action Cleanup (Anchor QEA 2009b).

1 BACKGROUND

The Port entered into an Agreed Order (AO) (No. DE 6083) with the Washington State Department of Ecology (Ecology) to complete an interim cleanup action to address cleanup of West Bay sediments adjacent to the Port's Berths 2 and 3 in South Budd Inlet, Olympia, Washington, and to accomplish maintenance dredging to a minimum of -39 feet below mean lower low water (MLLW). The Interim Action was completed on March 3, 2009 with final placement of clean sand cover in the dredged area. Previous chemical sampling and bathymetric data collection was conducted prior to dredging (September 2008), following dredging (February 2009), and following placement of the clean sand cover (March 2009).

Those results are included in the Completion Report (Anchor QEA 2009b). Sampling was also conducted 3 months following completion of the Interim Action, in June 2009 (Anchor QEA 2009a), and 9 months following completion of the Interim Action, in December 2009 (Anchor QEA 2010). This memorandum contains results from sediment monitoring conducted in June 2010 and bathymetric data collection conducted in July 2010.

The 15-month monitoring program was expanded beyond the required sampling as described in the Sampling Plan (Anchor Environmental 2009) based on requests from the U.S. Army Corps of Engineers (Corps) and Ecology to further evaluate the potential for sloughing/slumping of contaminated sediments at the toe of slope into the berth area. In response to a request from the Corps on April 8, 2010, the Port proposed additional monitoring in a memorandum dated April 28, 2010 to Ecology and the Corps. Following comments from the Corps on May 18, 2010, the Port provided responses and clarifications in a memorandum dated June 8, 2010. In a June 22, 2010 letter, the Corps agreed with modifications to the proposed monitoring. A summary of the required monitoring, as well as modifications and additions to the Sampling Plan, are described below.

Required 15-month monitoring, as described in the Sampling Plan (Anchor Environmental 2009) is summarized below:

1. Bathymetry measurements using multi-beam methodology
2. Sediment sampling and testing for dioxin/furan, total organic carbon, grain size, and total solids at the following stations:
    a. Underpier area: UP-20, UP-21, UP-22, and UP-23
    b. Berth area: BA-24, BA-25, BA-26, and BA-27B
    c. Ambient: BI-C16, BI-S37, and AM-28

Additional monitoring agreed to by the Corps and Ecology is summarized below:

1. Sediment profile imaging. The SPI survey is intended to determine the rate of sediment deposition since completion of the Interim Action and investigate the extent of mixing with the sand cover.
2. Additional surface sediment testing
    a. Berth area samples

   i. Sampling of the top 10 centimeters (cm) will be conducted at four new stations at the pierface: BA-28, BA-29, BA-30, and BA-31. These stations will be located in the material that has sloughed/slumped from beneath the pier into the toe of slope.
   ii. Sampling of the top 10 cm will be conducted at four new stations west of the previously established berth area stations: BA-32, BA-33, BA-34, and BA-35. These stations will be positioned in areas where dredging and placement of sand cover has occurred. These samples will be archived.
   iii. Sampling of the top 2 cm will be conducted from required berth area samples (BA-24, BA-25, BA-26, and BA-27), as well as new berth area stations (BA-32, BA-33, BA-34, and BA-35). All 2 cm samples will be archived.
 b. Additional ambient stations
   i. Sampling of the top 10 cm will be conducted at two new stations south of the berth area (AM-50 and AM-51). These stations were selected based on existing studies of West Bay circulation patterns. Samples will be tested.
   ii. Sampling of the top 2 cm will be conducted from new ambient stations (AM-50 and AM-51) and existing ambient stations (BI-C16, BI-S37, and AM-28). All 2 cm samples will be archived.

3. Subsurface core testing. Subsurface coring will be conducted at three stations along the pierface to assess the post-dredge surface if dredging were to be conducted to -42 feet MLLW plus 2 feet of allowable overdepth (to -44 feet MLLW). Z-samples will be submitted for testing from -44 to -46 feet MLLW from cores BA-101, BA-102, and BA-103. Samples of material that has accumulated on top of the sand cover (A interval) will also be collected and archived.

2 SEDIMENT MONITORING

Sediment sampling was conducted on June 15, 16, and 17, 2010 for the 15-month monitoring event in accordance with the sediment Sampling Plan (Anchor Environmental 2009) and additional monitoring as described in Section 1. This section describes sampling methods and results of surface and subsurface sediment testing along with SPI survey results.

2.1 Surface Sediment

Surface sediment testing was conducted in accordance with the Sampling Plan (Anchor Environmental 2009) and as conducted during previous monitoring events. Coordinates of each location sampled in June 2010 are provided in Table 1. Surface sediment chemistry results are presented in Tables 2 and 3 and Figure 1. Laboratory results and validation reports are included in Attachments A and B, respectively.

Surface sediment sampling was conducted from the top 10 cm at the following stations:

- Underpier area:
  - Submitted for testing: UP-20, UP-21, UP-22, and UP-23
- Berth area:
  - Submitted for testing: BA-24, BA-25, BA-26, BA-27B, BA-28, BA-29, BA-30, and BA-31
  - Archived: BA-32, BA-33, BA-34, and BA-35
- Ambient:
  - Submitted for testing: BI-C16, BI-S37, AM-28, AM-50, and AM-51

Surface sediment sampling was also conducted from the top 2 cm at the following stations:

- Berth area:
  - Archived: BA-24, BA-25, BA-26, BA-27B, BA-32, BA-33, BA-34, and BA-35
- Ambient:
  - Archived: BI-C16, BI-S37, AM-28, AM-50, and AM-51

The 0 to 2 cm and 0 to 10 cm samples from a single station were collected from the same grab, with each sample collected from separate parts of the grab (e.g., 0 to 2 cm from the left side and 0 to 10 cm from the right side). For the 0 to 2 cm samples, samples were collected from the material recently deposited on top of the sand cover. The thickness of fine-grained sediments above the interface with the sand cover varied between 1 and 20 cm, with most stations in the range of approximately 3 to 4 cm (Table 4). When the recently-deposited material was thicker than 2 cm, the top 0 to 2 cm was collected. When the thickness was less than 2 cm, the sample included only the recently-deposited material and not any of the sand cover.

Results of 0 to 10 cm surface sediment testing are presented in Table 2. As shown in Table 3, the surface sediment chemistry results from the 15-month post-cover sampling are lower than the 9-month, 3-month, and post-cover monitoring events in the underpier area and at ambient sample locations.

Underpier samples ranged from 8.9 parts per trillion toxic equivalency [TEQ] to 28.0 TEQ for the 15-month monitoring. The average of the underpier samples was 16.6 TEQ compared to 36.7 TEQ during the 9-month monitoring, 37.1 TEQ during the 3-month monitoring, and 38.9 TEQ during the post-cover survey. Results were lower than any of the previous sampling efforts for each underpier sample.

Ambient samples ranged from 1.8 TEQ to 14.0 TEQ and averaged 5.6 TEQ. The 15-month monitoring results for the three samples that were sampled previously (BI-C16, BI-S37, and AM-28) were lower than any of the previous sampling efforts, and averaged 2.6 TEQ compared to 21.8 TEQ during the 9-month monitoring, 22.7 TEQ during the 3-month monitoring, and 23.8 TEQ during the post-cover survey. New ambient samples AM-50 and AM-51 measured 14.0 TEQ and 6.0 TEQ, respectively.

Berth area samples were similar to the 9-month monitoring event. The average concentration in the berth area for required monitoring samples (BA-24, BA-25, BA-26, and BA-27B) was 8.6 TEQ, which is slightly lower than the 9-month monitoring event (11.1 TEQ), but higher than the 3-month monitoring event (2.4 TEQ) and post-cover survey (0.2 TEQ).

Berth area samples located at the toe of slope on the sloughed/slumped material averaged 13.4 TEQ and ranged from 7.4 to 22.8 TEQ. These samples were slightly higher than samples collected for required monitoring samples from the middle of the berth area (mean 8.6 TEQ).

Previous studies by Ecology indicated that the average sediment concentration in West Bay was 19.0 TEQ (SAIC 2008). With background sediment concentrations in that range, natural deposition and movement of sediments within West Bay would gradually increase berth area concentrations until equilibrated with surrounding background sediment concentrations. However, the 15-month monitoring results suggest that sediments with lower concentrations of dioxin have been deposited throughout West Bay, thus reducing average West Bay background surface sediment concentrations.

2.1.2 Capitol Lake

One potential explanation for this recent deposition is the management of Capitol Lake, located at the southern end of West Bay. The Capitol Lake dam is generally managed to control flooding from the Deschutes River and associated water levels in Capitol Lake. However, Capitol Lake was drawn down three times between December 9, 2009 and March 5, 2010 in an attempt to control invasive New Zealand mudsnails that were identified in Capitol Lake in the fall of 2009 (General Administration 2010). The first drawdown occurred on December 9, 2009 to purposely coincide with unusually cold weather that was several degrees below freezing in an attempt to kill the mudsnails (Deixis Consultants 2010). The second drawdown occurred between February 26 and 27, 2010 to allow Washington Department of Fish and Wildlife personnel to survey for mudsnail presence and measure the effects of rock salt on mudsnail mortality (Jones 2010). The lake was backflushed with saltwater from West Bay on March 1 and 2, 2010 (Jones 2010). The third drawdown occurred on March 5, 2010 to allow the lake to fill with freshwater from the Deschutes River (Jones 2010).

The repeated flushing of Capitol Lake likely contributed to higher-than-normal sedimentation between the 9-month sediment monitoring (conducted prior to the first drawdown on December 4, 2010) and the 15-month sediment monitoring (conducted June 15 to 17, 2010). The observation of sedimentation ranging from 1 to 12 cm of recently deposited light brown sediment on top of the sand cover also supports this conclusion (see Table 4 and Section 2.3).

Previous planned drawdowns of Capitol Lake occurred in 1997, 2002, 2003, and 2004 (Deixis Consultants 2010). Depending on the management of the Capitol Lake dam, surface sediment concentrations in the berth area, underpier area, and ambient area may remain similar to what they were in June 2010, or they may tend to increase toward historical background concentrations (e.g., 19.0 TEQ). Previous measurements of Capitol Lake sediment ranged from 1.9 to 3.9 TEQ (SAIC 2008). If the lake continues to be drawn down to manage for invasive mudsnails, sedimentation rates are likely to be higher than typically is experienced in West Bay, and West Bay sediment concentrations may tend to remain low. If normal management of the Capitol Lake dam returns, there is the potential that surface concentrations within West Bay may tend to increase toward historical background concentrations.

Regardless of the management of Capitol Lake, the Berth 2 & 3 area is located in an area though to receive higher net sedimentation from Capitol Lake than other parts of West Bay. The understanding of circulation patterns of West Bay is based on a circulation model of Budd Inlet developed by Ecology and on a hydrodynamic and sediment transport model of West Bay and Capitol Lake developed by the United States Geologic Service (USGS) as part of the Deschutes Estuary Restoration Feasibility Project. The circulation model developed by Ecology was summarized in a draft report in October 2008 and was provided to the Port by Ecology Engineer Mindy Roberts. The results of simulations completed by USGS to evaluate various restoration alternatives for the Deschutes River Estuary also suggest net flow to the north along the east side of West Bay (USGS 2008). In Figure 44 of the report, higher predicted net sedimentation is shown in the Port's berth areas under each of the various restoration alternatives simulated (USGS 2008).

2.2 Subsurface Sediment

Subsurface coring was conducted at three stations along the pierface to assess the post-dredge surface if dredging were to be conducted to -42 feet MLLW plus 2 feet of allowable overdepth (to -44 feet MLLW). Cores BA-101, BA-102, and BA-103 were driven 7 to 9 feet below mudline using a 4-inch vibracore. Z-samples were collected between -44 to -46 feet MLLW from each core, based on the preference by Ecology and the Corps to use a 2-foot Z-layer sample. Samples were also collected from the slough/slump material that had accumulated on top of the sand cover ("A" interval), but only the Z samples were submitted for testing.

All cores were fully logged and photographed, and the methodology for collection and sampling was identical to that conducted for the berth area cores collected in September

2008, prior to the Interim Action. Complete core logs for each core are provided in Attachment C.

Table 5 and Figure 2 provide subsurface dioxin/furan concentrations for the Z-samples collected from BA-101, BA-102, and BA-103. The Z-sample concentration for BA-101, BA-102, and BA-103 was 15.2, 154.3, and 59.8 TEQ, respectively. The concentration for BA-101 is in the range of the existing underpier samples (mean 16.6 TEQ) and surface sediment samples in the berth area adjacent to the pierface (mean 13.4 TEQ), but the concentrations for BA-102 and BA-103 are elevated above those concentrations. These two samples are also above 2008 background West Bay concentrations (19 TEQ; SAIC 2008).

This information suggests that the area in the vicinity of BA-102 and BA-103 has likely been dredged to at least -44 to -46 feet MLLW at some point in the past, which allowed sediments with elevated dioxin concentrations to accumulate. Subsurface sediment observations described in the core logs (Attachment C) indicate the presence of native sediment at -46.8 feet MLLW in core BA-103 and at -45.0 feet MLLW in core BA-102. Native material was characterized as stiff, olive brown slightly clayey silt in core BA-103 and as dense, dark gray slightly silty sand with 1 inch diameter rounded rocks in core BA-102. Core BA-101 did not contain any material characterized as native material. Based on the dioxin concentrations and subsurface sediment lithology observations, if additional dredging is to be considered for the area adjacent to the pierface, subsurface dioxin concentrations should be evaluated at depths deeper than -44 to -46 feet MLLW to determine the vertical extent of dioxin contamination.

2.3 Sediment Profile Imaging (SPI) Survey Results

A SPI survey was conducted on June 14, 2010 prior to sediment sampling on June 15, 16, and 17, 2010. The SPI survey was conducted to determine the amount of sediment deposition since completion of the Interim Action, and investigate the extent of mixing with the sand cover. Germano and Associates completed the SPI survey using procedures that were identical to those used during the post-cover survey, which were presented in Attachment A of the Sampling Plan (Anchor Environmental 2009).

A total of 25 SPI stations were visited within the dredged and covered area. A minimum of three replicate images were taken at each of the 25 stations. At some stations, the camera overpenetrated and an additional three replicate images were collected. Figure 3 provides the actual location of each of the SPI images in the dredged and covered area. Each image is provided in an interactive pdf in Attachment D. A description of each location is also provided in Attachment D.

Table 4 summarizes observations of sediment deposition on top of the cover for each station, and also presents observations of sediment deposition from the surface grabs and sediment cores. A range is provided for each station because some thickness measurements for SPI replicates from a single station varied, or the SPI unit overpenetrated, underpenetrated, and/or smearing of the SPI unit was observed. It should also be noted that penetration of the SPI device into the sediment may create the impression that more mixing is occurring, because the unit can drag down surface sediments along the viewing window as it penetrates. A discussion of results is provided for stations adjacent to the pierface, stations located in the middle of the dredge/cover area, and for stations located on the outer (western) edge of the dredge/cover area.

2.3.1 SPI Stations Adjacent to Pierface

SPI stations 1 through 11 were located as close as possible to the pierface. Nearly every replicate showed the presence of fine-grained sediment throughout the entire profile. Some replicates, such as 1C, 2F, 2D, 4B, 5A, 5B, 5C, 6A, 6B, 7A, 7B, and 11B showed the presence of light brown sediment deposited on top of dark gray or black fine-grained organic sediment, which could suggest the presence of recently deposited sediments (light brown) on top of sloughed/slumped material (dark gray or black). Sand cover material was observed in replicate 4C, which was located approximately 15 feet from the pierface. This replicate showed the presence of recently deposited light brown sediment on top of the sand cover material, but no presence of dark gray or black sloughed/slumped sediment.

2.3.2 Middle SPI Stations

Replicates 12A and 12B show 1 to 6 cm of recently deposited light brown sediment on top of the sand cover material, and no presence of dark gray or black sloughed/slumped sediment.

Replicate 12C also showed the presence of recently deposited sediment, but this was deposited on top of dark gray fine-grained material, with no sand cover material observed.

Replicates 13A and 13C show 5 to 7 cm of recently deposited light brown sediment mixed with both the sand cover material and some dark gray fine-grained sediment. Replicate 13B showed the presence of recently deposited light brown sediment mixed with the sand cover material.

Replicates 14A, 14B, and 14C show 4 to 8 cm of recently deposited light brown sediment on top of dark gray fine-grained material, but 14B shows the presence of sand cover material in the left half of the view frame.

Replicates 15A, 15B, and 15C show 2 to 3 cm of recently deposited light brown sediment above a gray, fine-grained layer (6 to 7 cm) followed by the sand cover material below.

Replicates 16A, 16B, and 16C showed 2 to 3 cm of recently deposited light brown sediment on top of a mixed layer of sand cover material and light gray fine-grained sediments.

Replicates 17A and 17C showed 3 to 8 cm of recently deposited light brown sediment on top of sand cover material. Replicate 17B showed 3 to 4 cm of recently deposited light brown sediment on top of a mixed layer of sand cover material and light gray fine-grained sediments.

Replicates 18A, 18B, and 18C showed 5 to 8 cm of recently deposited light brown sediment, but this layer was present on top of the sand cover material in 18B and 18C, and on top of light gray fine-grained sediments in 18A.

Replicates 19A, 19B, and 19C showed 5 to 8 cm of recently deposited light brown sediment on top of a mixed layer of sand cover material and light gray fine-grained sediments.

2.3.3 Outer SPI Stations

Replicates 20A, 20B, and 20C showed 3 to 8 cm of recently deposited light brown sediment on top of light gray to black fine-grained sediments.

Replicates 21A and 21B showed a 3 to 5 cm layer of recently deposited light brown sediment on top of a mixed layer of sand cover material. Replicate 21C had a 3-cm layer of light brown sediment on top of a mixed layer of light gray to light brown fine-grained sediment mixed with the sand cover material.

Replicates 22A and 22D showed a 5 to 8 cm layer of light brown sediment mixed with light gray sediment and sand cover material. Replicate 22B showed 4 cm of light brown sediment mixed with sand cover material. Replicate 22C showed more than 10 cm of recently deposited light brown sediment present.

Replicates 23A, 23B, and 23C showed 8 to 10 cm of light brown sediment mixed with sand cover material.

Replicate 24A showed 3 cm of light brown fine-grained sediment mixed with sand cover material. Replicate 24B overpenetrated, but showed light brown fine-grained sediment mixed with dark gray to black fine-grained sediment. Replicate 24C showed 5 to 6 cm of recently deposited light brown sediment mixed with the sand cover material. Some sand is also present on top of the recently deposited material in replicate 24C.

Replicates 25A and 25C showed 3 to 4 cm of recently deposited light brown sediment mixed with light gray fine-grained sediment and sand cover material. Replicate 25B showed 3 to 4 cm of recently deposited light brown sediment mixed with sand cover material.

2.3.4 Summary

In middle and outer SPI stations, total light brown sediment thickness ranged from 1 cm to more than 10 cm. In general, a moderate amount of mixing of the recently deposited light brown sediments with the sand cover material was observed. Low to moderate mixing was observed between underlying light gray or dark gray fine-grained sediments and the sand cover material.

Recent light brown sediment deposition was observed on top of, or mixed with sand cover material at every station where sand cover material was observed. In replicates where no sand cover material was observed, light brown sediment was generally present above and mixed with light gray or dark gray fine-grained sediment below. This deeper light gray or dark gray sediment may be undisturbed undredged material, or it may be undredged material that was redeposited by currents, propwash, or vessel movement (e.g., pressure fields generated by the hull of the vessel). It is unknown to what extent these forces may cause resuspension and mixing, but overall, based on the SPI images, mixing is generally no greater than 2 cm in the near surface throughout the dredged/covered area. It is also unknown to what extent bioturbation contributes to this mixing.

Stations along the pierface suggest that sloughing/slumping is present within the nearest 10 feet of the pierface, as evidenced by the presence of dark gray fine-grained sediments on top of the sand cover material. However, for replicates located 15 feet or more away from the pierface, no distinct dark gray fine-grained sediment was consistently observed on top of the sand cover material or light brown fine-grained sediment, suggesting that sloughing/ slumping of underpier sediments did not extend to 15 feet from the pierface.

3 BATHYMETRIC SURVEY RESULTS

Multibeam bathymetric surveys were conducted just after the placement of the sand cover (March 12, 2009), 3 months following placement (June 24, 2009), 9 months following placement (December 10, 2009), and approximately 15 months following placement (July 13, 2010). All post-cover surveys were conducted by eTrac Engineering using a multibeam sonar system. The surveys included the dredged portions of the berth area as well as the underpier area. The surveys were conducted in accordance with requirements presented in the Sampling Plan (Anchor Environmental 2009).

Results of the December bathymetric survey are provided in Figures 4 through 10. Figure 4 presents a plan view of the bathymetry results along with cross section locations. Ten cross sections are presented in Figures 5 through 9. Figure 10 presents a comparison of the December 2009 and July 2010 surveys.

During the July 2010 survey, multibeam bathymetric surveying was conducted throughout the entire Berth 2 & 3 area as well as in the underpier area. Identical methods and equipment were used for each of the previous surveys using a base station and Real Time

Kinematics (RTK) Global Positioning System (GPS). The RTK GPS provides horizontal positioning accuracy of 1 cm or less. The survey presented in Figures 4 through 10 provides RTK-quality horizontal GPS for the open water portions of the berth area; however, RTK-quality horizontal GPS positioning was not possible when collecting multibeam bathymetry in the underpier areas and adjacent to the pierface due to the presence of cranes in the Berth 2 and 3 area and the unfavorable satellite constellation pattern during the time of survey. The surveyor spent several days in the berth area attempting to acquire a better satellite constellation pattern to obtain RTK-quality horizontal GPS data in the area adjacent to the pierface to be used for underpier and pierface bathymetric measurements. When the surveyor was unable to acquire RTK-quality horizontal GPS data at the pierface, the use of differential GPS (DGPS) from the nearest United States Coast Guard (USCG) beacon stations was required. However, this method can result in up to a 1 m horizontal positioning error in certain locations. Because of the uncertainty associated with the bathymetric measurements collected from the underpier area and adjacent to the pierface, bathymetric information collected in this area has not been included in Figures 4 through 10 and has not been used for analysis. The Port collected mudline measurements using leadlines at the pierface on June 21, 2010, but those elevations differed from the multibeam measurements collected on July 13, 2010 at the same locations by up to 1 to 2 feet. Because of the uncertainty associated with the bathymetry measurements in the underpier and pierface areas, this memo presents and discusses the leadline measurements at the pierface rather than the pierface and underpier multibeam data.

The Port intends to recollect multibeam bathymetry in the underpier areas and at the pierface in October 2010. The multibeam survey will be scheduled during a period with a favorable satellite constellation pattern and while vessels are not berthed at the pierface. Those results will be provided to Ecology and the Corps after completion of the survey.

As part of the Interim Action, the area immediately adjacent to the pierface was dredged to between -40 and -41 feet MLLW; however, sloughing/slumping from the underpier slope resulted in an accumulation of material at the pierface shortly after the dredging was completed. The approach to dredge at the pierface to allow the slope to slough/slump in a controlled manner was discussed with Ecology during development of the Interim Action Plan. This approach was determined to be the most environmentally protective and present the least risk to the pile-supported structure. However, the slope sloughed/slumped less than expected during construction. As discussed with Ecology during plan development, this outcome meant that sloughing/slumping was likely to continue after dredging was complete until the slope reached equilibrium.

Table 6 provides a summary of bathymetry measurement comparisons between the December 2009 and June 2010 surveys. Based on the cross sections from the December 2009 survey, sediment elevations at the pierface within the dredged berth area range from -34.5 to -37.3 feet MLLW, except at the northern-most corner (which measured -30.9 feet MLLW). The mean depth was -35.5 feet MLLW.

Based on the leadline measurements at the pierface from June 21, 2010, elevations at the pierface ranged from -34.6 to -36.7 feet MLLW, except at the northern-most corner. Section 15+40 is located at the very northern edge of the dredge area (Figure 9) and is shallower than other areas (-33.1 feet MLLW at the pierface). The mean depth at the pierface along the project area was -35.3 feet MLLW. The mudline elevation along the pierface increased an average of 0.2 feet between December 2009 and June 2010 (Table 6).

The small increase in elevation along the pierface may be explained by additional sloughing/slumping from the underpier areas, as well as additional deposition at the toe of the slope from other areas. However, the amount of sloughing/slumping from the underpier areas continues to decrease, as evidenced by the slower rate of increase in mudline elevation at the pierface. Between the post-cover and 3-month survey, the average mudline elevation increased 1.1 feet. Between the 3-month survey and 9-month survey, the average mudline elevation increased 0.5 feet. Between the 9-month survey and 15-month surveys, the average mudline elevation increased 0.2 feet. This suggests that the underpier slope continues to become more even along the entire length of the underpier area, with less pronounced breakpoints in the slope. The angle of the underpier slope will be determined following the October 2010 underpier survey.

The small decrease in water depth at the pierface is likely attributable to a small amount of sloughing/slumping and flattening of the underpier slope, but could also be the result of continued deposition at the toe of the slope. As discussed previously, the natural rate of deposition along the toe of the slope may be higher than in other areas of the berth, possibly due to natural West Bay circulation patterns or vessel movement. However, based on the low mixing of recent sediments with the sand cover, it does not appear that vessel movement is responsible for increased accumulation at the toe.

It is expected that water depths at the pierface will continue to decrease; however, the role of sloughing/slumping is expected to be minimal in the future based on the decreasing rate of accumulation. The Port continues to use temporary mooring camels along the pierface as an interim measure to provide an offset from the toe of slope to allow berthing for vessels. The Port will continue to coordinate with Ecology and the Corps regarding any challenges posed to navigation by continued sediment accumulation in the berth area. The Port will also continue to coordinate with Ecology and the Corps to further evaluate the environmental need and/or benefit of dredging at the toe of the slope to remove material that has sloughed/slumped into the berth area.

4 NEXT STEPS

The Port will conduct a multibeam survey of the underpier area and adjacent to the pierface in October 2010. Those results will be provided to Ecology and the Corps following completion of the survey. The last required monitoring event will be conducted in December 2010. That event will consist of surface sediment sampling and bathymetric surveying. The Port will coordinate with Ecology and the Corps to review the information presented in this memorandum, and will discuss the need for additional supplemental sampling beyond the minimum required in the Sampling Plan (Anchor Environmental 2009).

5 REFERENCES

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Table 1
15-Month Post-Cover Surface Sediment Sample Locations

Station ID		Water Depth (feet MLLW)	Actual Coordinates[1]			
			Latitude (°N)	Longitude (°W)	Northing (feet)	Easting (feet)
Underpier	PO-UP-20-SE	20.6	47 03.2034	122 54.3436	636401	1040845
	PO-UP-21-SE	19.7	47 03.2457	122 54.3508	636659	1040823
	PO-UP-22-SE	20.7	47 03.2790	122 54.3557	636862	1040809
	PO-UP-23B-SE	18.3	47 03.3133	122 54.3608	637071	1040794
Berth Area	PO-BA-24-SE	40.1	47 03.2001	122 54.3608	636383	1040773
	PO-BA-25-SE	39.6	47 03.2268	122 54.3603	636545	1040780
	PO-BA-26-SE	39.6	47 03.2782	122 54.3653	636858	1040769
	PO-BA-27B-SE	40.5	47 03.3134	122 54.3746	637073	1040737
	PO-BA-28-SE	34.2	47 03.1969	122 54.3482	636362	1040825
	PO-BA-29-SE	37.8	47 03.2236	122 54.3525	636525	1040812
	PO-BA-30-SE	36.5	47 03.2757	122 54.3596	636842	1040792
	PO-BA-31-SE	37.3	47 03.3142	122 54.3654	637077	1040775
	PO-BA-32-SE	39.7	47 03.1984	122 54.3701	636374	1040734
	PO-BA-33-SE	37.2	47 03.2260	122 54.3728	636542	1040728
	PO-BA-34-SE	39.8	47 03.2767	122 54.3703	636850	1040748
	PO-BA-35-SE	40.2	47 03.3143	122 54.3859	637080	1040690
	PO-BA-101-SE (core)	39.5	47 03.2041	122 54.3504	636406	1040817
	PO-BA-102-SE (core)	40.1	47 03.2530	122 54.3574	636704	1040797
	PO-BA-103-SE (core)	39.3	47 03.3109	122 54.3660	637057	1040772
Ambient	PO-AM-28-SE	39.4	47 03.3428	122 54.3995	637255	1040639
	BI-S37	32.6	47 03.2881	122 54.4486	636929	1040425
	BI-C16	34.7	47 03.2227	122 54.3912	636524	1040651
	PO-AM-50-SE	16.7	47 03.0248	122 54.3354	635315	1040846
	PO-AM-51-SE	39.3	47 03.1389	122 54.3526	636010	1040796

Notes:
1 Washington South Zone, NAD 83 geographic and state plane coordinates – U.S. survey feet

Table 2
15-Month Post-Cover Sediment Chemistry Results

	Berth Area								Underpier Area				Ambient Samples				
Station ID	BA-24	BA-25	BS-26	BA-27B	BA-28	BA-29	BA-30	BA-31	UP-20	UP-21	UP-22	UP-23B	BI-C16	BI-S37	AM-28	AM-50	AM-51
Sample Date	6/15/2010	6/15/2010	6/15/2010	6/15/2010	6/16/2010	6/16/2010	6/16/2010	6/16/2010	6/15/2010	6/15/2010	6/15/2010	6/15/2010	6/16/2010	6/16/2010	6/16/2010	6/16/2010	6/16/2010
Depth	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
Conventional Parameters (pct)																	
Total organic carbon	1.4	0.58	2.4	2.2	6	5.5	5.3	7.8	5.8	4.4	5.5	7.4	3.8	4	4	4.2	4.6
Total solids	61	70	55	49	26	27	25	31	29	26	26	27	27	26	24	31	28
Grain Size (pct)																	
Cobbles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gravel	13	13	8.6	11	0.3	2.5	1	16	2.1	3.1	1	11	0	0.1	0	0.4	0
Sand	60	77	62	52	6.4	14	4	17	14	13	5.5	13	6.7	3.6	1.1	6.1	1.2
Silt	18	6.6	21	30	78	70	76	52	72	70	76	55	68	74	79	75	78
Clay	5.3	1.7	3.9	2.7	3.4	3.3	6.6	5.4	2	2.2	6.2	9.3	12	9.5	6.6	6	8.8
Total Fines (silt + clay)	23.3	8.3	24.9	32.7	81.4	73.3	82.6	57.4	74	72.2	82.2	64.3	80	83.5	85.6	81	86.8
Dioxin Furans (ng/kg)																	
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	0.204 U	0.151 U	0.226 U	0.278 U	0.302 U	0.405 U	0.272 U	0.51 U	0.348	0.236 U	0.387	0.538	0.124 U	0.346 U	0.45 U	0.457 U	0.266 U
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	0.893	0.389	0.911	1.13	1.25 U	1.9	1.02	2.24	1.8	0.794	2.12	3.38	0.727	0.67 U	0.918 U	2.14	1.09 U
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	1.48	0.772	1.52	1.78	2.68	3.53	1.89	3.95	3.94 U	1.77	3.81	6.87	0.8 U	3.43	1.27 U	2.98	1.98
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	7.59	3.14	7.3	9.11	9.02	14.7	10.1	29.1	18	6.71	17.4	28.8	5.43	1.11 U	2.49	18.5	8.83
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	3.51	1.37	3.17	4.36	6.64	7.81	4.32	10.6	9.52	2.92	9.22	14.9	2.01	1.56	1.33 U	7.41	3.8
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	171	84	171	204	284	489	342	843	437	410	483	934	118	74.1	76.3	419	206
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	1340	760	1370	1610	2460	4870	3320	6130 J	3670	4690	4120	8750 J	910	552	607	3410	1750
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.994 U	0.632	1.11	1.1	0.979	1.39	0.919	1.91	1.45	0.746	1.83 J	2.25	0.998	0.831	0.625 U	1.49	0.973
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.656	0.314	0.665	0.717	1.24	1.12	0.727	2	1.45	0.663	1.32	1.83	0.509	0.341	0.212 U	1.45	0.824
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	1.3	0.601	1.38	1.58	1.57	2.36	1.59	5.02	2.62	1	3.02	4.58	1.05 U	0.654	0.603	2.85	1.42
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	3.08	1.35	3.26	3.97	3.19	6.73	4.06	12.5	4.95	2.37	7.89	13.5	1.86	1.37	1.17	5.59	3.53
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	1.39	0.635	1.36	1.81	1.78	2.76	1.49	4.29	2.43	1.02	3.55	5.48	0.794	0.664 U	0.342 U	2.66	1.55
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.702	0.364	0.749	0.893	2.02	1.32	0.958	3.18	1.51	0.964	1.74	2.68	0.601	0.402 U	0.464 U	1.73	0.946
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	2.07	0.914	2.15	2.73	2.36	4.03	2.41	6.28	3.38	1.49	5.06	8.22	1.52	1.07	0.771	4.81	2.6
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	46.1	19.7	44.7	61.3	41.7	98.9	51.7	137	75.7	37.7	126	197	32.4	19.8	16.7	112	52.7
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	2.02	1.06 U	2.12	2.63	3.08	4.42	2.49	6.69	3.62	2.72	6.14	14.6	1.31	0.513 U	0.856 U	4.52	2.55
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	86.5	55.7	94.2	113	101	252	118	243	169	136	332	858	55.7	35.4	35	226	106
Total Tetrachlorodibenzo-p-dioxin (TCDD)	3.51	1.44	3.08	5.01	1.51	7.21	2.5	11.4	4.02	1.73	10.5	10.3	0.895	0.451	1.17 U	6.32	3.79
Total Pentachlorodibenzo-p-dioxin (PeCDD)	11.8	5.16	11.8	16.2	6.51	23.4	12.3	31.8	17.5	7.74	26.5	36.3	7.77	1.85 U	1.4	29.9	13.8
Total Hexachlorodibenzo-p-dioxin (HxCDD)	71	33.2	65.7	82.5	90.1	179	109	316	140	157	168	228	48.8	26.2	26	166	78.1
Total Heptachlorodibenzo-p-dioxin (HpCDD)	612	378	574	650	1340	2590	1660	3890	1890	3340	1830	2670	417	242	322	1520	736
Total Tetrachlorodibenzofuran (TCDF)	4.93 J	2.42 J	4.8 J	6.71 J	2.9 J	9.73 J	5.01 J	10.5 J	8.94 J	3.36 J	10.3 J	14.4 J	2.86	1.3	0.306	10.6 J	4.92
Total Pentachlorodibenzofuran (PeCDF)	6.25 J	2.65	6.56 J	7.94 J	6.04 J	11.7 J	6.57 J	20.1 J	10.3 J	4.43	14.6 J	21.6 J	3.72	2.14	1.41	14.3 J	7.41
Total Hexachlorodibenzofuran (HxCDF)	47.6	20.4	47.5 J	62.2 J	49.2 J	92.6 J	56.5	171	86 J	35.4	120 J	197 J	34.2	20.4	17.3	119	58.1
Total Heptachlorodibenzofuran (HpCDF)	147	68	150	195	145	339	180	470	260	162	444	870	99.1	64.6	53.7	401	174
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	5.9	2.8	6.0	7.4	7.4	14.3	9.1	22.8	13.4	8.9	16.0	28.0	3.9	2.1	1.7	14.0	6.0

Notes:

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

Totals are calculated as the sum of all detected results (U=0). If all results are not detected, the highest reporting limit value is reported as the sum.

Toxicity Equivalency (TEQ) values as of 2005, World Health Organization.

Level III data validation applied

Table 3
2009-2010 Post-Cover Surface Sediment Results

	Post-Cover Survey (March 2009)	3-Month Post-Cover Survey (June 2009)	9-Month Post-Cover Survey (December 2009)	15-Month Post-Cover Survey (June 2010)
Underpier Area				
UP-20	**39.4**	**39.0**	**33.4**	**13.4**
UP-21	**46.0**	**37.3**	**43.9**	**8.9**
UP-22	**32.3**	**36.2**	**32.1**	**16.0**
UP-23B	**37.8**	**36.0**	**37.4**	**28.0**
Average	**38.9**	**37.1**	**36.7**	**16.6**
Berth Area				
BA-24	**0.1**	**4.7**	**11.7**	**5.9**
BA-25	**0.5**	**1.8**	**4.6**	**2.8**
BA-26	**0.0**	**1.5**	**1.1 / 35.2 ***	**6.0**
BA-27B	**0.0**	**1.7**	**17.1**	**7.4**
Average	**0.2**	**2.4**	**11.1** [#]	**8.6**
Berth Area-Toe of Slope				
BA-28	-	-	-	**7.4**
BA-29	-	-	-	**14.3**
BA-30	-	-	-	**9.1**
BA-31	-	-	-	**22.8**
Average	-	-	-	**13.4**
Ambient Samples				
BI-C16	**24.7**	**21.3**	**22.7**	**3.9**
BI-S37	**23.3**	**22.9**	**21.7**	**2.2**
AM-28	**23.3**	**23.8**	**21.0**	**1.8**
AM-50	-	-	-	**14.0**
AM-51	-	-	-	**6.0**
Average	**23.8**	**22.7**	**21.8**	**5.6**

Notes:

TEQ values calculated using World Health Organization (2005)

* A field duplicate was collected at BA-26

[#] Average for Berth Area samples was calculated using the mean of the duplicate samples collected at BA-26

Table 4
Estimates of Recently Accumulated Sediment over the Sand Cover Layer

Station ID	Observed during Sediment Collection		Estimated from SPI Images	
	Light Brown Silt Portion of Recently Accumulated Sediment (cm)	Total Depth of Recently Accumulated Sediment above Sand Cover (cm)	Light Brown Silt Portion of Recently Accumulated Sediment (cm)	Total Depth of Recently Accumulated Sediment above Sand Cover (cm)
Co-located Sample Locations				
BA-24 / SPI 18	1.5 to 4	4.5 to 8	5 to 8	8 to 11
BA-25 / SPI 16	1 to 3	3 to 6	2 to 3	5 to 8
BA-26 / SPI 13	2 to 4	4 to 7	5 to 7	7 to 15
BA-27B / SPI 12	3 to 6	7 to 12	1 to 6	1 to 16
BA-28/BA-101/SPI 10	---[a]	33	overpenetrated	> 20[b]
BA-29 / SPI 8	---[a]	>36	overpenetrated	> 20[b]
BA-30 / SPI 4	---[a]	>36	3 to 8	8 to 18
BA-31/BA-103/SPI 1	---[a]	49	5 to 8	> 20[b]
BA-32 / SPI 24	4	4	3 to 6	8 to 15
BA-33 / SPI 22	2 to 4	2 to 4	4 to 8	8
BA-34 / SPI 14	3 to 5	6 to 8	4 to 8	10 to 16
BA-35 / SPI 20	1 to 4	2 to 5	3 to 8	15 to 20
BA-102 / SPI 6	---[a]	24	4 to 5	> 20[b]
Locations with SPI Images only				
SPI 2	---	---	8 to 12	10 to 18
SPI 3	---	---	8 to 10	12 to 15
SPI 5	---	---	5 to 8	16 to 18
SPI 7	---	---	10 to 12	15 to 20
SPI 9	---	---	1 to 2	10
SPI 11	---	---	8	> 10[c]
SPI 15	---	---	2 to 3	8 to 10
SPI 17	---	---	3 to 8	5 to 8
SPI 19	---	---	5 to 8	> 10[c]
SPI 21	---	---	3 to 5	8 to 10
SPI 23	---	---	8 to 10	8 to 10
SPI 25	---	---	3 to 4	12

Notes:

a. A light brown silt layer was not observed in the grab or core samples BA-28/BA-101, BA-29, BA-30, BA-31/BA-103, and BA-102.

b. The SPI images in core locations were entirely recently accumulated sediment. The frame is approximately 20 cm tall.

c. Image did not penetrate deep enough to capture sand cover layer.

Table 5
Subsurface Sediment Chemistry Results

		Berth Area		
Sample Location		BA-101	BA-102	BA-103
Sample Date		6/17/2010	6/17/2010	6/17/2010
Depth (in ft MLLW)		-44 to -46	-44 to -46	-44 to -46
Conventional Parameters (pct)				
Total organic carbon	pct	**3.1**	**5.3**	**3.5**
Total solids	pct	**67**	**49**	**61**
Grain Size (pct)				
Cobbles	pct	**0**	**0**	**0**
Gravel	pct	**10**	**11**	**17**
Sand	pct	**60**	**22**	**48**
Silt	pct	**16**	**33**	**24**
Clay	pct	**7.5**	**18**	**7.2**
Total Fines (silt + clay)	pct	**23.5**	**51**	**31.2**
Dioxin Furans (ng/kg)				
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	ng/kg	**0.548**	**1.37**	0.911 U
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	ng/kg	1.89 U	**8.13**	3.52 U
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	ng/kg	2.52 U	**13.6**	**7.06**
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	ng/kg	**15.4**	**137**	**59**
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	ng/kg	5.93 U	**43.7**	**12.8**
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	ng/kg	**447**	**3520 J**	**1650 J**
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	ng/kg	**3530 J**	**28600 J**	**13000 J**
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	ng/kg	1.46 U	**5.13**	4.07 U
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	ng/kg	**1.95**	**10.1**	**5.51**
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	ng/kg	**6.51**	**38.5**	**36**
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	ng/kg	**20.9**	**236**	105 U
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	ng/kg	**4.9**	**46.7**	20.9 U
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	ng/kg	3.34 U	**32**	**21.6**
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	ng/kg	**7.49**	**77.1**	**34.1**
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	ng/kg	**207**	**2850 J**	**1420**
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	ng/kg	8.68 U	2.16 U	1.64 U
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	ng/kg	**437**	**5000 J**	**2500**
Total Tetrachlorodibenzo-p-dioxin (TCDD)	ng/kg	**7.01**	**40.3**	**21.3**
Total Pentachlorodibenzo-p-dioxin (PeCDD)	ng/kg	**22.8**	**115**	**50.6**
Total Hexachlorodibenzo-p-dioxin (HxCDD)	ng/kg	**132**	**902**	**386**
Total Heptachlorodibenzo-p-dioxin (HpCDD)	ng/kg	**1260**	**9780**	**3920**
Total Tetrachlorodibenzofuran (TCDF)	ng/kg	**17.3 J**	**72.7 J**	**51.4 J**
Total Pentachlorodibenzofuran (PeCDF)	ng/kg	**28.3 J**	**178 J**	**64.1 J**
Total Hexachlorodibenzofuran (HxCDF)	ng/kg	**211**	**2240 J**	**1050**
Total Heptachlorodibenzofuran (HpCDF)	ng/kg	**738**	**10400**	**4710**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	ng/kg	**15.2**	**154.3**	**59.8**

Notes:

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

Totals are calculated as the sum of all detected results (U=0).

If all results are not detected, the highest reporting limit value is reported as the sum.

Toxicity Equivalency (TEQ) values as of 2005, World Health Organization.

Data validation applied.

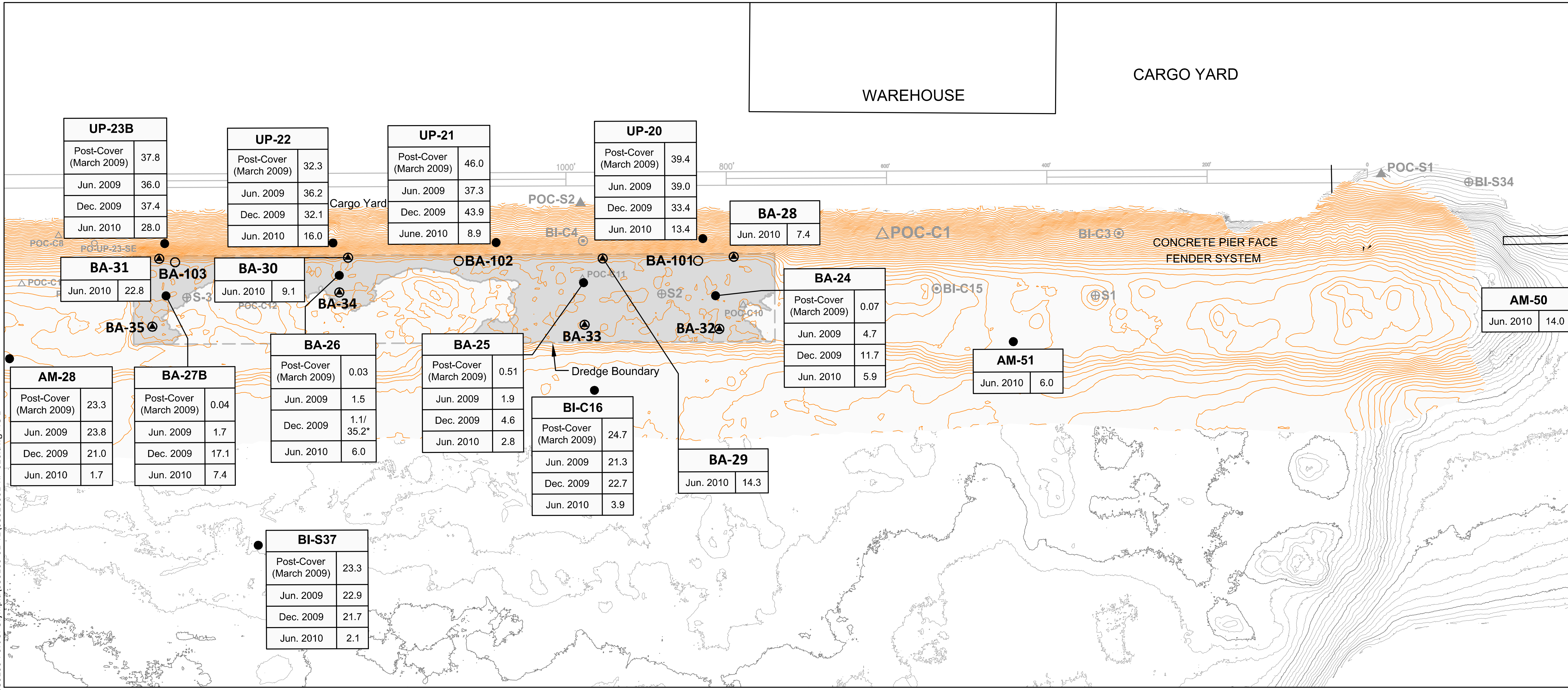
Table 6
Bathymetry Comparison

	Post-Construction Elevation (feet MLLW)				Change in Mudline Elevation at Pierface (feet)	Distance Under Pier to Top of Sloughed Slope (from fender line; feet)				Increase in Lateral Distance to Top of Sloughed Slope (feet)
	Post-Cover	3-Month Survey	9-Month Survey	15-Month Survey *						
	Mar 9, 2009	Jun 24, 2009	Dec 10, 2009	Jun 21, 2010	Dec 2009 - Jun 2010	Mar 9, 2009	Jun 24, 2009	Dec 10, 2009	Oct 4, 2010	Dec 2009 - Oct 2010
Cross Section										
7+40	**-35.2**	**-34.9**	**-34.5**	-34.6	-0.1	7.0	8.0	16.5	27.0	10.5
7+90	**-39.9**	**-38.2**	**-37.1**	-36.6	0.5	11.0	11.5	14.5	30.0	15.5
8+90	**-37.6**	**-37.3**	**-36.6**	-35.1	1.5	9.0	11.0	13.0	24.0	11.0
9+70	**-35.6**	**-36.6**	**-35.3**	-36.6	-1.3	1.5	8.5	11.5	27.0	15.5
10+90	**-37.7**	**-36.2**	**-35.9**	-34.9	1.0	12.0	12.0	15.0	27.0	12.0
11+90	**-39.6**	**-37.5**	**-37.3**	-36.7	0.6	4.0	7.5	10.0	18.0	8.0
12+90	**-36.8**	**-35.9**	**-35.3**	-34.8	0.5	13.0	13.0	18.0	26.0	8.0
13+90	**-37.7**	**-36.7**	**-35.9**	-35.2	0.7	10.0	10.0	10.0	27.0	17.0
14+90	**-39.0**	**-36.6**	**-36.1**	-35.3	0.8	7.0	8.0	8.5	19.0	10.5
15+40	**-31.8**	**-30.2**	**-30.9**	-33.1	-2.2	0.0	0.0	9.0	26.0	17.0
Minimum	**-39.9**	**-38.2**	**-37.3**	**-36.7**	**-2.2**	**0.0**	**0.0**	**8.5**	**18.0**	**8.0**
Average	**-37.1**	**-36.0**	**-35.5**	**-35.3**	**0.2**	**7.5**	**9.0**	**12.6**	**25.1**	**12.5**
Maximum	**-31.8**	**-30.2**	**-30.9**	**-33.1**	**1.5**	**13.0**	**13.0**	**18.0**	**30.0**	**17.0**

Note:

* Because of the undertainty of the accuracy of the multibeam survey at the pierface, mudline elevations at the pierface are provided using leadlines collected on June 21, 2010.

NA = distance underepier to the top of the sloughed slope is not available due to the uncertainty associated with the underpier multibeam bathymetry results.



LEGEND:

- Dredged Area
- BA-27 ● Required Sediment Grab Location
- BA-31 ⊕ Supplemental Surface Sediment Location
- BA-103 ○ 2010 Subsurface Core Location
- S4 ⊕ Core Sample - DMMP 2006
- BI-C4 ⊙ Core Sample - Ecology 2007
- POC-S2 ▲ Surface Sample - Port 2007
- POC-S5 △ Core Sample - Port 2007
- PO-UP-22-SE ○ Core Sample - Port 2008
- PO-BA-27-SE ● Core Sample - Port 2008

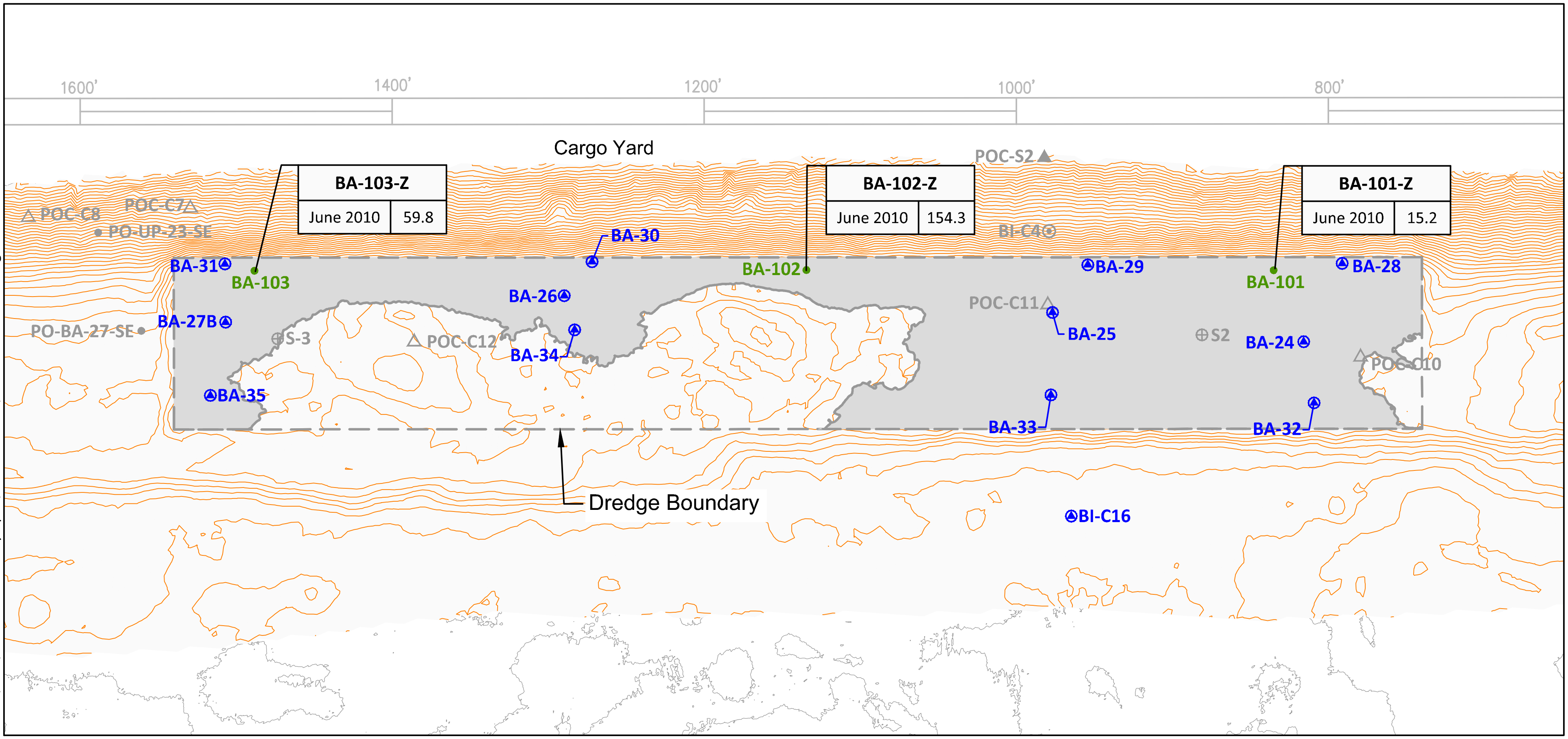
0 125
Scale in Feet

HORIZONTAL DATUM: Horizontal datum is Washington State Plane - South Zone (NAD 83(91)), U.S. survey feet.
VERTICAL DATUM: Vertical datum is Mean Lower Low Water (MLLW).
NOTES:
1. Bathymetric survey provided by eTrac, dated July 13, 2010 (gray) and October 4, 2010 (orange).
2. Contour interval is 1 foot.
3. * Field Duplicate.
4. Data are Total Dioxin/Furan TEQ 2005 (Mammal) (U=0) in ng/kg.
5. Surface sediment is 0 - 10 cm.

K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-026.dwg FIG 1
Oct 28, 2010 3:20pm cdavidson

ANCHOR QEA

Figure 1
Post-Construction Dioxin Concentrations through June 2010
Berth 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia



K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-028.dwg FIG 2

HORIZONTAL DATUM: Washington State Plane - South Zone (NAD 83(91)), U.S. Survey Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).
NOTES:
1. Bathymetric survey provided by eTrac, dated July 13, 2010 (gray) and October 4, 2010 (orange).
2. Contour interval is 1 foot.
3. Data are Total Dioxin/Furan TEQ 2005 (Mammal) (U=0) in ng/kg.

LEGEND:

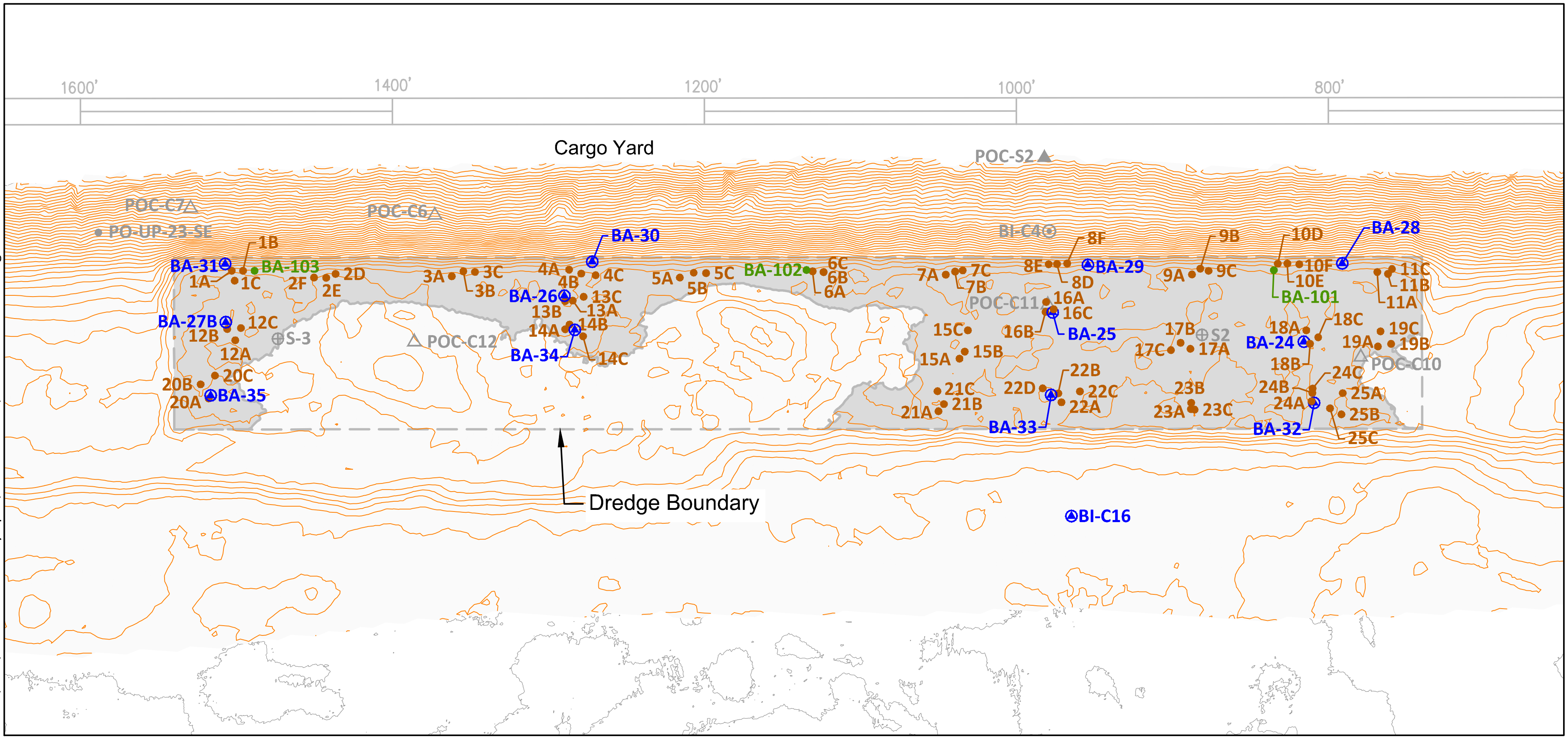
(gray box)	Dredged Area
BA-103 ●	Actual Subsurface Core Location
BA-31	Actual 2010 Surface Sediment Location
S4 ⊕	Core Sample - DMMP 2006
BI-C4 ⊙	Core Sample - Ecology 2007
POC-S2 ▲	Surface Sample - Port 2007
POC-S5 △	Core Sample - Port 2007
PO-UP-22-SE ●	Core Sample - Port 2008
PO-BA-27-SE ●	Core Sample - Port 2008

0 100
Scale in Feet

Oct 28, 2010 3:22pm cdavidson

ANCHOR QEA

Figure 2
June 2010 Subsurface Dioxin Concentrations
Berth 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia



K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-030.dwg FIG 3

Oct 28, 2010 3:59pm cdavidson

HORIZONTAL DATUM: Washington State Plane - South Zone (NAD 83(91)), U.S. Survey Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).
NOTES:

1. Bathymetric survey provided by eTrac, dated July 13, 2010 (gray) and October 4, 2010 (orange).
2. Contour interval is 1 foot.
3. AM-50 and AM-51 are included in the sampling program but are not shown on this figure.

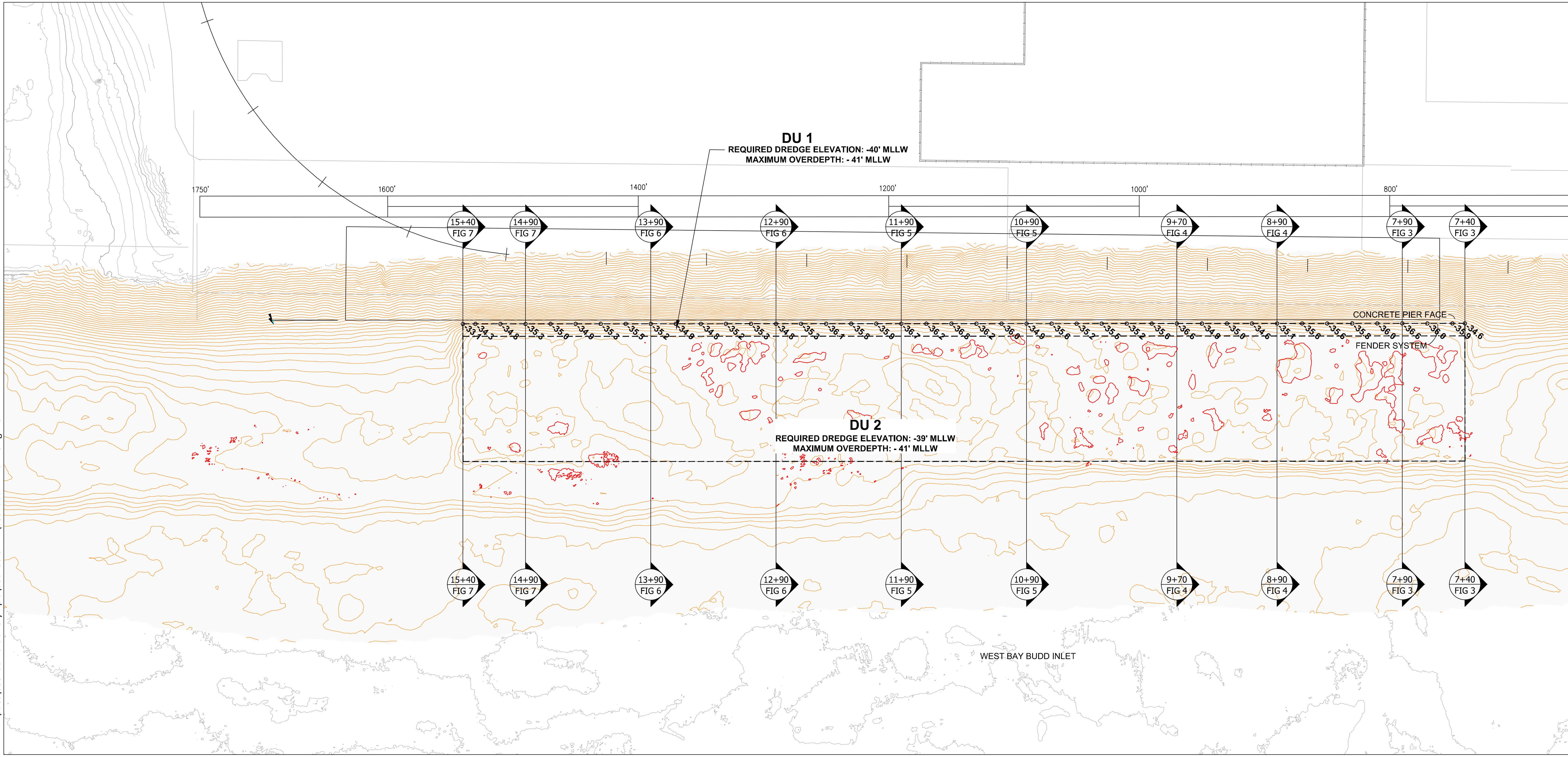
LEGEND:

- Dredged Area
- BA-103 ● Actual Subsurface Core Location
- BA-31 ⊕ Actual 2010 Surface Sediment Location
- 12 ● Actual SPI Sample Location
- S4 ⊕ Core Sample - DMMP 2006
- BI-C4 ⊙ Core Sample - Ecology 2007
- POC-S2 ▲ Surface Sample - Port 2007
- POC-S5 △ Core Sample - Port 2007
- PO-UP-22-SE ● Core Sample - Port 2008
- PO-BA-27-SE ● Core Sample - Port 2008

0 100
Scale in Feet

ANCHOR QEA

Figure 3
Actual SPI and Sediment Monitoring Locations, June 2010
Berth 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia



K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-027.dwg FIG 4

Oct 28, 2010 4:03pm cdavidson

HORIZONTAL DATUM: WASHINGTON STATE PLANE - SOUTH ZONE (NAD 83(91)), U.S. SURVEY FEET.

VERTICAL DATUM: NOS MEAN LOWER LOW WATER (MLLW).

SURVEY: BATHYMETRIC SURVEY PROVIDED BY ETRAC, DATED JULY 13, 2010 (GRAY) AND OCTOBER 4, 2010 (ORANGE).

NOTES: CONTOUR INTERVAL IS 1 FOOT.

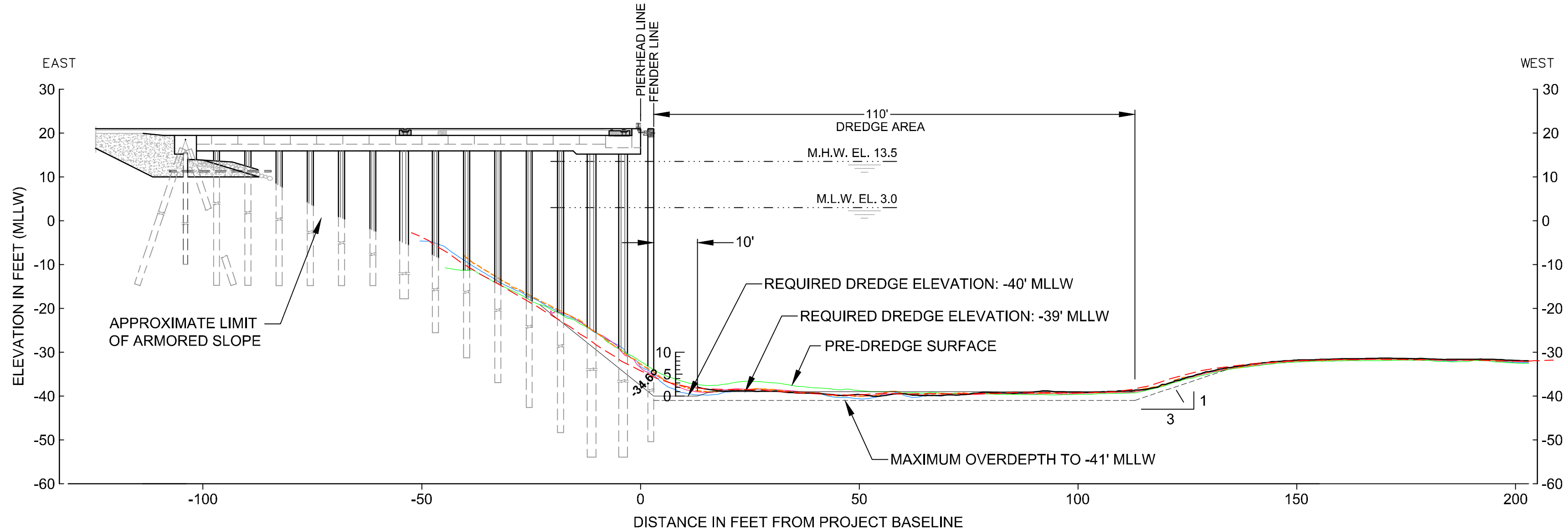
LEGEND:

- FENDER LINE
- PIERHEAD LINE
- CONTOURS
- RAIL LINE
- DREDGE AREA
- -39 -39 FEET MLLW
- 33.1 LEADLINE ELEVATION IN FEET (JUNE 21 2010)

0 80
Scale in Feet

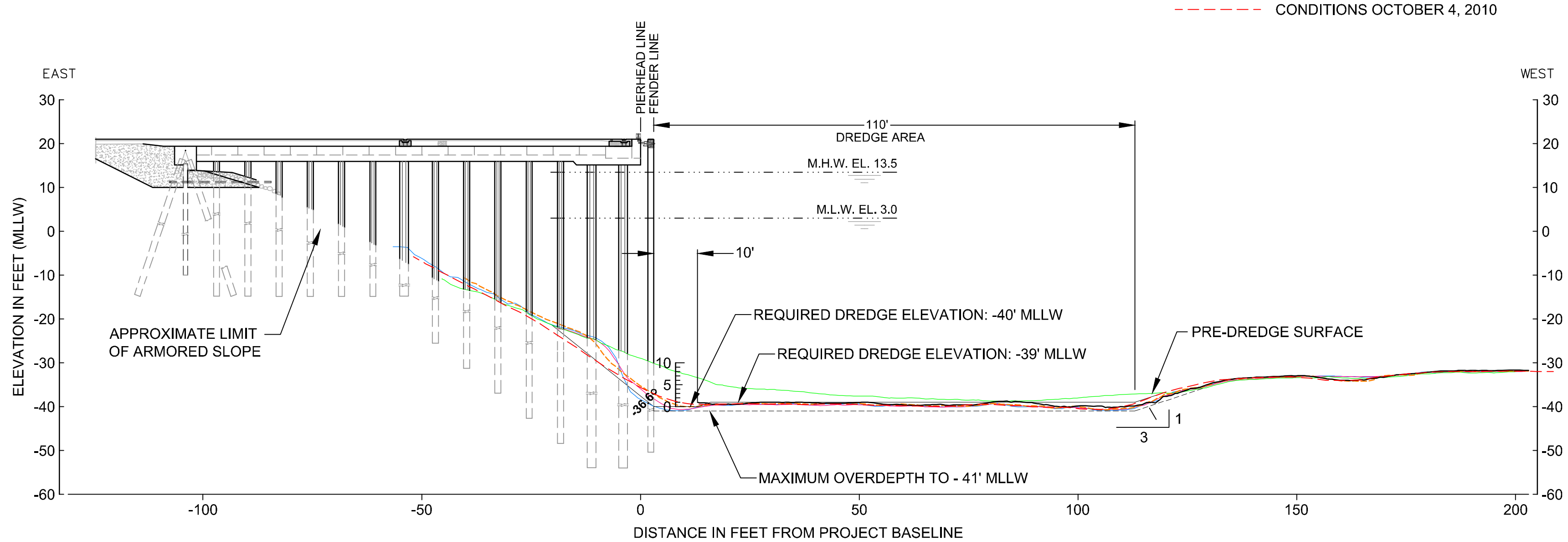
ANCHOR QEA

Figure 4
15-Month Post-Dredge Bathymetry
Berths 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia



7+40 FIG 1 CROSS SECTION
SCALE: 1" = 40'

- PRE-DREDGE MARCH 27, 2008
- POST-COVER MARCH 9, 2009
- CONDITIONS JUNE 24, 2009
- CONDITIONS DECEMBER 10, 2009
- CONDITIONS JULY 13, 2010
- CONDITIONS OCTOBER 4, 2010



7+90 FIG 1 CROSS SECTION
SCALE: 1" = 40'

LEGEND:

-33.1 LEADLINE ELEVATION IN FEET (JUNE 21 2010)

HORIZONTAL DATUM: WASHINGTON STATE PLANE - SOUTH ZONE (NAD 83(91)), U.S. SURVEY FEET.
VERTICAL DATUM: NOS MEAN LOWER LOW WATER (MLLW).
SURVEYS:

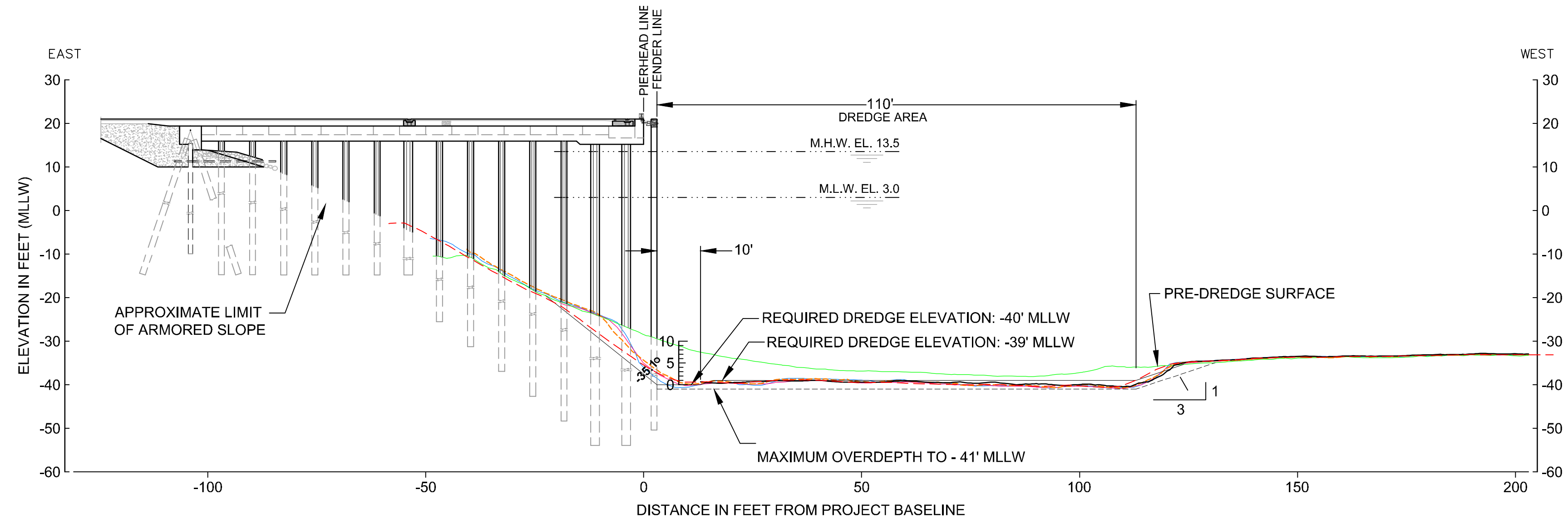
1. PRE-DREDGE SURVEY PROVIDED BY DAVID EVANS AND ASSOCIATES, INC., DATED MARCH 27, 2008
2. POST CONSTRUCTION SURVEY PROVIDED BY ETRAC, DATED MARCH 9, 2009.
3. 3-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JUNE 24, 2009.
4. 9-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED DECEMBER 10, 2009.
5. 15-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JULY 13, 2010 IN BERTHING AREAS AND OCTOBER 4, 2010 IN UNDERPIER AREA.

0 40
Scale in Feet

K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-027.dwg FIG 5
Oct 28, 2010 3:06pm cdavidson

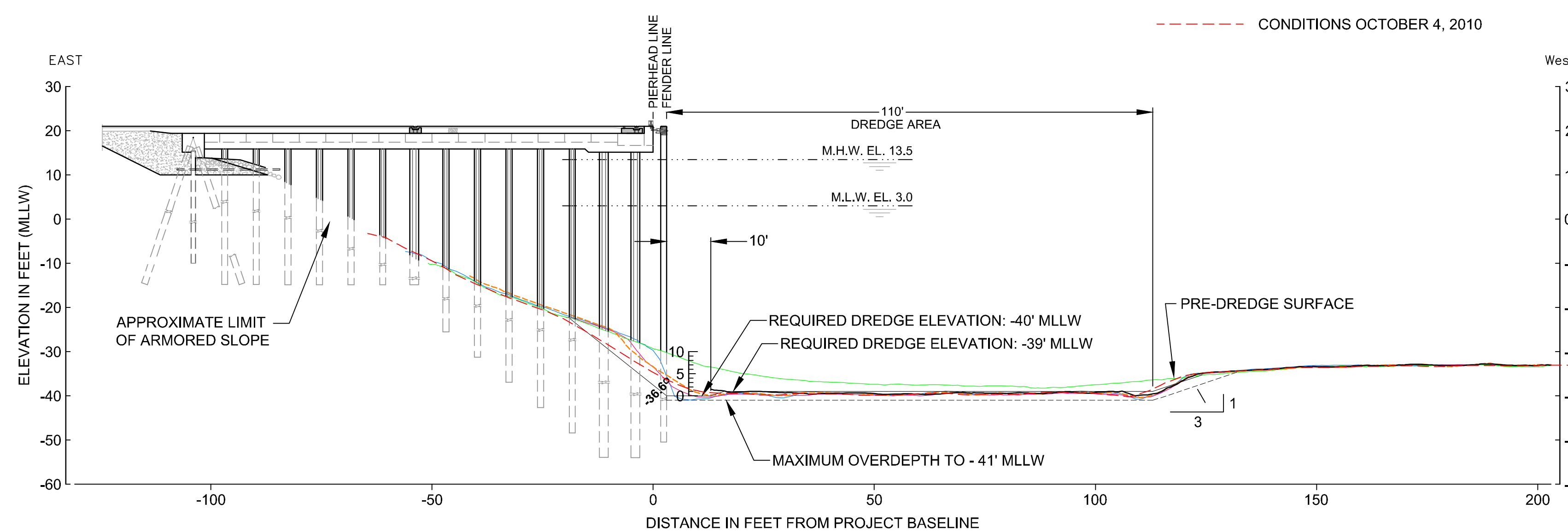
Figure 5
Cross Sections 7+40 and 7+90
Berths 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia

ANCHOR QEA



8+90 FIG 1 CROSS SECTION
SCALE: 1" = 40'

PRE-DREDGE MARCH 27, 2008
POST-COVER MARCH 9, 2009
CONDITIONS JUNE 24, 2009
CONDITIONS DECEMBER 10, 2009
CONDITIONS JULY 13, 2010
CONDITIONS OCTOBER 4, 2010



9+70 FIG 1 CROSS SECTION
SCALE: 1" = 40'

LEGEND:

-33.1 LEADLINE ELEVATION IN FEET (JUNE 21 2010)

HORIZONTAL DATUM: WASHINGTON STATE PLANE - SOUTH ZONE (NAD 83(91)), U.S. SURVEY FEET.
VERTICAL DATUM: NOS MEAN LOWER LOW WATER (MLLW).
SURVEYS:

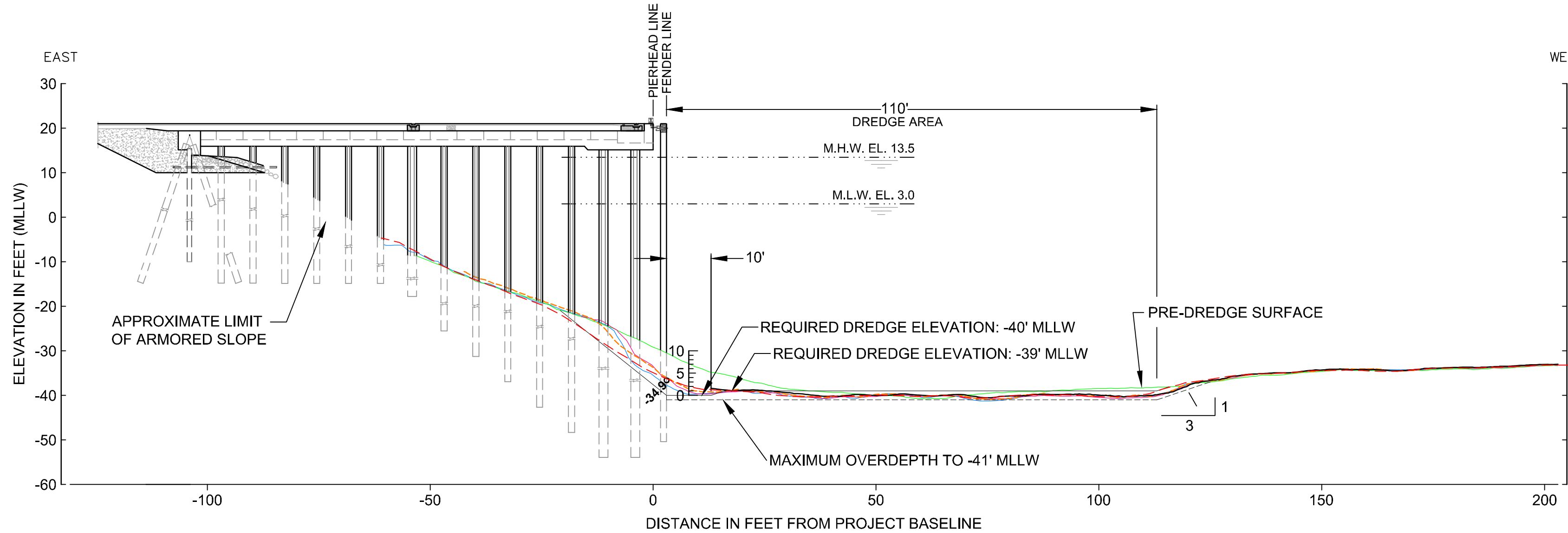
1. PRE-DREDGE SURVEY PROVIDED BY DAVID EVANS AND ASSOCIATES, INC., DATED MARCH 27, 2008
2. POST CONSTRUCTION SURVEY PROVIDED BY ETRAC, DATED MARCH 9, 2009.
3. 3-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JUNE 24, 2009.
4. 9-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED DECEMBER 10, 2009.
5. 15-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JULY 13, 2010 IN BERTHING AREAS AND OCTOBER 4, 2010 IN UNDERPIER AREA.

0 40
Scale in Feet

K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-027.dwg FIG 6
Oct 28, 2010 3:11pm cdavidson

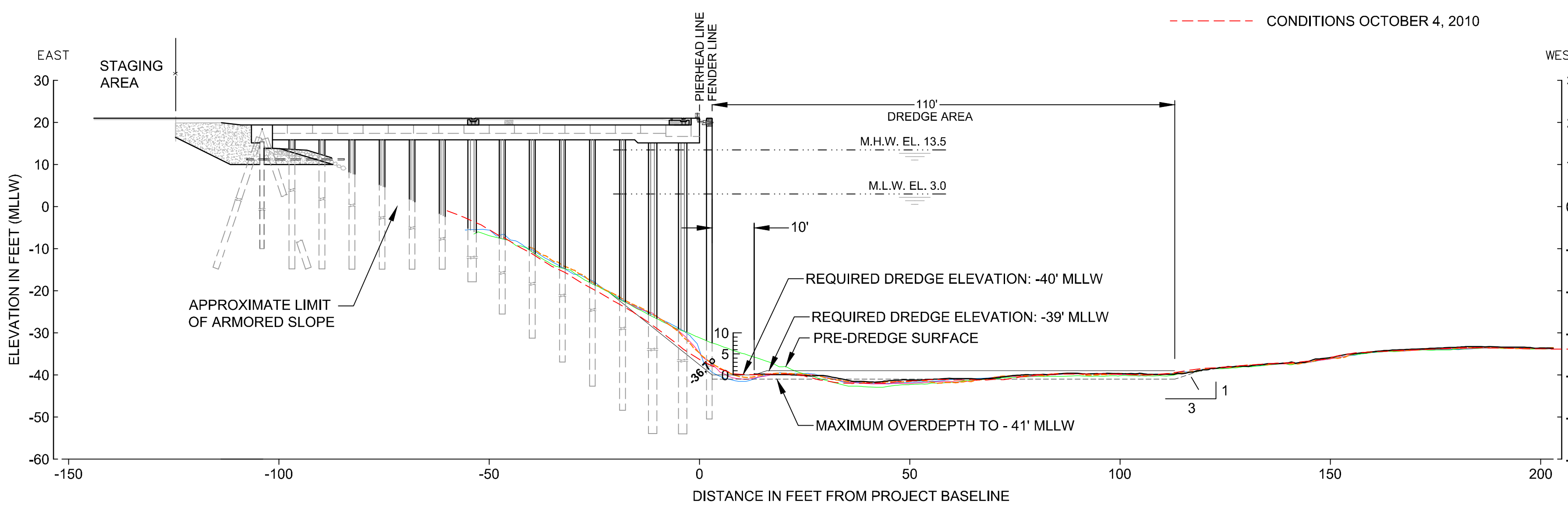
ANCHOR QEA

Figure 6
Cross Sections 8+90 and 9+70
Berths 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia



10+90 FIG 1 CROSS SECTION
SCALE: 1" = 40'

PRE-DREDGE MARCH 27, 2008
POST-COVER MARCH 9, 2009
CONDITIONS JUNE 24, 2009
CONDITIONS DECEMBER 10, 2009
CONDITIONS JULY 13, 2010
CONDITIONS OCTOBER 4, 2010



11+90 FIG 1 CROSS SECTION
SCALE: 1" = 40'

LEGEND:

-33.7 LEADLINE ELEVATION IN FEET (JUNE 21 2010)

HORIZONTAL DATUM: WASHINGTON STATE PLANE - SOUTH ZONE (NAD 83(91)), U.S. SURVEY FEET.
VERTICAL DATUM: NOS MEAN LOWER LOW WATER (MLLW).
SURVEYS:

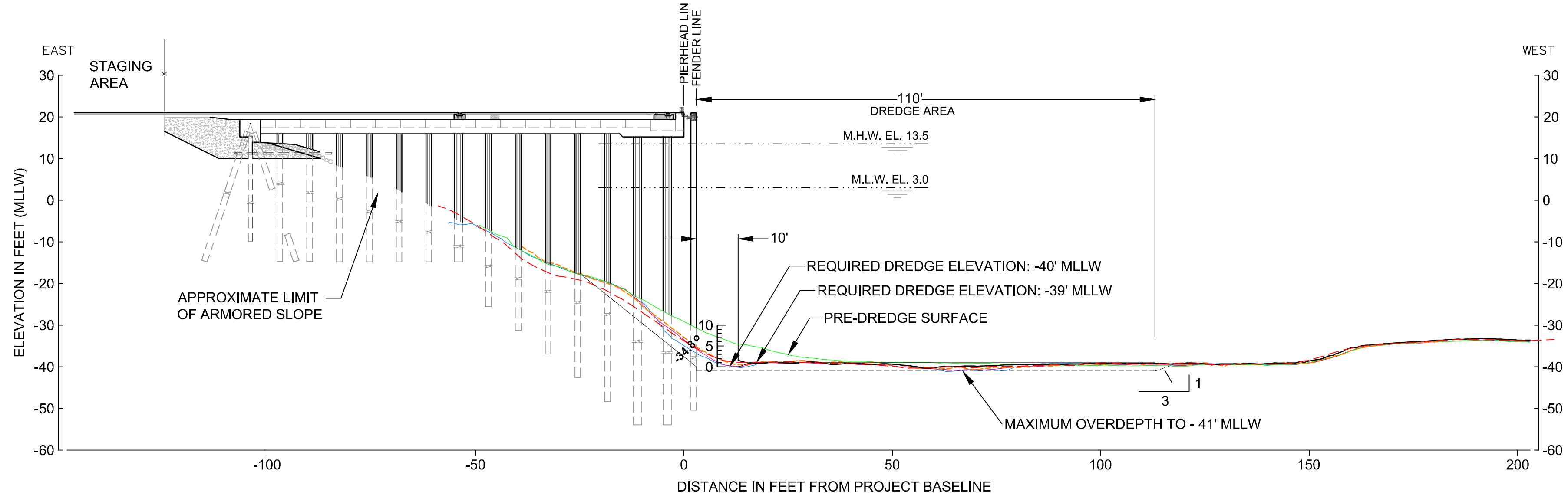
1. PRE-DREDGE SURVEY PROVIDED BY DAVID EVANS AND ASSOCIATES, INC., DATED MARCH 27, 2008
2. POST CONSTRUCTION SURVEY PROVIDED BY ETRAC, DATED MARCH 9, 2009.
3. 3-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JUNE 24, 2009.
4. 9-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED DECEMBER 10, 2009.
5. 15-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JULY 13, 2010 IN BERTHING AREAS AND OCTOBER 4, 2010 IN UNDERPIER AREA.

0 40
Scale in Feet

K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-027.dwg FIG 7
Oct 28, 2010 3:12pm cdavidson

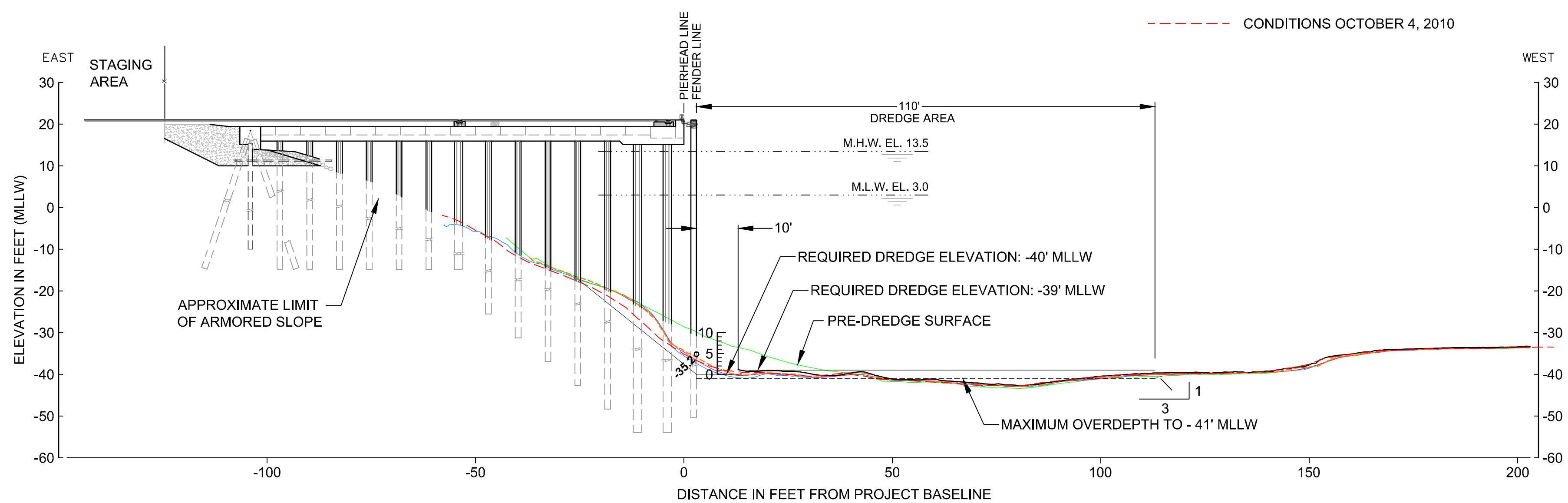
ANCHOR QEA

Figure 7
Cross Sections 10+90 and 11+90
Berths 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia



12+90 FIG 1 CROSS SECTION
SCALE: 1" = 40'

- PRE-DREDGE MARCH 27, 2008
- POST-COVER MARCH 9, 2009
- CONDITIONS JUNE 24, 2009
- CONDITIONS DECEMBER 10, 2009
- CONDITIONS JULY 13, 2010
- CONDITIONS OCTOBER 4, 2010



13+90 FIG 1 CROSS SECTION
SCALE: 1" = 40'

LEGEND:

-33.1 LEADLINE ELEVATION IN FEET (JUNE 21 2010)

HORIZONTAL DATUM: WASHINGTON STATE PLANE - SOUTH ZONE (NAD 83(91)), U.S. SURVEY FEET.
VERTICAL DATUM: NOS MEAN LOWER LOW WATER (MLLW).
SURVEYS:

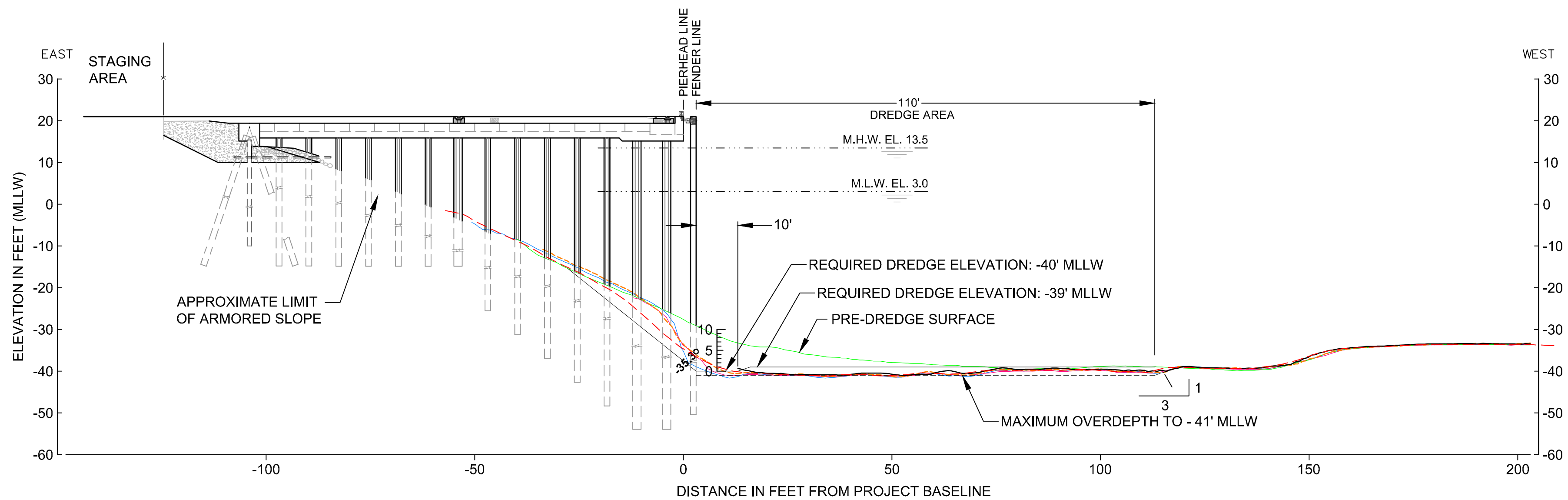
1. PRE-DREDGE SURVEY PROVIDED BY DAVID EVANS AND ASSOCIATES, INC., DATED MARCH 27, 2008
2. POST CONSTRUCTION SURVEY PROVIDED BY ETRAC, DATED MARCH 9, 2009.
3. 3-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JUNE 24, 2009.
4. 9-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED DECEMBER 10, 2009.
5. 15-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JULY 13, 2010 IN BERTHING AREAS AND OCTOBER 4, 2010 IN UNDERPIER AREA.

0 40
Scale in Feet

K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-027.dwg FIG 8
Oct 28, 2010 3:16pm cdavidson

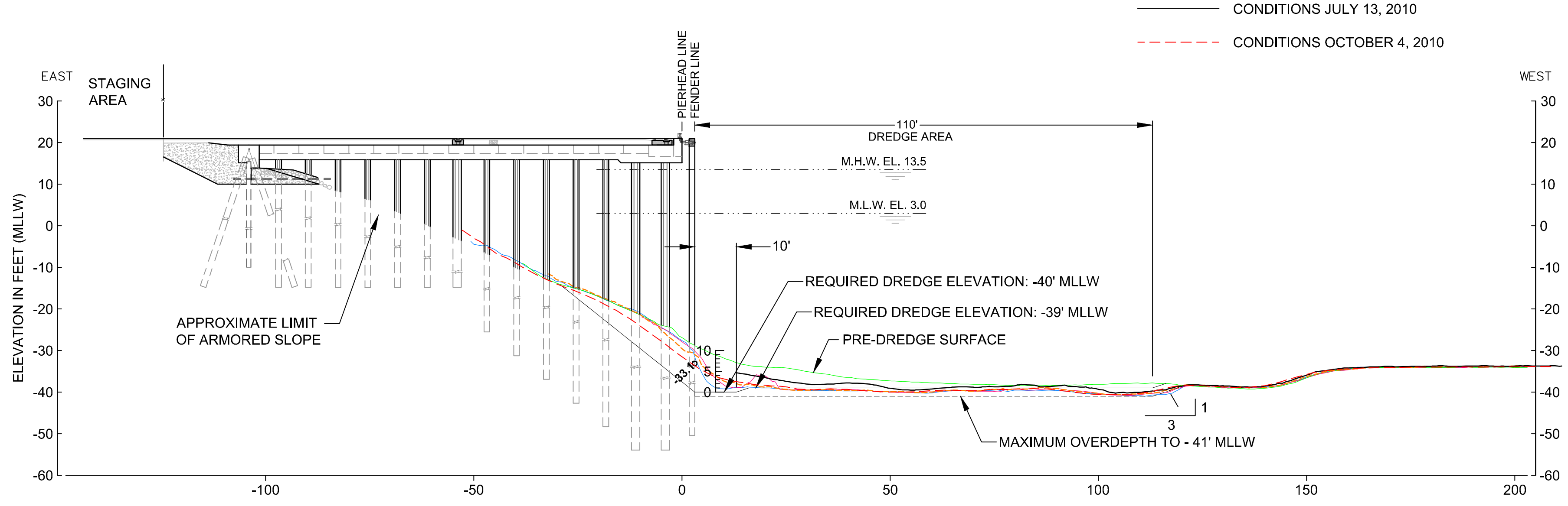
ANCHOR QEA

Figure 8
Cross Sections 12+90 and 13+90
Berths 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia



14+90 FIG 1 CROSS SECTION
SCALE: 1" = 40'

PRE-DREDGE MARCH 27, 2008
POST-COVER MARCH 9, 2009
CONDITIONS JUNE 24, 2009
CONDITIONS DECEMBER 10, 2009
CONDITIONS JULY 13, 2010
CONDITIONS OCTOBER 4, 2010



15+40 FIG 1 CROSS SECTION
SCALE: 1" = 40'

LEGEND:

-33.1 LEADLINE ELEVATION IN FEET (JUNE 21 2010)

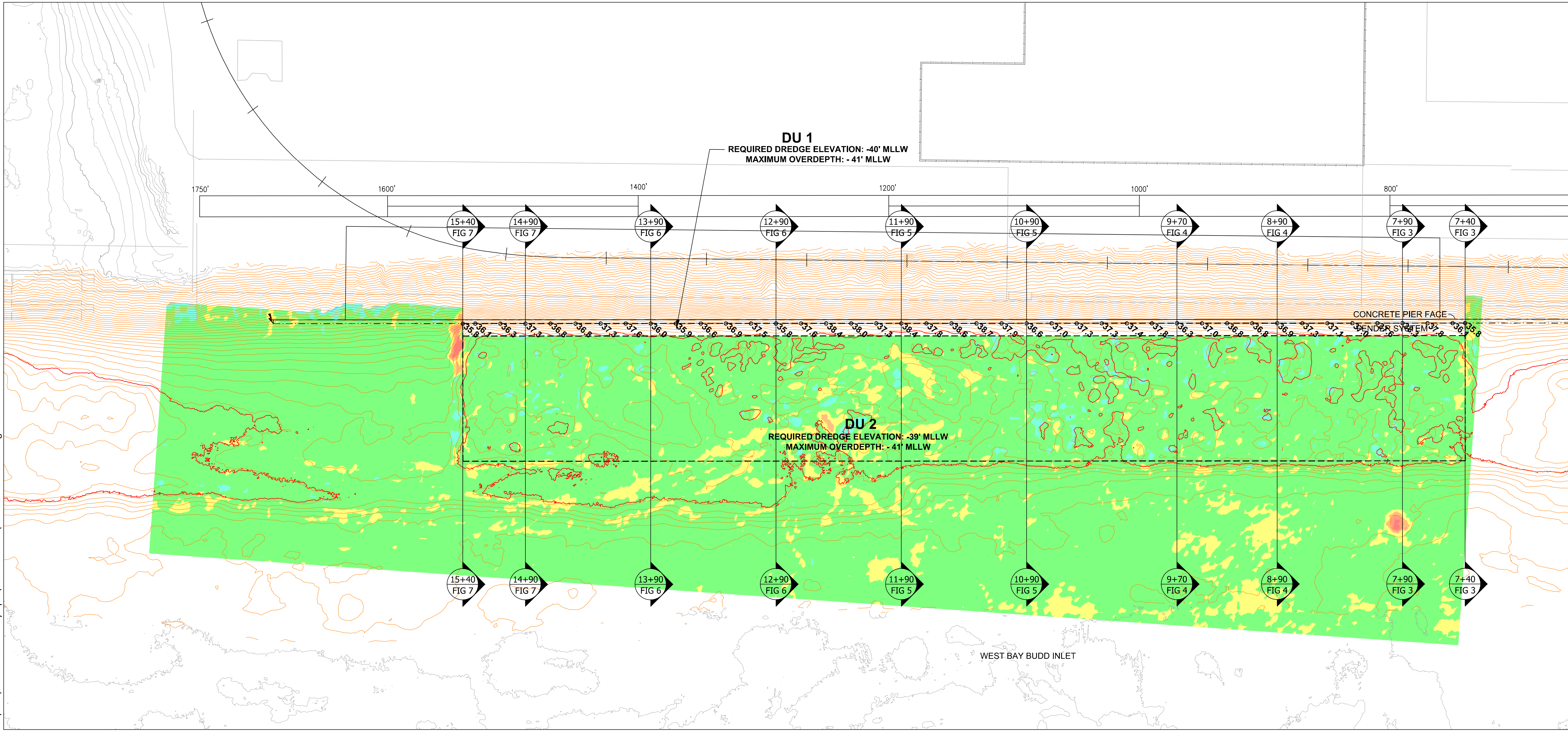
HORIZONTAL DATUM: WASHINGTON STATE PLANE - SOUTH ZONE (NAD 83(91)), U.S. SURVEY FEET.
VERTICAL DATUM: NOS MEAN LOWER LOW WATER (MLLW).
SURVEYS:

1. PRE-DREDGE SURVEY PROVIDED BY DAVID EVANS AND ASSOCIATES, INC., DATED MARCH 27, 2008
2. POST CONSTRUCTION SURVEY PROVIDED BY ETRAC, DATED MARCH 9, 2009.
3. 3-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JUNE 24, 2009.
4. 9-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED DECEMBER 10, 2009.
5. 15-MONTH CONDITIONS SURVEY PROVIDED BY ETRAC, DATED JULY 13, 2010 IN BERTHING AREAS AND OCTOBER 4, 2010 IN UNDERPIER AREA.

K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-027.dwg FIG 9
Oct 28, 2010 3:14pm cdavidson

ANCHOR QEA

Figure 9
Cross Sections 14+90 and 15+40
Berths 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia



K:\Jobs\080166-Port of Olympia\080166-01-T2\08016601-RP-029.dwg FIG 10

Oct 28, 2010 3:55pm cdavidson

HORIZONTAL DATUM: WASHINGTON STATE PLANE - SOUTH ZONE (NAD 83(91)), U.S. SURVEY FEET.

VERTICAL DATUM: NOS MEAN LOWER LOW WATER (MLLW).

SURVEY: BATHYMETRIC SURVEY PROVIDED BY eTRAC, DATED JULY 13, 2010 BATHYMETRIC SURVEY PROVIDED BY ETRAC, DATED JULY 13, 2010 (GRAY) AND OCTOBER 4, 2010 (ORANGE).

NOTES: CONTOUR INTERVAL IS 1 FOOT.

ISOPACH SHOWING DIFERENCE IN FEET BETWEEN SURVEYS CONDUCTED ON 06/24/2009 AND 12/10/2009.

RANGE BEG.	RANGE END	
< -2.00	-1.50	CURRENT CONDITION IS DEEPER THAN PREVIOUS
-1.50	-1.00	
-1.00	-0.50	
-0.50	0.00	
0.00	0.50	CURRENT CONDITION IS SHALLOWER THAN PREVIOUS
0.50	1.00	
1.00	1.50	
1.50	> 2.00	

LEGEND:

- FENDER LINE
- PIERHEAD LINE
- CONTOURS
- RAIL LINE
- DREDGE AREA
- -39 -39 FEET MLLW

0 80
Scale in Feet

Figure 10
Comparison of June 2010 and December 2009 Bathymetric Surveys
Berths 2 and 3 Interim Cleanup Action Pilot Study
Port of Olympia

ANCHOR QEA