Prepared by:
Dredged Material Management Office
Seattle District, US Army Corps of Engineers

MEMORANDUM FOR RECORD February 14, 2019

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM BHP BILLITON CANADA, INC. PROPOSED POTASH EXPORT FACILITY IN HOQUIAM, WASHINGTON (NWS-2017-715), FOR OPEN-WATER DISPOSAL AT THE SOUTH JETTY OR POINT CHEHALIS DISPERSIVE SITES OR FOR IN-WATER BENEFICIAL USE.

1. INTRODUCTION. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and Washington Departments of Ecology and Natural Resources) regarding the suitability of material proposed for dredging by BHP Billiton Canada Inc. (BHP) for open-water disposal at the South Jetty or Point Chehalis sites, for potential in-water beneficial use, and for compliance with the State of Washington Antidegradation Policy.

2. PROJECT BACKGROUND. BHP proposes to construct and operate a shipping terminal in and adjacent to Grays Harbor (Figure 2) that would transfer up to 8 million tons of potash per year from trains to ocean-going vessels. Potash (potassium chloride) is a naturally occurring mineral used as a key ingredient in agricultural and household fertilizer. The potash would be mined in Saskatchewan, Canada, for export to markets primarily along the Pacific Rim. The proposed terminal would consist of facilities to unload potash from trains, stockpile the potash on-site, and load the potash into ocean-going vessels (Figure 3). Construction of the terminal would involve dredging, in-water disposal of dredged material, filling wetlands, constructing new overwater structures, and fill in waters of the United States.

3. PROPOSED DREDGING. For the dredging portion of the project, BHP proposes to remove approximately 107,606 cubic yards (cy) of sediment to provide a new berth capable of servicing bulk material export vessels in Grays Harbor, Washington. Proposed dredging is planned to begin during the 2019/2020 in-water work window. The Port of Grays Harbor Terminal 3 berth, which overlaps the BHP dredging footprint, is currently authorized to a depth of -41 feet mean lower low water (MLLW) with two feet of overdredge allowance. The proposed depth for the new export facility berth is -43 feet MLLW plus two feet of allowable overdredge to -45 feet MLLW. BergerABAM Inc. oversaw planning and execution of the characterization effort on behalf of BHP.

Table 1. Project Tracking

APPLICANT	BHP BILLITON CANADA, INC.
Project rank	Low-moderate
Proposed dredging volume	107,606 cy
Proposed dredging depth	-45 ft. MLLW (incl. 2 ft. overdepth)
Round 1 Sampling	
1st draft SAP received	August 29, 2017
Comments provided on 1st draft SAP	September 11, 2017
2nd draft SAP received	October 16, 2017
2nd draft SAP approved	October 30, 2017
Final SAP received (updated sample equipment)	December 1, 2017
Final SAP approved	December 6, 2017
1st sampling attempt (no samples collected; incorrect bathymetry)	December 12, 2017

Table 1. Project Tracking

APPLICANT	BHP BILLITON CANADA, INC.
1st draft revised SAP received	February 9, 2018
Comments provided on 1st draft revised SAP	February 16, 2018
2nd draft revised SAP received	February 22, 2018
Comments provided on 2nd draft revised SAP	February 23, 2018
Final SAP received	February 25, 2018
Sampling dates (incomplete due to sampling difficulties)	February 26-27, 2018
Draft data report received	May 18, 2018
Updated draft data received	June 20, 2018
Status of sediment characterization memo provided; more sampling needed prior to SDM	July 3, 2018
Round 2 Sampling	
1st draft. SAP Addendum (SAPA) received	July 13, 2018
Comments provided on 1st draft SAPA	July 17, 2018
Revised draft SAPA received	July 19, 2018
Revised SAPA approved	July 30, 2018
Final SAPA received	August 9, 2018
Sampling dates	August 15-16, 2018
1st draft data report received	September 25, 2018
Comments provided on 1st draft data report	October 25, 2018
Revised data report received	November 29, 2018
Comments provided on revised draft data report	January 4, 2019
Final data report received	January 8, 2019
DMMP Tracking number	BHPGH-1-A-F-399
EIM Project number	BHPGH18
USACE Public Notice #	NWS-2017-715
Recency Expiration Date (LM – 6 years)	February 2024

4. PROJECT RANK AND SAMPLING REQUIREMENTS. This project was ranked "low-moderate" by the DMMP agencies according to the guidelines set out in the DMMP User Manual for areas not likely to be contaminated but with no data to confirm a low rank. In a low-moderate-ranked area the number of samples and analyses are calculated using the following guidelines (DMMP 2016/2018):

   - Maximum volume of sediment represented by each field sample = 8,000 cubic yards
   - Maximum volume of sediment represented by each analysis in the upper 4-feet of the dredging prism (surface sediment) = 32,000 cubic yards
   - Maximum volume of sediment represented by each analysis in the subsurface portion of the dredging prism = 48,000 cubic yards

   The total project volume in the sampling and analysis plan (SAP) was 107,606 cubic yards (cy), which included a design depth of -45 ft. MLLW (including 2 ft. of overdredge depth). Using the DMMP sampling and testing guidelines above, a total of eight (8) cores were planned to characterize two surface DMMUs and two subsurface DMMUs, as shown in Table 2.

Table 2. Proposed Project Rank and Sampling

DMMU ID	Core Station	DMMU Subunit ID	Rank	Frequency Requirement Based on LM Rank	Approximate Total DMMU Volume (cy)
DMMU-1 (surface)	SS-1	SS-1A	LM	1 sample/ 8,000 cy and 1 DMMU/32,000 cy (surface)	22,616
	SS-2	SS-2A			
	SS-5	SS-5A			
	SS-6	SS-6A			
DMMU-2 (surface)	SS-3	SS-3A			22,675
	SS-4	SS-4A			
	SS-7	SS-7A			
	SS-8	SS-8A			
DMMU-3 (subsurface)	SS-1	SS-1B	LM	1 sample/ 8,000 cy and 1 DMMU/48,000 cy (subsurface)	31,154
	SS-2	SS-2B			
	SS-5	SS-5B			
	SS-6	SS-6B			
DMMU-4 (subsurface)	SS-3	SS-3B			31,161
	SS-4	SS-4B			
	SS-7	SS-7B			
	SS-8	SS-8B			
TOTAL					107,606

5. ROUND 1 SAMPLING. Planned field sampling took place on February 26-27, 2018. Cores were collected with a MudMole pneumatic corer owned and operated by AMEC/WOOD of Lynnwood, Washington, with dive support provided by Research Support Services (RSS) of Bainbridge Island, Washington. Current and wind conditions made it difficult for sampling vessels and equipment to maintain positions at the identified core locations, and only six out of the eight planned core samples were obtained. Other sample station locations were moved, sample recovery was difficult, and core penetration was limited. In some cases the actual core locations weren't moved very far, but moving even a little ways on a steep slope resulted in large differences in planned vs. actual sample elevations (Table 3). These moves—again, due to difficult sampling conditions--also resulted in changes to the relative depths of the subsurface DMMUs and Z-layer (see cross-sections in Figures 5 through 8).

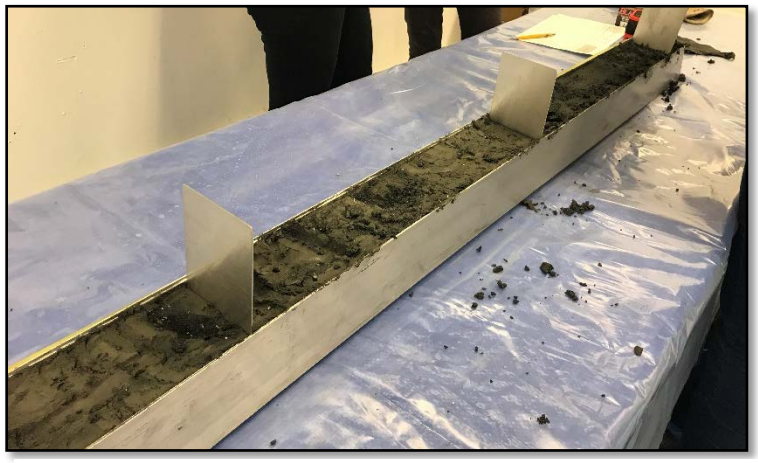


Figure 1. Core sample SS-1, February 2018.

Collected cores were transferred to a building on the Port of Grays Harbor T3 pier were they were opened, logged, and subsampled. All material obtained was composited into four DMMU samples per the approved SAP--to the extent possible--and submitted for chemical analysis to Analytical Resources Inc. in Tukwila, Washington (BergerABAM 2019).

Table 3. Round 1 Sampling: Planned vs. actual core locations and recovery

DMMU ID	Core Station	Planned Sample Elevation (MLLW)	Actual Sample Elevation (MLLW)	Approx. Actual Location
DMMU-1 (surface)	SS-1	-32 to -36	-26 to -30	Moved 5.7 ft. N
	SS-2	-25 to -29	-15 to -19	Moved 5.7 ft. N
	SS-5	-27 to -31	-24 to -28	Moved 4.0 ft. S
	SS-6	-12 to -16	-1 to -5	Moved 35.7 ft. W
DMMU-2 (surface)	SS-3	-36 to -40	-33 to -37	Moved 29.2 ft. E
	SS-4	-35 to -39	NS	NA
	SS-7	-37 to -41	NS	NA
	SS-8	--37 to --41	-35 to -39	Moved 13.7 ft. N
DMMU-3 (subsurface)	SS-1	-36 to -42	-30 to -34	Moved 5.7 ft. N
	SS-2	-29 to -35	-19 to -27	Moved 5.7 ft. N
	SS-5	-31 to -47	-28 to -33	Moved 4.0 ft. S
	SS-6	-16 to -33	-5 to -6	Moved 35.7 ft. W
DMMU-4 (subsurface)	SS-3	-40 to -47	NS	Moved 29.2 ft. E; no penetration or recovery
	SS-4	-39 to -47	NS	NA
	SS-7	-41 to -47	NS	NA
	SS-8	-41 to -47	-39 to -45	

Notes:

- NS = Not sampled
- NA – Not applicable
- Purple shaded samples were not collected.

6. ROUND 1 ANALYSIS. The agencies reviewed Round 1 data for compliance with DMMP guidelines, in order to establish whether the agencies could determine suitability for open-water disposal without additional data. This analysis considered number of samples, representativeness of sampled material, and results of laboratory analyses.

   a. *Round 1 - Number of Samples.* This project was ranked "low-moderate," based on DMMP guidelines used when there are few or no sources of chemicals of concern but insufficient data to support a "low" rank. Some of the BHP footprint overlaps the current Port of Grays Harbor T3, which is ranked "low." The T3 overlap area (both horizontal and vertical areas of prism overlap), whereT3 maintenance dredging has previously occurred, consists mainly of recently deposited sediments. But the BHP footprint also includes new dredging of bedded sediments—and thus similar characteristics to material tested at T3 cannot be assumed.

      The approved SAP identified four DMMUs, per Table 2. All planned samples were collected for surface DMMU-1 and subsurface DMMU-3. Surface DMMU-2 only had ½ the planned number of samples collected. However, the total number of surface samples falls within the range for required sampling density. Thus the DMMP was willing to look at further evidence for DMMU-2 to see if additional sampling would be required to determine whether DMMU-2 was suitable for open-water disposal.

Subsurface DMMU-4 had only one sample successfully collected. The DMMP did not consider this sufficient sampling density to evaluate this DMMU for open-water disposal.

b. *Representativeness of Samples*. The DMMP agencies looked at both horizontal (area) and vertical (depth) representativeness of the samples collected. In the most shoreward DMMUs (surface DMMU 1 and subsurface DMMU 3) successful samples were collected from different areas of the dredge prism. The shoreward area represents a steep slope, and samples were also collected from both the bottom and top of that slope. Thus, for both surface DMMU-1 and subsurface DMMU-3, the DMMP considers horizontal representation of those samples sufficient. Surface DMMU-2 had two successful samples (SS-3 and SS-8), with both the east and west ends of the prism represented, which was also considered sufficient. The only sample for subsurface DMMU-4, from SS8, was from the east end of the dredge prism. This was not considered sufficient horizontal coverage for DMMU-4.

   All core samples were driven until penetration slowed down considerably or stopped, apparently due to material too dense to penetrate. This sampling refusal occurred at some point in every core sample prior to reaching target depth. Refusal typically happens in undisturbed subsurface sediments and, especially when overlain by softer material in a location of known dredging or other disturbance, is indicative of native material that has not been exposed in recent history, *i.e.* not exposed to potential contamination.

   All sample cores from the surface DMMUs (1 and 2) had successful vertical coverage as they recovered the full 4 ft. portion of the planned vertical surface of the dredge prism. Subsurface samples had much more limited vertical recovery, due primarily to hitting refusal before reaching the bottom of the planned core. At least 4 ft. of vertical subsurface material was recovered in subsurface DMMU-3 samples SS1, SS2, and SS5. Only one foot of material was recovered from subsurface DMMU-3 sample SS6, though that sample was from the shallowest portion of the dredge prism and reached the bottom of the dredge prism. Subsurface sample SS8, from subsurface DMMU-4, obtained 6 ft. of vertical recovery, and was the only sample successfully collected from subsurface DMMU-4 in this sampling round. Mudmole bore logs, core logs and sample photographs confirmed stiff dense, presumably native material from the deepest sections of the core samples.

c. *Results of Laboratory Analyses.* The main contamination concerns in this area are residual dioxins/furans from previous local operation of chlor-oxide bleach process paper mills. Thus the DMMP is particularly concerned about fine-grained sediments within the estuary that may have been exposed prior to mill closures but not removed as part of previous dredging. Chemical analysis of all current samples showed no detected or undetected screening-level (SL) exceedances of any DMMP chemical of concern, including dioxins. The one sample representing subsurface DMMU-4 showed slightly higher detections of some chemicals than in the other three DMMUs (Table 6).

d. *Determination of Characterization Status.* Based on the preceding analysis, the DMMP concluded that suitability for open-water disposal could be determined with existing data for DMMU-1 and DMMU-3. For DMMU-2, the agencies agreed that there was sufficient sample representation and laboratory evidence to determine its suitability for open-water disposal.

   For subsurface DMMU-4, a determination of suitability could not be made with existing Round 1 data. BHP decided to pursue additional sampling and testing to address the identified data gaps. At

that time the DMMP requested that any additional surface DMMU-2 material, collected serendipitously in cores during follow-up sampling for underlying DMMU-4, be analyzed for physical characteristics (grain size and TOC) to determine physical consistency with previously characterized material within DMMU-2.

Table 5. Grain size results from Round 1 samples.

	Surface		Subsurface	
	DMMU-1	DMMU-2	DMMU-3	DMMU-4
Gravel	0.0%	0.2%	0.0%	0.0%
Sand	46.9%	73.2%	37.2%	48.6%
Silt	45.4%	25.4%	53.0%	43.6%
Clay	7.7%	1.2%	9.9%	7.8%
Total Fines (Silt + Clay)	53.1%	26.6%	62.9%	51.5%

Note: DMMU 4 is represented by only one sample

Table 6. Results of dioxin/furan analyses for Round 1 samples.

	DMMP Grays Harbor Guidelines			Surface		Subsurface	
	SL	BT	ML	DMMU-1	DMMU-2	DMMU-3	DMMU-4
2,3,7,8-TCDD (ng/kg dry wt.)	---	5	---	0.78 J	0.54 J	0.767 J	1.22
Total TEQ (ng/kg dry wt); U = ½ RL	---	15	---	2.81	1.48	2.61	4.52

Note: DMMU 4 is represented by only one sample

7. ROUND 2 SAMPLING. The second sampling event took place during August 14-16, 2018. Cores were collected with a vibracore owned and operated by RSS of Bainbridge Island, Washington. The sampler was a 4-inch-round core tube with a butyrate liner and electric vibracore assembly attached on top. Tidal currents again caused the sampling vessel to swing off station and to drag the sampler along the bottom. Many core attempts were unsuccessful, so core locations were moved in the field, sometimes substantially, to maximize likelihood of successful penetration into the subsurface (Table 7, Figure 4). Successful samples were collected during short windows of slack tide (thus cores SS-3A and SS-3B were taken in close proximity to each other), and/or with the boat secured between two dolphins (thus core SS-4B was very close to the border between subsurface DMMUs). Close coordination between field samplers and the DMMO was maintained throughout the sampling effort.

   Full penetration, including the planned Z-layer representing the proposed post-dredge surface, was not obtained in any of the Round 2 cores. All cores were driven to refusal, apparently encountering dense native material that sometimes appeared in the bottom of the core sample. Material from cores were composited proportionally into two DMMU samples for analyses, per Table 7. Material from surface sample DMMU-2A was submitted only for analyses of grain size and total organic carbon (TOC). Material from DMMU-4A was submitted for the full suite of DMMP chemicals of concern.

Table 7. Round 2 Sampling: Planned vs. actual core locations and recovery

DMMU ID	Core Station	Planned Sample Elevation (MLLW)	Actual Sample Elevation (MLLW)	Approx. Actual Location
DMMU-2A (surface)	SS-3A	-36 to -40	-35 to -39	Moved ~ 30 ft. E
	SS-3B	-36 to -40	-35 to -39	Moved ~ 24 ft. E
	SS-4B	-35 to -39	NS	---
	SS-7	-37 to -41	-36 to -39	Not moved
DMMU-4A (subsurface)	SS-3A	-40 to -45	-39 to -41	Moved ~ 30 ft. E
	SS-3B	-36 to -40	-39 to -41	Moved ~ 24 ft. E
	SS-4B	-39 to -45	-29 to -35	Moved ~ 560 ft. E
	SS-7	-41 to -45	NS	No subsurface material retrieved

8. LABORATORY ANALYSES. All samples were submitted for laboratory analysis to Analytical Resources Inc. (ARI) of Tukwila, Washington. All material collected in a given DMMU was proportionally composited into 4 DMMUs (Round 1) and 2 DMMUs (Round 2), and all were considered as part of this evaluation. The conventional and chemical analyses portions of the sampling and analysis plan were generally followed, and quality control guidelines specified by the PSEP and DMMP programs were met, with only minor quality control deviations (BergerABAM 2018). Results underwent a Level 1 quality assurance (QA1) review. Resulting data were considered sufficient and acceptable for regulatory decision-making under the DMMP program, as detailed below.

   a. *Conventional Results.* The grain size and conventional results indicated primarily sand and silt fractions, consistent with observations denoted in project core logs, which exhibited sediment primarily consisting of fine and very fine sand interbedded with silt and clay. Samples collected from DMMU-2 during Round 2 sampling (DMMU-2A) showed material to be generally finer-grained than that collected during Round 1. Reasons for this variability in DMMU-2 could not be determined with the existing information; it may have been related to seasonality, sampler differences, or localized bathymetric differences.

   Results of Chemical Analysis and Comparison with DMMP Guidelines. There were no detected or undetected exceedances of DMMP chemicals of concern for any DMMU samples in either of the Round 1 or Round 2 samples (Table 11). In addition to routine DMMP chemicals of concern, analyses of both tributyltin (TBT) and dioxins/furans were required for this project. Bulk TBT analysis was run on surface DMMUs and on subsurface DMMU 4A. No TBT was detected in any sample.

   Dioxins/furans were detected at low levels in all samples (Table 9). Toxicity equivalents (TEQ, with U = ½ estimated detection limit) ranged from 1.48 – 4.52 ng/kg dry wt., all below the 15 ng/kg TEQ suitability level set for Grays Harbor. For comparison purposes, dioxin TEQs found in 2015 during sampling of the adjacent T3 material were 5.59 and 3.99 ng/kg dry wt., and TEQs found in 2017 in the Federal Navigation Channel DMMUs closest to this project (HR-01 and HR-02) were 3.54 and 2.28 ng/kg dry wt. respectively (DMMP 2015a and DMMP 2018). Levels of 2,3,7,8 TCDD were also below the 5 ng/kg suitability level set for this dioxin congener, with levels ranging from 0.54 to 1.22 ng/kg. Dioxin levels from surface and subsurface samples were within the range of apparent background levels of dioxin in this part of Grays Harbor, and lower than levels seen in other Port of Grays Harbor Terminals tested in 2014.

Table 8. Conventional results for all BHP sampling

	Round 1				Round 2	
	DMMU-1	DMMU-2	DMMU-3	DMMU-4	DMMU-2A	DMMU-4A
GRAIN SIZES (%)						
Gravel	0.0	0.0	0.0	0.0	0.0	0.0
Sand	46.9	73.0	37.2	48.6	25.5	49.5
Silt	20.9	25.4	53.0	43.6	65.4	43.3
Clay	7.7	1.2	9.9	7.8	9.2	7.2
Total Fines*	53.1	26.6	62.9	51.5	74.5	50.5
CONVENTIONALS (mg/kg dry weight)						
Ammonia	128 D	187 D	209 D	163 D	---	169 D
Total sulfides	291.00	85.20	88.80	249.00	---	66.02
Total solids	64.07	63.83	65.39	60.77	66.50	64.55
Total volatile solids	4.75	10.05	4.81	5.22	---	4.62
Total organic carbon	1.65	1.02	0.98	1.26	1.02	1.46

* Total fines were determined using a #200 sieve (0.074 mm) as opposed to a #230 sieve (0.063 mm) as required in the DMMP program and designated in the approved SAP. This means that total fines are somewhat over-estimated compared to other DMMP projects.

Table 9. Comparison of dioxin/furan BHP results with other recent local data

	DMMP Grays Harbor Guidelines			T3 2014		GH O&M 2017		BHP				
	SL	BT	ML	T3D1	T3D2	HR-01	HR-02	DMMU 1	DMMU 2	DMMU 3	DMMU 4	DMMU 4A
2,3,7,8-TCDD ng/kg	---	5	---	1.64	0.85	1.23	1.05	0.78 J	0.54 J	0.77 J	1.22 J	0.83 J
Total TEQ ng/kg dry wt u = 1/2	---	15	---	5.59	3.99	3.54	2.28	2.81	1.48	2.61	4.52	2.42

9. BIOLOGICAL TESTING. Because no DMMP screening levels (SLs) were exceeded in the Tier 2 chemical testing, no Tier 3 biological tests (bioassays or bioaccumulation tests) were required for this project.

10. SUITABILITY DETERMINATION. This memorandum documents the evaluation of the suitability of sediment proposed for dredging by BHP Billiton for open-water disposal. The results may also be used in assessing these sediments for other in-water and/or upland beneficial uses on a project-specific basis. The approved sampling and analysis plan was generally followed and the data gathered were deemed sufficient and acceptable for regulatory decision-making under the DMMP program.

    a. *Sediment Exposed by Dredging.* Sediment exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) (Ecology 2013) or the State's antidegradation standard (DMMP 2008). Unless there is evidence of increasing contamination with depth, analysis of the proposed post-dredge surface (Z-layer) is not required if the overlying material does not contain elevated concentrations of DMMP COCs. Due to no exceedances of any DMMP screening levels, the DMMP agencies did not require evaluation of the post-dredge surface. Other evidence also contributed to this finding, including sample refusal at depths below current dredge elevations, and no notable differences between COC detections of surface and subsurface DMMUs.

    b. *Beneficial Uses*. Results of chemical analyses were compared to Washington State Sediment Management Standards as an indicator of potential suitability for in-water beneficial use. No chemicals of concern exceeded SMS guidelines (Table 12), indicating that material in the proposed dredge prism may also be potentially suitable for in-water beneficial use. "Potentially" suitable material means only that the DMMP has tested the material for in-water chemical suitability; a given project may require specific grain sizes or other characteristics to be appropriate for a given project-specific use. In addition, any proposed beneficial use site must be separately permitted and may have additional material guidelines or requirements.

    c. *Debris Management*. The DMMP agencies implemented a debris management requirement in 2015 in order to prevent the disposal of debris (wood or otherwise) greater than 12 inches in any dimension at open-water disposal sites (DMMP 2015b). It 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 this project, a 12"x12" debris screen must be used for dredging of surface DMMUs, unless information is provided to the DMMP that meets the "reason to believe" criteria laid out in DMMP 2015b.

    Based on the results of the previously described testing, the DMMP agencies concluded that all material tested is suitable for open-water disposal at the DMMP South Jetty and Point Chehalis dispersive sites.

    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 will provide input on the overall project. A final decision will be made after full consideration of agency input, and after an alternatives analysis is done under section 404(b)(1) of the Clean Water Act.

    A pre-dredge conference call with DNR, Ecology and the Corps of Engineers will be required. A dredging quality control plan must be developed and submitted to the DMMP prior to the pre-dredge conference call. A DNR site use authorization must also be acquired.

11. REFERENCES.

BergerABAM 2019. *Revised Dredged Material Characterization Report, Proposed Grays Harbor Potash Export Facility*, Hoquiam, Washington. January 2019

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 the Port of Grays Harbor Terminals 1,2,3 and 4, Aberdeen, Grays Harbor County, for open-water disposal at the South Jetty or Point Chehalis dispersive sites or for in-water beneficial use.* Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, February 20, 2015.

DMMP 2015b. *Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites*. FINAL DMMP Clarification Paper, prepared by Erika Hoffman (U.S. Environmental Protection Agency), Celia Barton (Washington State Department of Natural Resources), and David Fox (U.S. Army Corps of Engineers) for the DMMP agencies. October 2, 2015.

DMMP 2016. *Dredged Material Evaluation and Disposal Procedures (User Manual)*. Dredged Material Management Program, updated August 2016.

DMMP 2018. *Dredged Material Evaluation and Disposal Procedures (User Manual)*. Dredged Material Management Program, updated December 2018.

DMMP 2018. *Determination regarding the suitability of proposed dredged material from maintenance of the Grays Harbor Federal Navigation Channel, Grays Harbor, Washington, for placement at the Pt. Chehalis or South Jetty dispersive open-water disposal sites or at an approved beneficial use location.* Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, February 8, 2018.

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

Signed copy on file at USACE Seattle DMMO.

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM BHP BILLITON CANADA, INC. PROPOSED POTASH EXPORT FACILITY IN HOQUIAM, WASHINGTON (NWS-2017-715), FOR OPEN-WATER DISPOSAL AT THE SOUTH JETTY OR POINT CHEHALIS DISPERSIVE SITES OR FOR IN-WATER BENEFICIAL USE.

Concur:

_____ _____

Date Lauran Cole Warner - Seattle District Corps of Engineers

_____ _____

Date Justine Barton - Environmental Protection Agency

_____ _____

Date Laura Inouye, Ph.D. - Washington Department of Ecology

_____ _____

Date Celia Barton - Washington Department of Natural Resources

Copies furnished:

DMMP signatories
Evan Carnes, Seattle District Regulatory
Victoria England, BergerABAM
Joe Schumacker, Quinault Tribe

Table 10. Summary of sample coordinates, adjusted mudline elevations and sample depths. Adapted from BergerABAM 2018.

DMMU ID	Sample ID	Date Sampled	Northing	Easting	Latitude	Longitude	Water Depth (ft)	Adjusted Mudline Elevation (ft MLLW)	Sample Depth Recovered (inches)
Round 1: February 2018									
1	SS-1	2/26/2018	615440.00	787469.00	47.4188390	-124.641960	26	-25.90	47.04
	SS-2	2/26/2018	615425.00	787743.00	46.9703067	-123.916550	15	-15.00	42
	SS-5	2/27/2018	615366.00	788095.00	46.9701868	-123.915132	33	-24.00	54.24
	SS-6	2/27/2018	615431.00	788362.00	46.9703966	-123.914074	5.6	-0.6	38.76
2	SS-3	2/27/2018	615258.00	787616.00	46.9698341	-123.917030	43	-33.00	50.4
	SS-4	Not Applicable							
	SS-7	Not Applicable							
	SS-8	2/26/2018	615266.00	788387.00	46.9699475	-123.913946	45	-35.00	44.04
3	SS-1	2/26/2018	615440.00	787469.00	47.4188390	-124.641960	26	-25.90	47.52
	SS-2	2/26/2018	615425.00	787743.00	46.9703067	-123.916550	15	-15.00	93
	SS-5	2/27/2018	615366.00	788095.00	46.9701868	-123.915132	33	-24.00	54.36
	SS-6	2/27/2018	615431.00	788362.00	46.9703966	-123.914074	5.6	-0.6	92.52
4	SS-3	2/27/2018	615258.00	787616.00	46.9698341	-123.917030	43	-33.00	No Recovery
	SS-4	Not Applicable							
	SS-7	Not Applicable							
	SS-8	2/26/2018	615266.00	788387.00	46.9699475	-123.913946	45	-35.00	84.12
Round 2: August 2018									
2A	SS-3A	8/15/2018	615259.136	787616.620	46.9698373	-123.917027	35.1	-35.01	84
	SS-3B	8/15/2018	615253.052	787609.583	46.9698198	-123.917054	35.1	-35.01	99.6
	SS-7	8/15/2018	615249.803	787998.719	46.9698571	-123.915497	46.3	-36.00	34.8
4A	SS-3A	8/15/2018	615259.136	787616.620	46.9698373	-123.917027	35.1	-35.01	84
	SS-3B	8/15/2018	615253.052	787609.583	46.9698198	-123.917054	35.1	-35.01	99.6
	SS-4B	8/15/2018	615309.747	788448.942	46.9700747	-123.913705	30.2	-24.57	126

Notes:

- Northing and easting are based on the North American Datum of 1983 (NAD83) State Plane Coordinate System, Washington South, Survey Feet
- Adjusted Mudline Elevation = Water Depth + Tidal Stage

Table 11. BHP Results from Chemical Analyses Compared to DMMP Guidelines

	DMMP Marine Guidelines			Surface						Subsurface					
	SL	BT	ML	DMMU-1		DMMU-2		DMMU-2A		DMMU-3		DMMU-4		DMMU-4A	
CONVENTIONALS (mg/kg dry weight)															
Ammonia				128	D	187	D	---		209	D	163	D	169	D
Total sulfides				291.00		85.20		---		88.80		249.00		66.02	
Total solids				64.07		63.83		66.50		65.39		60.77		64.55	
Total volatile solids				4.75		10.05		---		4.81		5.22		4.62	
Total organic carbon				1.65		1.02		1.02		0.98		1.26		1.46	
METALS (mg/kg dry weight)															
Antimony	150	---	200	0.03	J	0.29	U	---		0.29	U	0.33	U	0.03	U
Arsenic	57	507.1	700	5.89		5.70		---		6.30		5.69		5.59	
Cadmium	5.1	--	14	0.14	J	0.17		---		0.13	J	0.1	J	0.11	J
Chromium	260	--	---	32.1		29.4		---		30.8		30.6		25.9	
Copper	390	--	1,300	37.2		42.8		---		38.5		46.9		35.5	
Lead	450	975	1,200	5.70		6.04		---		5.92		6.32		4.72	
Mercury	0.41	1.5	2.3	0.0341	U	0.0311		---		0.0316		0.0322		0.0281	
Selenium	--	3	--	1.36		1.13		---		1.20		1.42		2.21	
Silver	6.1	--	8.4	0.18	J	0.18	J	---		0.17	J	0.18	J	0.15	J
Zinc	410	--	3,800	82.2		70.2		---		62.5		73.9		59.8	
ORGANOMETALLIC COMPOUNDS															
Tributyltin ion (bulk; ug/kg)	---	73	---	3.73	U	3.75	U	---		---		---		0.427	U
PAHs (µg/kg dry weight)															
Total LPAH	5,200	---	29,000	23.9		7.3		---		21.4		44.2		169.4	
Acenaphthylene	560	---	1,300	19.4	U	19.4	U	---		19.1	U	19.7	U	4.7	U
Acenaphthene	500	---	2,000	19.4	U	19.4	U	---		19.1	U	5.4	J	39.60	
Anthracene	960	---	13,000	19.4	U	19.4	U	---		19.1	U	19.7	U	7	J
Fluorene	540	---	3,600	19.4	U	19.4	U	---		19.1	U	6.2	J	35.9	
Naphthalene	2,100	---	2,400	11.1	J	19.4	U	---		9	J	15.2	J	26.9	
Phenanthrene	1,500	---	21,000	12.8	J	7.3	J	---		12.4	J	17.4	J	65.00	
2-Methylnaphthalene	670	---	1,900	7.3	J	19.4	U	---		6.3	J	7.1	J	22.4	
Total HPAH	12,000	---	69,000	34.9		21.3		---		30.1		58.6		40.7	
Benz(a)anthracene	1,300	---	5,100	19.4	U	19.4	U	---		19.1	U	19.7	U	7.8	J

Table 11. BHP Results from Chemical Analyses Compared to DMMP Guidelines

	DMMP Marine Guidelines			Surface						Subsurface					
	SL	BT	ML	DMMU-1		DMMU-2		DMMU-2A		DMMU-3		DMMU-4		DMMU-4A	
Benzo(a)pyrene	1,600	---	3,600	19.4	U	19.4	U	---		19.1	U	19.7	U	6.4	U
Total Benzofluoranthenes (b, j ,k)	3,200	---	9,900	38.7	U	38.9	U	---		38.1	U	10.8	J	10.1	U
Benzo(g,h,i)perylene	670	---	3,200	19.4	U	19.4	U	---		19.1	U	19.7	U	5.8	U
Chrysene	1,400	---	21,000	5.3	J	6.4	J	---		5.1	J	8.2	J	8.7	J
Dibenz(a,h)anthracene	230	---	1,900	4.8	U	4.9	U	---		4.8	U	1.2	J	0.9	U
Fluoranthene	1,700	4,600	30,000	14.2	J	8.1	J	---		13.2	J	20.9	J	31.2	
Indeno(1,2,3-c,d)pyrene	600	---	4,400	19.4	U	19.4	U	---		19.1	U	19.7	U	5.9	U
Pyrene	2,600	11,980	16,000	15.4	J	6.8	J	---		11.8	J	17.5	J	22.9	
CHLORINATED HYDROCARBONS (µg/kg dry weight)															
Hexachlorobenzene (HCB)	22	168	230	0.49	U	0.49	U	---		0.49	U	1.28		0.7	U
1,2-Dichlorobenzene	35	---	110	4.8	U	4.9	U	---		4.8	U	4.9	U	0.7	U
1,4-Dichlorobenzene	110	---	120	4.8	U	4.9	U	---		4.8	U	4.9	U	0.6	U
1,2,4-Trichlorobenzene	31	---	64	4.8	U	4.9	U	---		4.8	U	4.9	U	0.7	U
PHTHALATES (µg/kg dry weight)															
Bis(2-ethylhexyl) phthalate	1,300	---	8,300	48.4	U	48.6	U	---		47.7	U	49.2	U	28.5	U
Butyl benzyl phthalate	63	---	970	4.8	U	4.9	U	---		4.8	U	4.9	U	0.7	U
Diethyl phthalate	200	---	1,200	19.4	U	19.4	U	---		19.1	U	19.7	U	17.5	U
Dimethyl phthalate	71	---	1,400	19.4	U	19.4	U	---		19.1	U	19.7	U	6.4	U
Di-n-butyl phthalate	1,400	---	5,100	19.4	U	19.4	U	---		19.1	U	19.7	U	5.2	U
Di-n-octyl phthalate	6,200	---	6,200	19.4	U	19.4	U	---		19.1	U	19.7	U	8.6	U
PHENOLS (µg/kg dry weight)															
Pentachlorophenol	400	504	690	96.8	U	97.2	U	---		95.3	U	98.3	U	30.9	U
Phenol	420	---	1,200	19.4	U	19.4	U	---		19.1	U	18.4	J	23.4	
2-Methylphenol	63	---	77	19.4	U	19.4	U	---		19.1	U	19.7	U	7.7	U
4-Methylphenol	670	---	3,600	19.4	U	19.4	U	---		19.1	U	19.7	U	14.5	U
2,4-Dimethylphenol	29	---	210	24.2	U	24.3	U	---		23.8	U	24.6	U	2.1	U
MISCELLANEOUS EXTRACTABLES (µg/kg dry weight)															
Dibenzofuran	540	---	1,700	19.4	U	19.4	U	---		19.1	U	19.7	U	31.1	
Hexachlorobutadiene	11	---	270	0.49	U	0.49	U	---		0.49	U	0.5	U	0.7	U
N-Nitrosodiphenylamine	28	---	130	4.8	U	4.9	U	---		4.8	U	4.9	U	1.3	U
Benzoic acid	650	---	760	194	U	194	U	---		191	U	197	U	58.4	U

Table 11. BHP Results from Chemical Analyses Compared to DMMP Guidelines

	DMMP Marine Guidelines			Surface						Subsurface					
	SL	BT	ML	DMMU-1		DMMU-2		DMMU-2A		DMMU-3		DMMU-4		DMMU-4A	
Benzyl alcohol	57	---	870	19.4	U	19.4	U	---		19.1	U	19.7	U	14.7	U
PESTICIDES & PCBs (µg/kg dry weight)															
4,4'-DDD	16	---	---	0.97	U	0.97	U	---		0.99	U	1	U	0.31	U
4,4'-DDE	9	---	---	0.97	U	0.97	U	---		0.99	U	1	U	0.13	U
4,4'-DDT	12	---	---	0.97	U	0.97	U	---		0.99	U	0.5	U	0.32	U
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	---	50	69	0.97	U	0.97	U	---		0.99	U	1	U	0.98	U
Aldrin	9.5	---	---	0.49	U	0.49	U	---		0.49	U	0.5	U	0.36	U
Dieldrin	1.9	---	1,700	0.97	U	0.97	U	---		0.99	U	1	U	0.11	U
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane)	2.8	37	---	0.97	U	0.97	U	---		0.99	U	1	U	0.99	U
Heptachlor	1.5	---	270	0.49	U	0.49	U			0.49	U	0.5	U	0.05	U
Total PCBs (Aroclors)	130	38 [1]	3,100	3.9	U	3.9	U			3.9	U	4	U	3.8	U
DIOXINS/FURANS															
2,3,7,8-TCDD		5	---	0.78	J	0.54	J			0.77	J	1.22	J	0.83	J
Total TEQ (pptr dry wt)		15	---	2.81		1.48				2.61		4.52		2.42	

Notes:

Bolded values indicated compound was detected.
[1] This value is normalized to total organic carbon, and is expressed in mg/kg organic carbon
Total LPAH = sum of acenaphthylene, acenaphthene, anthracene, fluorene, naphthalene and phenanthrene.
Total HPAH = sum of benzo(a)anthracene, benzo(a)pyrene, total benzofluoranthenes, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3,-c,d)pyrene and pyrene.
Total benzofluoranthenes = the sum of the "b," "j" and "k" isomers. The "j" isomer co-elutes with the "k" isomer, thus the concentration of the "j" isomer is included in the "k" isomer concentration.
SL = Screening Level
BT = Bioaccumulation Trigger
ML = Maximum Level
D = The reported value is from a dilution
J = Estimated concentration when the value is less than ARI's established reporting limits
--- = not analyzed

Table 12. BHP Results from Chemical Analyses Compared to SMS Guidelines

		SMS Marine Guidelines		Surface				Subsurface					
	Unit	SQS	CSL	DMMU-1		DMMU-2		DMMU-3		DMMU-4		DMMU-4A	
TOC	mg/kg			1.65		1.02		0.98		1.26		1.46	
METALS													
Antimony	mg/kg	--	--	0.03	J	0.29	U	0.29	U	0.33	U	0.03	U
Arsenic	mg/kg	57	93	5.89		5.7		6.3		5.69		5.59	
Cadmium	mg/kg	5.1	6.7	0.14	J	0.17		0.13	J	0.1	J	0.11	J
Chromium	mg/kg	260	270	32.1		29.4		30.8		30.6		25.9	
Copper	mg/kg	390	390	37.2		42.8		38.5		46.9		35.5	
Lead	mg/kg	450	530	5.7		6.04		5.92		6.32		4.72	
Mercury	mg/kg	0.41	0.59	0.0341	U	0.0311		0.0316		0.0322		0.0281	
Selenium	mg/kg	--	--	1.36		1.13		1.2		1.42		2.21	
Silver	mg/kg	6.1	6.1	0.18	J	0.18	J	0.17	J	0.18	J	0.15	J
Zinc	mg/kg	410	960	82.2		70.2		62.5		73.9		59.8	
PCBs													
Total PCBs	mg/kg/OC	12	65	0.002	U	0.004	U	0.004	U	0.003	U	0.003	U
PAHs													
2-Methylnaphthalene	mg/kg-OC	38	64	0.004	J	0.02	U	0.01	J	0.01	J	0.02	
Acenaphthene	mg/kg-OC	16	57	0.012	U	0.02	U	0.02	U	0.00	J	0.03	
Acenaphthylene	mg/kg-OC	66	66	0.012	U	0.02	U	0.02	U	0.02	U	0.00	U
Anthracene	mg/kg-OC	220	1200	0.012	U	0.02	U	0.02	U	0.02	U	0.00	J
Fluorene	mg/kg-OC	23	79	0.012	U	0.02	U	0.02	U	0.00	J	0.02	
Naphthalene	mg/kg-OC	99	170	0.007	J	0.02	U	0.01	J	0.01	J	0.02	
Phenanthrene	mg/kg-OC	100	480	0.008	J	0.01	J	0.01	J	0.01	J	0.04	
Total LPAHs	*mg/kg-OC*	*370*	*780*	*0.014*		*0.01*		*0.02*		*0.04*		*0.12*	
Benzo(a)anthracene	mg/kg-OC	110	270	0.012	U	0.019	U	0.02	U	0.02	U	0.01	J
Benzo(a)pyrene	mg/kg-OC	99	210	0.012	U	0.019	U	0.02	U	0.02	U	0.00	U
Total Benzofluoranthenes	mg/kg/OC	230	450	0.023	U	0.038	U	0.04	U	0.01	J	0.01	U
Benzo(g,h,i)perylene	mg/kg-OC	31	78	0.012	U	0.019	U	0.02	U	0.02	U	0.00	U
Chrysene	mg/kg-OC	110	460	0.003	J	0.006	J	0.01	J	0.01	J	0.01	J
Dibenzo(a,h)anthracene	mg/kg-OC	12	33	0.003	U	0.005	U	0.00	U	0.00	J	0.00	U

Table 12. BHP Results from Chemical Analyses Compared to SMS Guidelines

		SMS Marine Guidelines		Surface				Subsurface					
	Unit	SQS	CSL	DMMU-1		DMMU-2		DMMU-3		DMMU-4		DMMU-4A	
Fluoranthene	mg/kg-OC	160	1200	0.009	J	0.008	J	0.01	J	0.02	J	0.02	
Indeno(1,2,3-cd)pyrene	mg/kg-OC	34	88	0.012	U	0.019	U	0.02	U	0.02	U	0.00	U
Pyrene	mg/kg-OC	1000	1400	0.009	J	0.007	J	0.01	J	0.01	J	0.02	
Total HPAHs	*mg/kg-OC*	*960*	*5300*	*0.021*		*0.021*		*0.03*		*0.05*		*0.03*	
CHLORINATED HYDROCARBONS													
1,4-Dichlorobenzene	mg/kg-OC	3.1	9	0.003	U	0.005	U	0.005	U	0.004	U	0.003	U
1,2-Dichlorobenzene	mg/kg-OC	2.3	2.3	0.003	U	0.005	U	0.005	U	0.004	U	0.003	U
1,2,4-Trichlorobenzene	mg/kg-OC	0.81	1.8	0.003	U	0.005	U	0.005	U	0.004	U	0.003	U
Hexachlorobenzene	mg/kg-OC	0.38	2.3	0.000	U	0.000	U	0.001	U	0.001	U	0.003	U
PHTHALATES													
Dimethyl phthalate	mg/kg-OC	53	53	0.012	U	0.019	U	0.019	U	0.016	U	0.014	U
Diethyl phthalate	mg/kg-OC	61	110	0.012	U	0.019	U	0.019	U	0.016	U	0.014	U
Di-n-butyl phthalate	mg/kg-OC	220	1700	0.012	U	0.019	U	0.019	U	0.016	U	0.014	U
Butyl benzyl phthalate	mg/kg-OC	4.9	64	0.003	U	0.005	U	0.005	U	0.004	U	0.014	U
Bis(2-ethylhexyl) phthalate	mg/kg-OC	47	78	0.029	U	0.048	U	0.049	U	0.039	U	0.034	U
Di-n-octyl phthalate	mg/kg-OC	58	4500	0.012	U	0.019	U	0.019	U	0.016	U	0.014	U
PHENOLS													
Phenol	ug/kg	420	1200	19.4	U	19.4	U	19.1	U	18.4	J	23.4	J
2-Methylphenol	ug/kg	63	63	19.4	U	19.4	U	19.1	U	19.7	U	19.8	U
4-Methylphenol	ug/kg	670	670	19.4	U	19.4	U	19.1	U	19.7	U	19.8	U
2,4-Dimethylphenol	ug/kg	29	29	24.2	U	24.3	U	23.8	U	24.6	U	24.7	U
Pentachlorophenol	ug/kg	360	690	96.8	U	97.2	U	95.3	U	98.3	U	98.8	U
MISCELLANEOUS EXTRACTABLES													
Benzyl Alcohol	ug/kg	57	73	19.4	U	19.4	U	19.1	U	19.7	U	19.8	U
Benzoic Acid	ug/kg	650	650	194	U	194	U	191	U	197	U	198	U
Dibenzofuran	mg/kg-OC	15	58	0.012	U	0.019	U	0.019	U	0.016	U	0.021	
Hexachlorobutadiene	mg/kg-OC	3.9	6.2	0.000	U	0.000	U	0.001	U	0.000	U	0.003	U
N-Nitrosodiphenylamine	mg/kg-OC	11	11	0.003	U	0.005	U	0.005	U	0.004	U	0.003	U

DMMP Suitability Determination
Figure 2. Project Vicinity

Proposed Grays Harbor Potash Export Facility-
Revised Dredged Material Characterization Report

Sheet 1- Vicinity Map and Project Site Location

September 2018

Legend

- Surface DMMU Boundary
- Site Plan
- Federal Navigation Channel

2017 Bathymetry

- CONT-MAJR-EX
- CONT-MINR-EX

NEW ACCESS TRESTLE

ROAD ON NEW ACCESS WAY

NEW WHARF CONVEYOR

NEW QUADRANT SHIPLOADER

NEW CATWALK (TYP.)

APPROXIMATE DREDGING LIMITS

EXISTING SHIPPING CHANNEL

QUADRANT SHIPLOADER

MOORING DOLPHIN (TYP.)

TERMINAL 3

0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

N

0 125 250 500 Feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

DMMP Suitability Determination
Figure 3. Project Proposal

BHP BergerABAM

Proposed Grays Harbor Potash Export Facility -
Revised Dredged Material Characterization Report

Sheet 2- Proposed Project Features
September 2018

General Notes

1. DREDGING UP TO 110,000 CY WILL BE REQUIRED TO ACCOMODATE THE NEW FACILITY AND BERTH
2. HYDROGRAPHIC SURVEY DATA COLLECTED BY BERGLUND, SCHMIDT & ASSOCIATES DECEMBER 2017.
3. HORIZONTAL DATUM; WASHINGTON STATE PLANE SOUTH (WSPS), NAV83, US FEET.
4. VERTICAL DATUM: MEAN LOWER LOW WATER
5. BASE MAP WAS DEVELOPED BY AUSENCO ENGINEERING 2017.

LEGEND

- 11+00 — Station
- Proposed Bathymetry
- Surface DMMU
- Sub Surface DMMU
- SS-1 — Sediment Sample Location (Feb. 2018)
- SS-4 — Actual Sediment Sample Location (Aug. 2018)
- PSS-1 — Planned Sediment Sample Location (Aug. 2018)
- DMMU-1 — Dredged Material Management Unit

DMMP Suitability Determination
Figure 4. Sediment Sample Locations

BHP
BergerABAM
210 East 13th Street, Suite 300
Vancouver, Washington 98660-3231
(360) 823-6100 FAX: (360) 823-6101

Proposed Grays Harbor Potash Export Facility -
Revised Dredged Material Characterization Report

Sheet 3 -Proposed Dredge Prism and Sampling Locations

September 2018

1" = 120' scale 60 0 60 120 feet

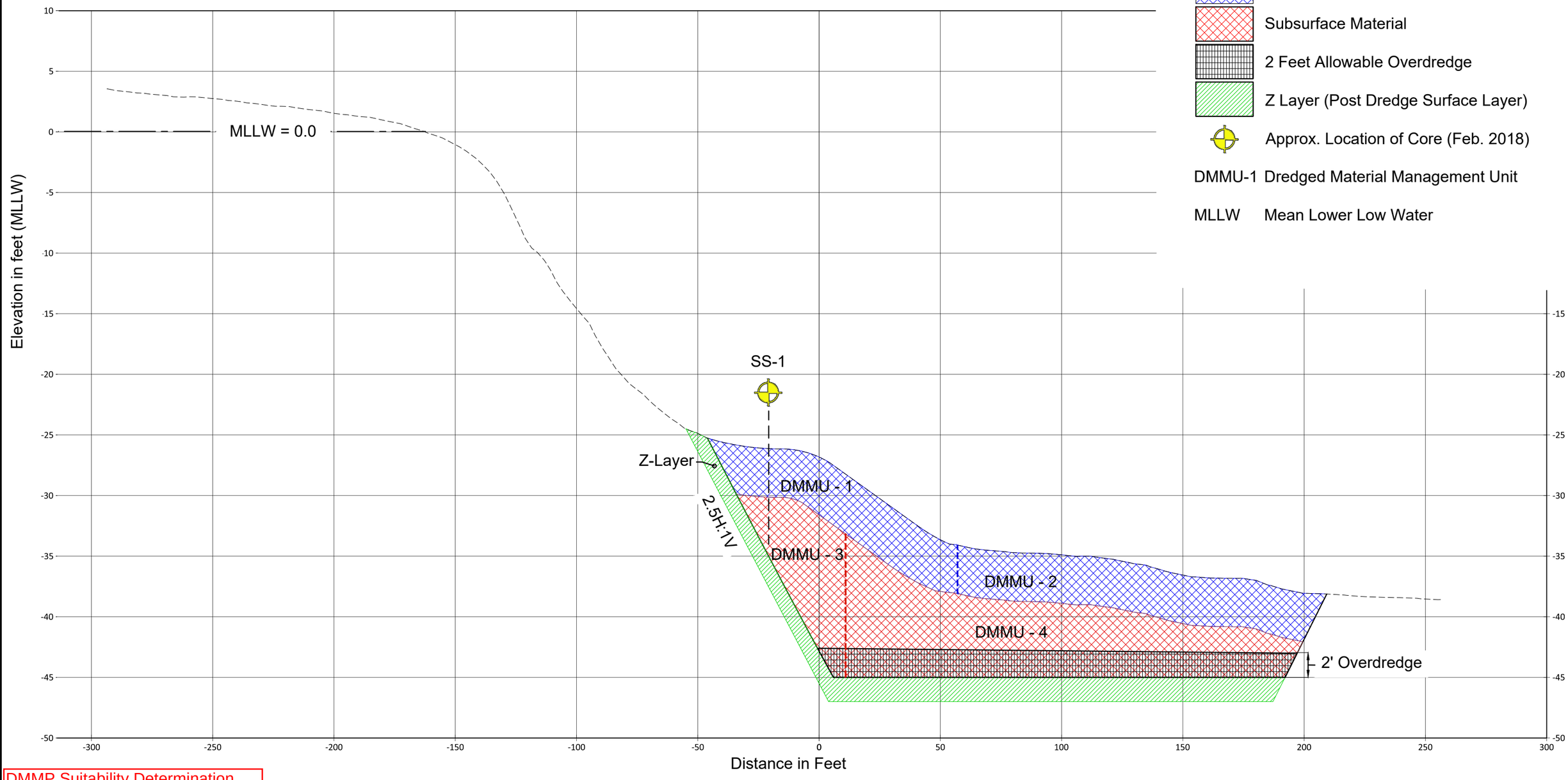
GENERAL NOTES:

1. DREDGING UP TO 110,000 CY WILL BE REQUIRED TO ACCOMMODATE THE NEW FACILITY AND BERTH
2. HYDROGRAPHIC SURVEY DATA COLLECTED BY BERGLUND, SCHMIDT & ASSOCIATES DECEMBER 2017.
3. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH (WSPS), NAD83, US FEET.
4. VERTICAL DATUM: MEAN LOWER LOW WATER
5. BASE MAP WAS DEVELOPED BY AUSENCO ENGINEERING, 2017

N S

Q:\VANCOUVER\2017\A17.0202\00\CADD\C3D\DREDGE-ADJ 18SEPT2018.DWG

Cross Section A



LEGEND

- Surface Material
- Subsurface Material
- 2 Feet Allowable Overdredge
- Z Layer (Post Dredge Surface Layer)
- Approx. Location of Core (Feb. 2018)

DMMU-1 Dredged Material Management Unit

MLLW Mean Lower Low Water

DMMP Suitability Determination
Figure 5. Cross Section A

BHP BergerABAM

Proposed Grays Harbor Potash Export Facility -
Revised Dredged Material Characterization Report

Sheet 4 - Cross Section A: STA 3+00

September 2018

Horizontal Scale 1" = 40' 20 0 20 40 feet

Vertical Scale 1" = 8' 4 0 4 8 feet

GENERAL NOTES:

1. DREDGING UP TO 110,000 CY WILL BE REQUIRED TO ACCOMMODATE THE NEW FACILITY AND BERTH
2. HYDROGRAPHIC SURVEY DATA COLLECTED BY BERGLUND, SCHMIDT & ASSOCIATES DECEMBER 2017.
3. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH (WSPS), NAD83, US FEET.
4. VERTICAL DATUM: MEAN LOWER LOW WATER
5. BASE MAP WAS DEVELOPED BY AUSENCO ENGINEERING, 2017

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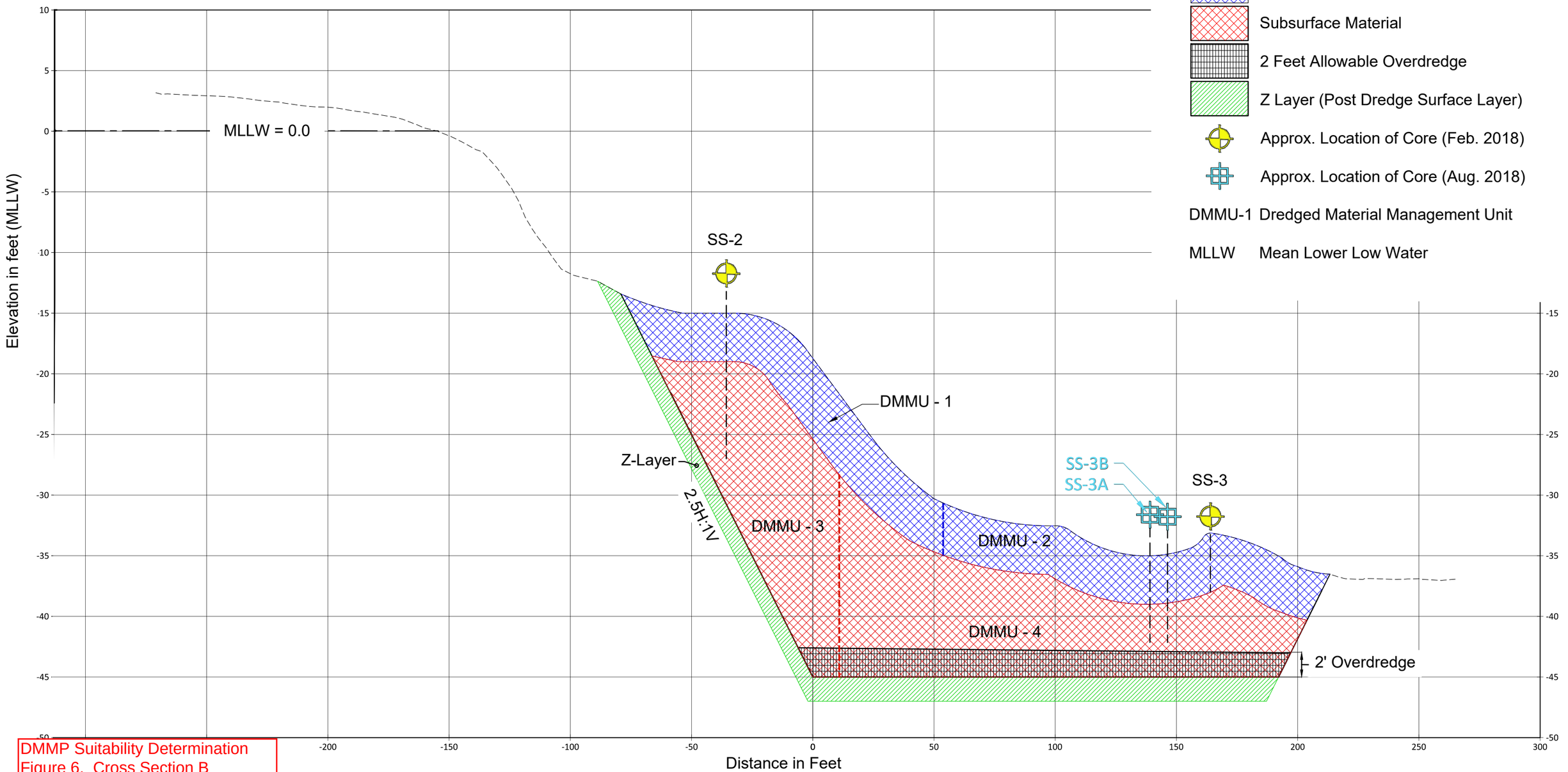
Cross Section B



LEGEND

- Surface Material
- Subsurface Material
- 2 Feet Allowable Overdredge
- Z Layer (Post Dredge Surface Layer)
- Approx. Location of Core (Feb. 2018)
- Approx. Location of Core (Aug. 2018)

DMMU-1 Dredged Material Management Unit

MLLW Mean Lower Low Water

DMMP Suitability Determination
Figure 6. Cross Section B

BHP BergerABAM

Proposed Grays Harbor Potash Export Facility -
Revised Dredged Material Characterization Report

Sheet 5 - Cross Section B: STA 5+00

September 2018

Horizontal Scale 1" = 40' (20 0 20 40 feet)

Vertical Scale 1" = 8' (4 0 4 8 feet)

GENERAL NOTES:

1. DREDGING UP TO 110,000 CY WILL BE REQUIRED TO ACCOMMODATE THE NEW FACILITY AND BERTH
2. HYDROGRAPHIC SURVEY DATA COLLECTED BY BERGLUND, SCHMIDT & ASSOCIATES DECEMBER 2017.
3. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH (WSPS), NAD83, US FEET.
4. VERTICAL DATUM: MEAN LOWER LOW WATER
5. BASE MAP WAS DEVELOPED BY AUSENCO ENGINEERING, 2017

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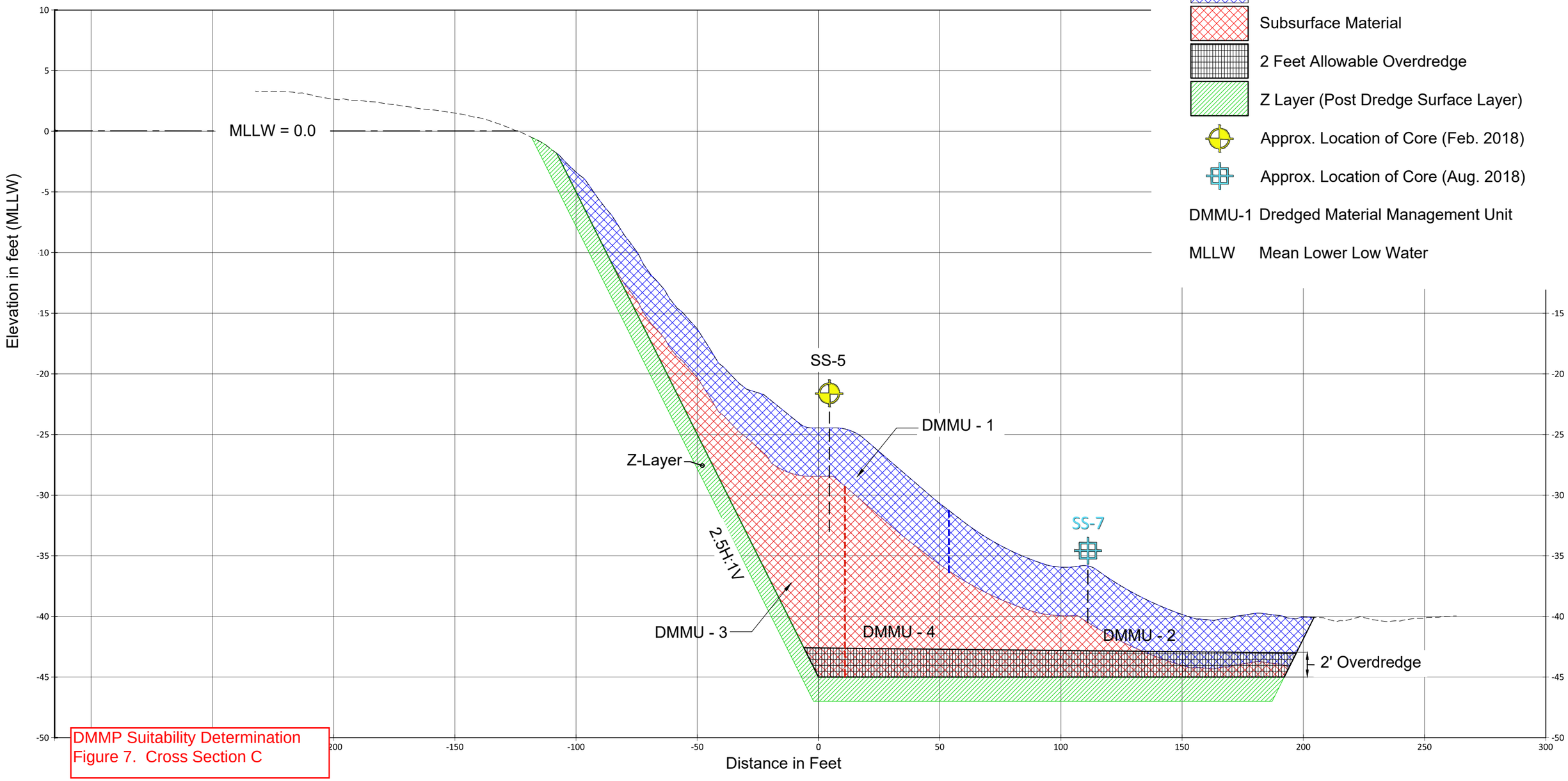
Cross Section C



LEGEND

- Surface Material
- Subsurface Material
- 2 Feet Allowable Overdredge
- Z Layer (Post Dredge Surface Layer)
- Approx. Location of Core (Feb. 2018)
- Approx. Location of Core (Aug. 2018)

DMMU-1 Dredged Material Management Unit

MLLW Mean Lower Low Water

DMMP Suitability Determination
Figure 7. Cross Section C

BHP BergerABAM

Proposed Grays Harbor Potash Export Facility -
Revised Dredged Material Characterization Report

Sheet 6 - Cross Section C: STA 9+00

September 2018

Horizontal Scale 1" = 40' (20 0 20 40 feet)

Vertical Scale 1" = 8' (4 0 4 8 feet)

GENERAL NOTES:

1. DREDGING UP TO 110,000 CY WILL BE REQUIRED TO ACCOMMODATE THE NEW FACILITY AND BERTH
2. HYDROGRAPHIC SURVEY DATA COLLECTED BY BERGLUND, SCHMIDT & ASSOCIATES DECEMBER 2017.
3. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH (WSPS), NAD83, US FEET.
4. VERTICAL DATUM: MEAN LOWER LOW WATER
5. BASE MAP WAS DEVELOPED BY AUSENCO ENGINEERING, 2017

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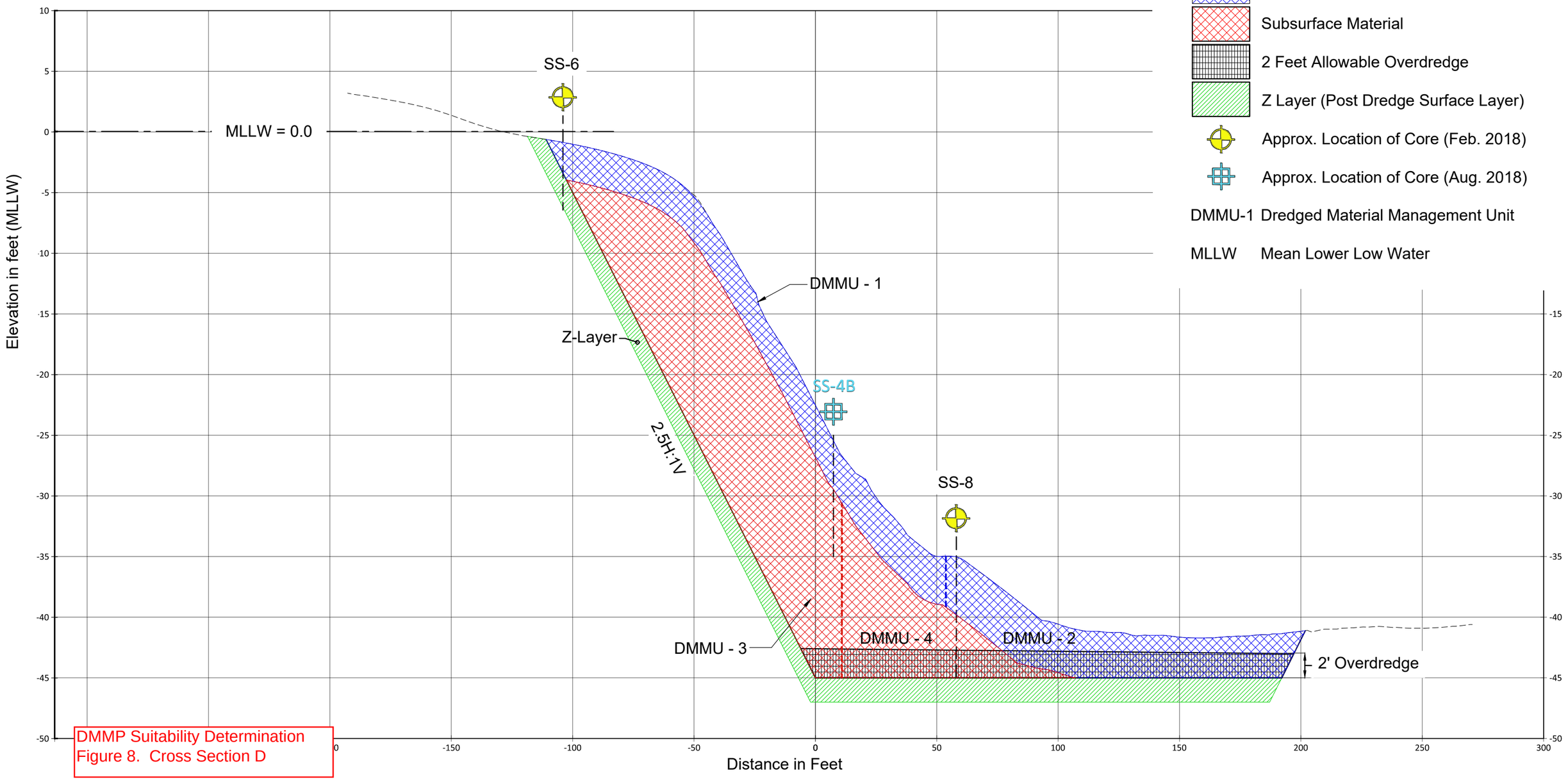
Cross Section D



DMMP Suitability Determination
Figure 8. Cross Section D

BHP BergerABAM

Proposed Grays Harbor Potash Export Facility -
Revised Dredged Material Characterization Report

Sheet 7 - Cross Section D: STA 12+00

September 2018

Horizontal Scale 1" = 40' 20 0 20 40 feet
Vertical Scale 1" = 8' 4 0 4 8 feet

GENERAL NOTES:

1. DREDGING UP TO 110,000 CY WILL BE REQUIRED TO ACCOMMODATE THE NEW FACILITY AND BERTH
2. HYDROGRAPHIC SURVEY DATA COLLECTED BY BERGLUND, SCHMIDT & ASSOCIATES DECEMBER 2017.
3. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH (WSPS), NAD83, US FEET.
4. VERTICAL DATUM: MEAN LOWER LOW WATER
5. BASE MAP WAS DEVELOPED BY AUSENCO ENGINEERING, 2017

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