Dickman Mill Sediment Transport Study

Task 1 Technical Summary Memorandum

Project:	Dickman Mill Sediment Transport Study		
Our reference:	507101897	**Your reference:**	AE 437
Prepared by:	Aaron Porter	**Date:**	December 17, 2020
Approved by:	Scott Fenical	**Checked by:**	Scott Fenical
Subject:	Task 1 - Technical Summary		

1 Introduction

The Washington Department of Natural Resources (DNR) plans to remove approximately 1,000 timber piles from the intertidal and nearshore areas at the site of the old Dickman Mill (Figure 1). Dickman Mill is located along Ruston Way in Tacoma, Washington, on Commencement Bay in Puget Sound. The mill operated from 1889 to 1977 and was located on a large wharf built over the water. The remaining creosote treated piles are suspected to be an ongoing source of contamination. Prior to removing the pile field, DNR is assessing the risk of releasing additional contaminants of concern (COCs) and potential effects on nearby properties due to the removal of the piles.

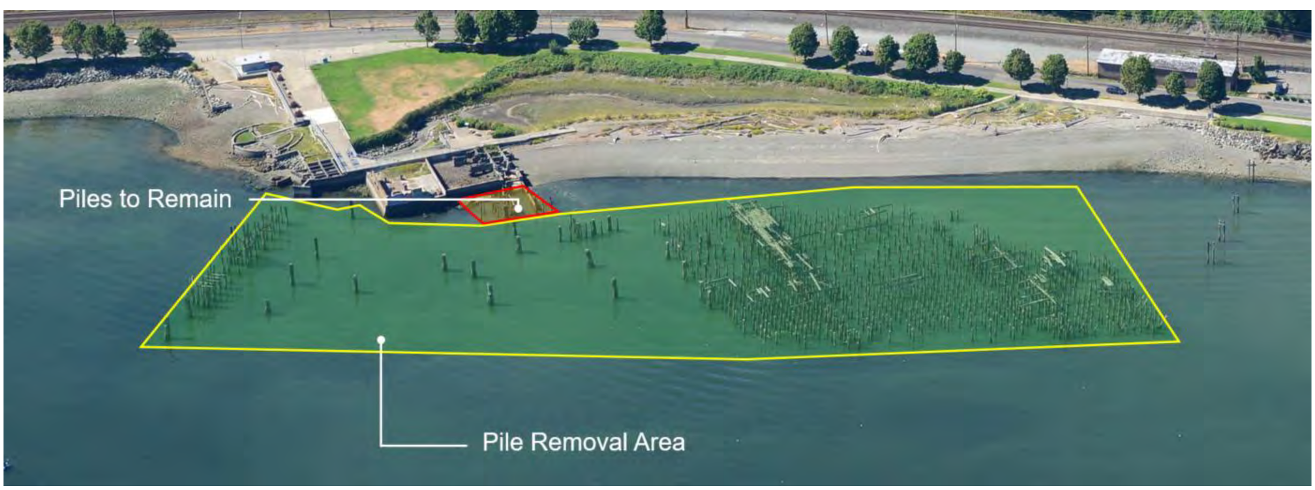

Figure 1. Pile Removal Areas Assessed

DNR requested Mott MacDonald to evaluate risks of pile removal following a two-step process – Task 1 as a qualitative assessment; and Task 2 as a contingent quantitative modeling assessment. The overarching purpose of Task 1 is to develop an initial opinion on the risk and level of contaminant distribution outside the study area due to removal of the pile field. A contingent Task 2 would quantify potential movement of sediment and related contaminants following removal of the pile field, if determined to be necessary following the results of Task 1.

Work conducted in Task 1 to qualitatively assess these risks includes:

- Data and existing study collection and compilation.
- Site visit to review and assess the existing site processes and conditions.
- Basis of Assessment preparation, to align the project team on data sources, assumptions, project objectives and site conditions.
- Existing data review and interpretation for conducting site contaminant background mapping.
- Qualitative seabed profile and sediment chemical evaluation.
- Conceptual site model development to describe conditions and processes affecting the assessment.

The following appendices summarize work performed as part of this study and are provided as supplemental information forming the basis of our assessment results:

- The slide set from a Project Team (consisting of Mott MacDonald (coastal processes), GeoEngineers (sediment characterization) and Department of Natural Resources) progress meeting is attached as Appendix A.
- Draft Sediment Data Memorandum (GeoEngineers, August 21, 2020) - Appendix B.
- Basis of Assessment - Appendix C.
- Site Observations Memorandum - Appendix D.

2 Study Criteria

The study criteria proposed for use in conducting the Task 1 qualitative assessment are summarized within this section. Details are provided in Appendix C.

- Removal Area: The pile removal area is shown in Figure 1 and does not include the piles directly adjacent to the mill site.
- Pile Removal: All piles within the designated area are to be removed. Removal of pile stubs requires a different extraction process than full pile removal. Whether the stubs will be included in the removal depends in part on actions out of this analysis (Task 1 and Task 2).
- Sea-Level Rise: Sea-level rise (SLR) projections were established using local guidelines for the City of Tacoma and Washington Coastal Resilience Project. SLR projections for 2050 and 2100 are provided in Appendix C and range between 5 inches and 40 inches approximately.
- Coastal Processes:
  - Waves: Significant wave height in more frequent storms (annual) are likely to be in the range 1-2 feet. Extreme storm significant wave heights are likely to be in the range of 2.5-4.0 feet. Storm wave heights will be refined in Task 2.
  - Currents: Nearby experience indicates ebb and flood tidal current speeds of approximately 1 knot.
  - Sediment Transport: Field observations indicate that net littoral drift is likely directed from NW to NE.
- Vessel Wakes: Vessel wakes associated with recreational and commercial vessels were evaluated and determined to not be a controlling wave condition for the assessment.
- Contaminants of Concern (COCs):
  - The surface sediment dataset was screened against the Marine Sediment Management Standards (Chapter 173-204 Washington Administrative Code [WAC]) benthic and bioaccumulation criteria to identify contaminants of concern (COCs).

– Screening for bioaccumulative COCs was based on Puget Sound natural background provided in SCUM guidance (Ecology 2019) and regional background values for South Puget Sound (Ecology 2018). These screening values are expressed on a dry-weight basis.
– The maximum detected concentration for each analyte measured in Study Area sediment was compared to its applicable criteria. The COCs were identified as the following and were used throughout the assessment:
  - Dioxins (expressed as a toxic equivalent concentration or TEQ)
  - Carcinogenic polycyclic aromatic hydrocarbons (cPAHs; also expressed as a TEQ)
  - Low-molecular-weight PAHs (LPAHs)
  - High-molecular-weight PAHs (HPAHs)
– For the protection of benthic community impacts, the Sediment Cleanup Objective (SCO), based on the Apparent Effect Thresholds (AETs) expressed on a dry-weight basis, rather than TOC-normalized criteria were used for the identification of COCs. AETs were used as the screening values for COC identification because some of site TOC values fell outside of the range (0.5 to 3.5 percent) where TOC normalization is recommended.
– Comparison of dry-weight and TOC-normalized data to criteria are provided in Table 1 below. Bold values exceed SMS criteria. Ecology guidance requires the use of the more conservative result; therefore, we used data based on dry-weight results in our assessment.

Table 1 - Comparison of Dry-Weight Versus TOC-Normalized Data

Location	Fines (%)	TOC (%)	Dioxin TEQ (pg/g)	cPAH TEQ (µg/Kg)	LPAH (µg/Kg)	LPAH OC Normalized (mg/Kg)	HPAH (µg/Kg)	HPAH OC Normalized (mg/Kg)
DMPR2015-01	26.6	**10.2**	–	**1,112**	3,310	32	9,760	96
DMPR2015-03	22	2.26	–	**480**	1,976	87	4,758	211
DMPR2015-05	28.5	**16.7**	–	**1,154**	4,350	26	11,060	66
DMPR2015-06	9.3	0.901	–	**408**	764	85	3,409	378
DMPR2015-08	34.3	**3.54**	–	**39,470**	**167,480**	**4,731**	**1,278,900**	**36,127**
DMPR2015-D01	16.9	2.48	12.18	**553**	1,757	71	7,517	303
DMPR2015-D02	15.8	2.15	**26.88**	**1,315**	**5,670**	264	**16,800**	781
DMPR2015-D03	16.7	1.42	15.78	**987**	3,251	229	**15,751**	**1,109**
DMPR2015-D04	23.6	**8.02**	**21.20**	**1,077**	3,720	46	**16,820**	210
DMPR2015-D05	27.5	**3.58**	**33.16**	**1,602**	**5,570**	156	**23,030**	643
UWI-CB-285-2014	11.8	0.55	–	74	267	49	543	99
Screening Criteria		0.5-3.0	19	78	5,200	370	12,000	960

Notes:
values in **bold** exceed screening criteria,
pg/g = picograms per gram,
µg/Kg = micrograms per kilogram,
mg/Kg = milligrams per kilogram,
LPAH = low-molecular-weight polycyclic aromatic hydrocarbons,
HPAH = high-molecular-weight polycyclic aromatic hydrocarbons

3 Site Assessment

As part of Task 1, a site visit was conducted to document and evaluate site conditions along the adjacent shoreline, photo-document beach conditions, and observe beach sediment grain sizes. In addition, bathymetric and topographic survey data were collected along the beach and in the nearshore including in the pile field[1]. The survey data analysis was used to confirm site visit observations and to inform the conceptual site model. The observations from the site visit and corresponding assessments are summarized below.

3.1 Coastal Processes

3.1.1 Observations

Key observations from the Site Observations Memorandum (Appendix D) are listed below:

- Below mean lower low water (MLLW), black sands and fines were observed with wood waste below the beach surface.
- Gravel and sand were observed above MLLW with wood waste below the beach surface.
- The wood waste was noted to be closer to the beach surface at hand dug pits below MLLW, than areas higher up on the beach profile. Wood waste (sawdust, timber) was also observed on the beach surface.
- Eelgrass beds were noted outside the pile field, but not within.
- A convex-shaped longitudinal profile (salient) was observed in the intertidal (near MLLW) zone of the beach which could be an indication that the pile field is attenuating the wave energy reaching the beach.
- The beach berm above ordinary high water (OHW) protecting the tidal channel is wide (20+ feet), but is narrower directly behind the pile field than along the shoreline north of the pile field.

3.1.2 Assessment

A bathymetric and topographic survey was conducted within the pile field and along the beach landward of the pile field to supplement the 2019 DNR Survey. Both data sets were used to evaluate the beach profile and potential effects removing the pile field could have on the adjacent shoreline. As shown in Appendix C, the beach profile within the pile field compared to the beach profile updrift of the pile field (“natural” beach) showed an over steepened lower intertidal and subtidal profile. Within the pile field, there appears to be several feet (3-5 feet) of sedimentation above the “natural” beach profile at those tidal elevations. Site observations of beach material and grades near and above MLLW match those shown in available permit drawings from the 1990 restoration project.

The convex shape of the beach noted during the site visit was confirmed during the survey data analysis. The convex shape of the beach is indicative of a salient, which are commonly found behind detached offshore breakwaters. This feature indicates the pile field may be providing wave attenuation in the nearshore. The beach likely reached dynamic equilibrium prior to the restoration work. The restored beach was therefore likely constructed to tie in with these elevations. Removal of the pile field may cause a shift in the dynamic equilibrium of the beach, and any beach profile adjustment may potentially expose material under the restored beach (cap).

[1] Bathymetric data (single-beam soundings) were collected by remote vessel. Topographic data were collected using a land-based RTK system.

As noted in the site observations, the berm between the tidal channel and the beach appears to be narrower behind the pile field than elsewhere along the shoreline. If the beach profile were to adjust, the berm width could also adjust and become narrower, though the risk of a breach appears to be low.

3.2 Contaminants

The Mott MacDonald Project Team reviewed WA State Department of Ecology's Environmental Information Management (EIM) System data to identify and map the site contaminants of concern. This subsection provides a summary of the site conditions, contaminants of concern, surface weighted average concentrations (SWAC) and data gaps. Details including mapped SWACs for COCs are included in Appendix B.

3.2.1 Observations

Patches of bacterial mats and associated anoxia were noted on the sediment surface throughout the Study Area. Signs of large infauna (burrows, siphon holes, etc.) were largely absent in areas surveyed, further supporting widespread anoxic conditions within the sediment. A large continuous eelgrass bed was observed west of the pile field that abutted the pile perimeter. Isolated patches of eelgrass were also observed east of the pile field.

3.2.2 Assessment

3.2.2.1 Data

Datasets reviewed include:

- Existing investigation reports provided by Washington Department of Natural Resources (WDNR).
- Available data from EIM database.

3.2.2.2 Sediment Grain Size

Surface sediment grain size analysis at several locations in the pile field[2] indicate the following:

- Surface material consists of a mix gravel, sands, and fines.
- Sand content ranged from 45 to 90 percent (very fine sand to very coarse sand).
- Fine-grained fraction of surface sediment ranged from 9 to 34 percent.
- Organic carbon content of the sediment ranged from 1 to 16 percent.

3.2.2.3 Contaminants of Concern

To characterize representative concentrations of COCs within surface sediment, a SWAC for the Study Area was calculated for each COC. Interpolation of the available data points was conducted to develop the ranges of concentration by COC across the Study Area (Figures 3 through 6 of Appendix B). Exceedance magnitudes range from 1.1 (dioxin TEQ) to 68 (cPAHs) times greater than their respective criterion, when including all available samples.

Except for one location (DMPR-08), concentrations within the pile field surface sediment were within the same order of magnitude; concentrations at DMPR-08 are elevated relative to all other samples. Based on review of the field log and photo, this sample contained a high percentage of wood debris (40 percent) including a large chunk of wood visible in the sample photo. We performed additional statistical analyses limiting the effect of

[2] Size gradations and subsurface information were not available.

DMPR-08 and ultimately removed this outlier from the analysis. Table 2 lists SWACs for all COCs with and without DMPR-08 excluded from the calculations; all other parameters remained the same. As shown in Table 2, the SWAC remains above the criteria for cPAHs and dioxins[3] while LPAH and HPAH averages are at or below cleanup criteria, when DMPR-08 is not included.

Table 2. SWAC by Contaminant of Concern

Contaminant of Concern (COC)	Units	SWAC Estimates	SWAC Estimates without DMPR-08	Criterion	Exceedance Factor (all samples)	Exceedance Factor (without DMPR-08)
Dioxin TEQ	pg/g	21.7	21.7*	19	1.1	1.1
cPAH TEQ	µg/Kg	5,285	939	78	68	12
Total LPAH	µg/Kg	21,766	3,291	5,200	4.2	0.63
Total HPAH	µg/Kg	153,770	11,931	12,000	13	0.99

Notes:
SWAC = surface-area-weighted-average concentration, cPAH = carcinogenic polycyclic aromatic hydrocarbons, LPAH = low-molecular weight polycyclic aromatic hydrocarbons, HPAH = high-molecular-weight polycyclic aromatic hydrocarbons. *DMPR-08 was not analyzed for dioxin and therefore the SWAC does not change

4 Results and Conclusions

Below is a summary of our results and conclusions, as presented in the August 5, 2020 meeting.

- Contaminants of Concern:
  - Surface concentrations exceed cleanup criteria[4] within, and outside of pile field.
  - Subsurface COC concentrations not known.
  - One sample significantly skews the SWAC mapping results, and upon investigation of the sample, it was removed from the analysis. SWAC maps with and without this sample are in Appendix B.
- Concept Site Model:
  - A conceptual site model was developed based on the site assessment and review of historical information and data. The conceptual site model provides a description of the physical processes influencing the site sediment transport.
  - Figure 2 summarizes the key physical processes influencing the existing site.
  - Figure 3 summarizes the potential qualitative site response to pile field removal.
- Risk of mobilizing contaminated sediments
  - Within pile field**:**
    - Removal will likely result in mobilization and dispersal of mapped contaminants with some locations at higher risk. The higher risk areas include a majority of the pile field; but in particular, the area of accumulated material sitting at a steeper slope near the seaward side of the pile field. Estimating the potential rate and extent of sediment dispersal requires numerical modeling.
    - Dioxins appears to have a lower likelihood of contributing to exceedances of cleanup criteria offsite, but do exceed cleanup thresholds at select points within the pile field.

[3] Exceedances of samples within the pile field vary. Specific sample TEQ values are shown in Appendix B.

[4] Marine Sediment Management Standards (Chapter 173-204 Washington Administrative Code [WAC]) benthic1 and bioaccumulation2 criteria.

    - CPAHs exceed Commencement Bay Nearshore/Tideflats Superfund Site (CB N/T Site) chemical criteria at locations within the pile field and appear to have a higher likelihood of causing offsite cleanup criteria exceedances if dispersed.
    - LPAH and HPAH concentrations exceed the CB N/T Site criteria at select locations within the pile field, but the adjusted SWAC is lower than the cleanup criteria. Exceedances are likely attributable to ongoing degradation of creosote-treated piles in the area.
  - Outside the pile field:
    - Removal of piles appears unlikely to mobilize sediment offshore or in-water to the north/south of the pile field, but further verification is required.
    - Adjustment of the lower beach profile within the area landward of the pile field (restored/capped area) could further expose previously capped wood waste and contaminants.
- Qualitative risks to adjacent shoreline areas after the piles are removed:
  - Wave energy is likely to increase at the restored beach.
  - Restored beach planform and profile are at risk of adjusting to a new dynamic equilibrium.
  - Change in equilibrium profile could re-distribute COCs within the pile field and potentially expose COCs under the restored beach along the lower portions of the beach profile.
  - Tidal channel breaching is at a lower risk depending on beach planform adjustment; this risk increases with SLR.
- Construction:
  - Prior studies recommended capping either with or without excavation of the top layer of material (Anchor QEA, 2017).
  - If piles are pulled, the pile stubs may become more exposed over time if left in place (if beach adjusts). The pile stubs could then potentially continue releasing COCs.
- Next Steps:
  - Analysis: Task 2 work including wind-wave and hydrodynamic analysis and modeling of the site post-pile removal is recommended. This work is intended to quantify the areas and extent of erosion, corresponding sediment transport pathways, and risks of beach profile adjustment.
  - Data collection: Sediment gradations within the pile field would be helpful to provide refined inputs to beach profile adjustment modeling which will evaluate changes from removal of the pile field. Subsurface samples may be beneficial for characterizing chemical characteristics and for sediment fate modeling and were identified as a data gap. Future work will likely require subsurface data.

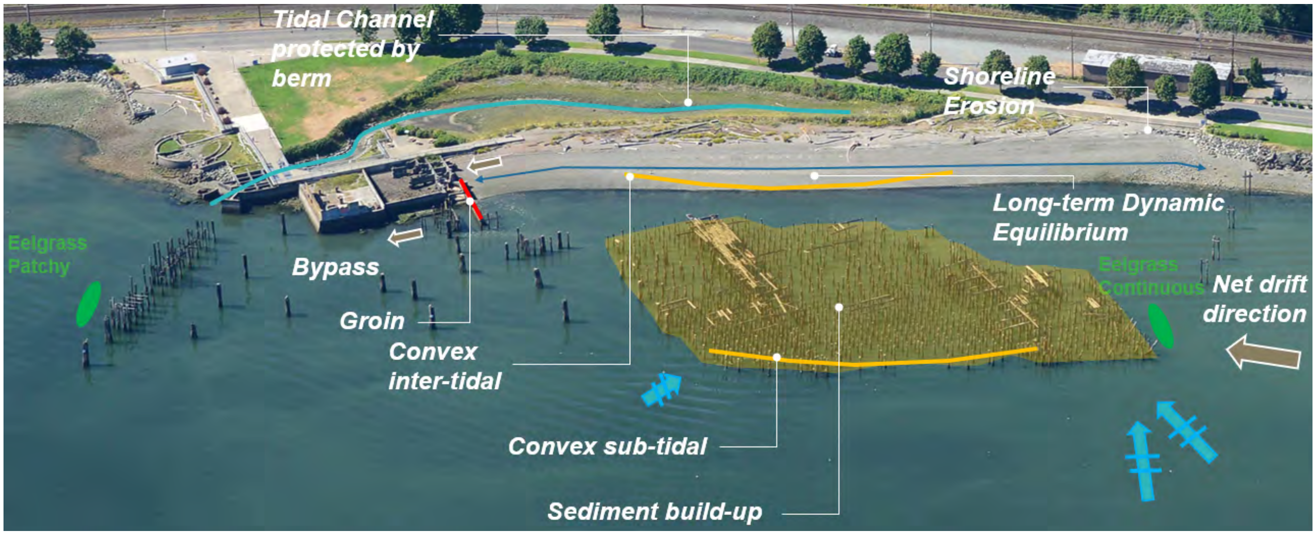

Figure 2. Existing Conditions - Conceptual Site Model

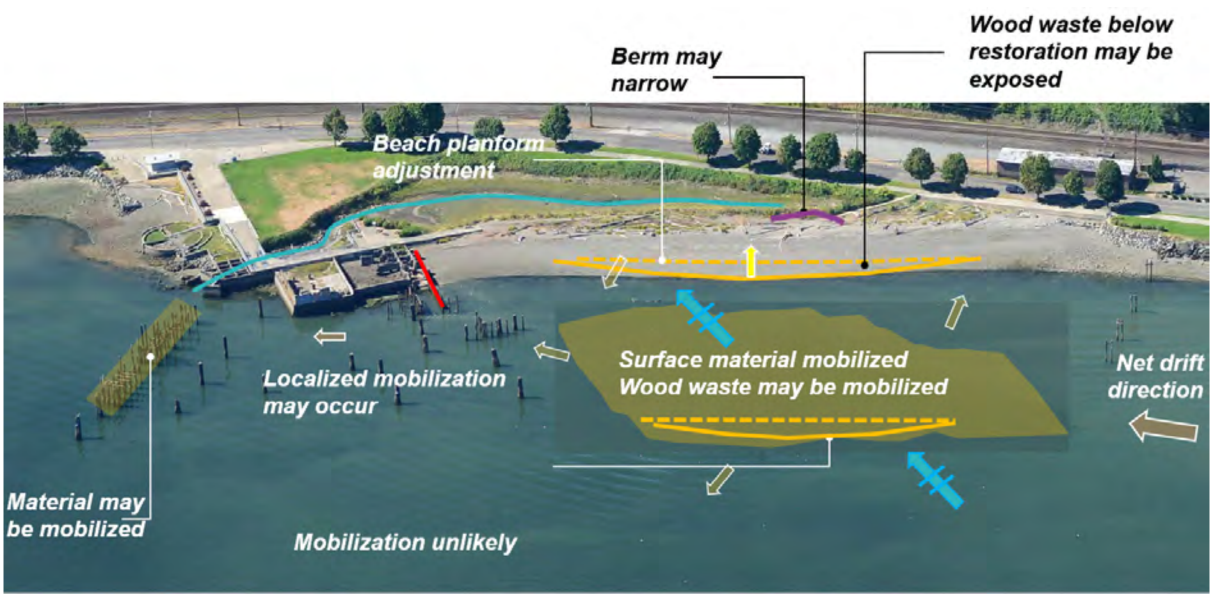

Figure 3. Post Pile Field Removal - Conceptual Site Model

Appendix A: Progress Meeting Slides (August 5, 2020)

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Dickman Mill Pile Removal Progress Update

Aug 5, 2020

Table of Contents

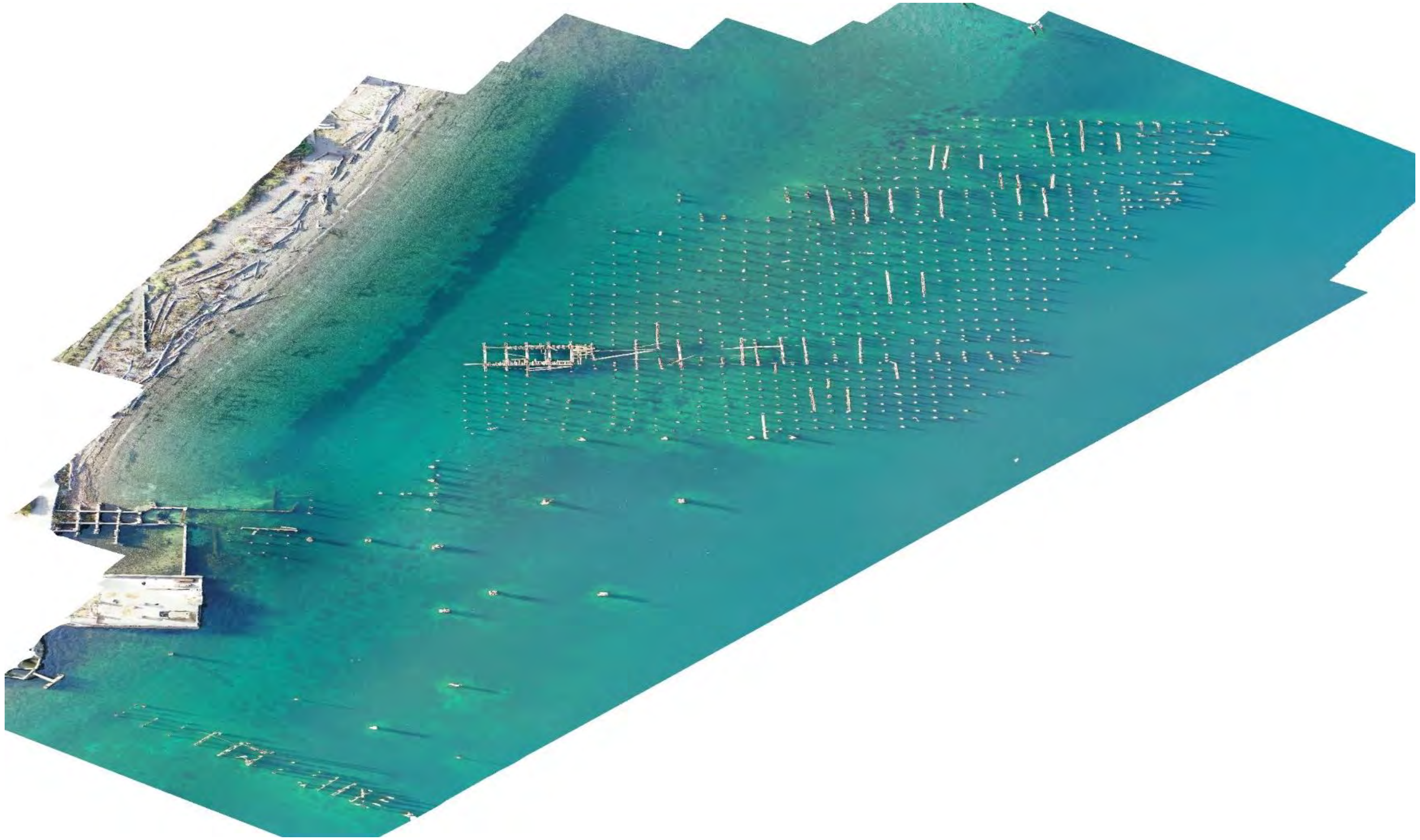
Basis of Assessment

Site Assessment – Physical

Site Assessment – Contaminants

Draft Concept Site Model

Takeaways



Basis of Assessment

Scope of Work

Task 1

Data Collection, Compilation and Summary

- Data compilation
- New Data
- Site Visit
- Existing Structure Documentation
- Site contaminant background
- Existing study compilation
- Seabed Profile and Sediment Evaluation (Qualitative)

Conceptual Site Model

Contingent Task 2

Quantify potential movement of sediment and related contaminants following removal of pile field

- Wind-Wave Analysis and Modeling
- Hydrodynamic Analysis and Modeling
- Sediment Transport Analysis and Modeling

Basis of Assessment Outline Summary

Click and play animation

Purpose and Objectives

Assess risk of releasing additional contaminants, and risk of affecting nearby properties

Phase 1 – Data review and qualitative assessment

Phase 2- (Not yet conducted) – Quantitative assessment if necessary

Site Description

Site Visit Memorandum

Project Data

Elevation Data

Datum Conversion

Wind data sources

Substrate Type

Contaminants

Project Criteria

Removal Area

Removal type

Design Storm

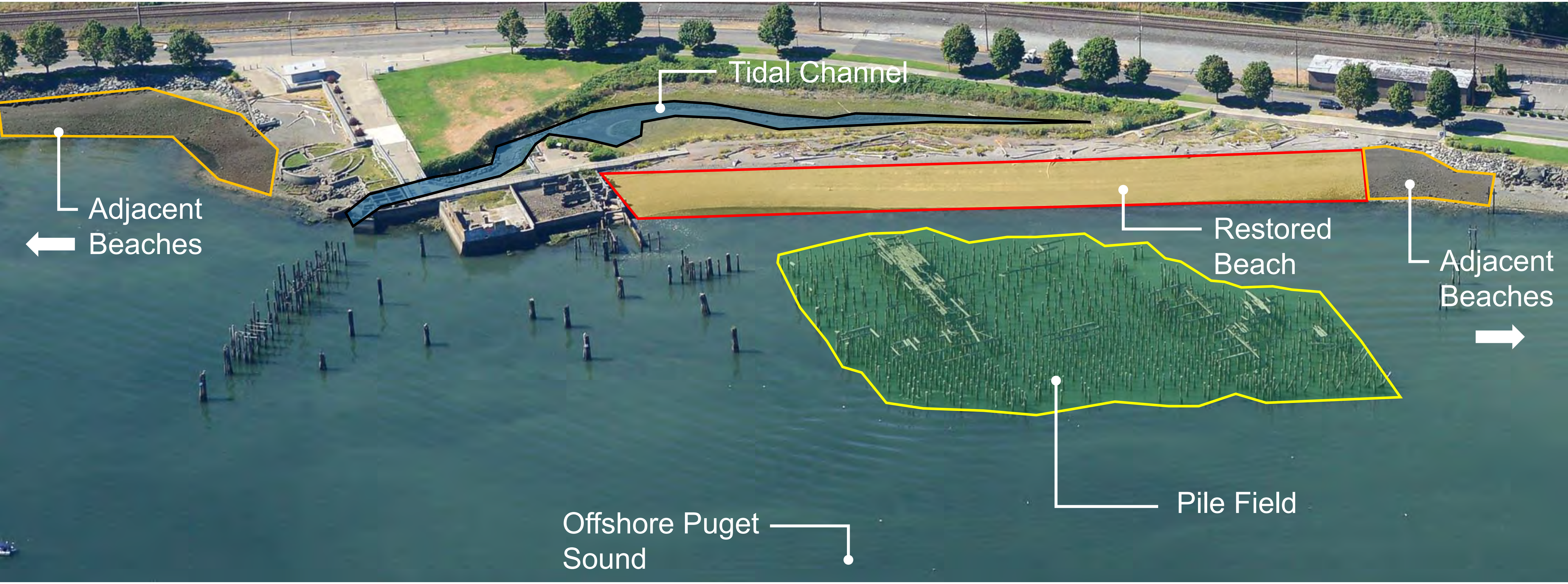
Contaminant Levels

Sea-Level Rise

Coastal Processes

Vessel Wake

Potentially Affected Areas



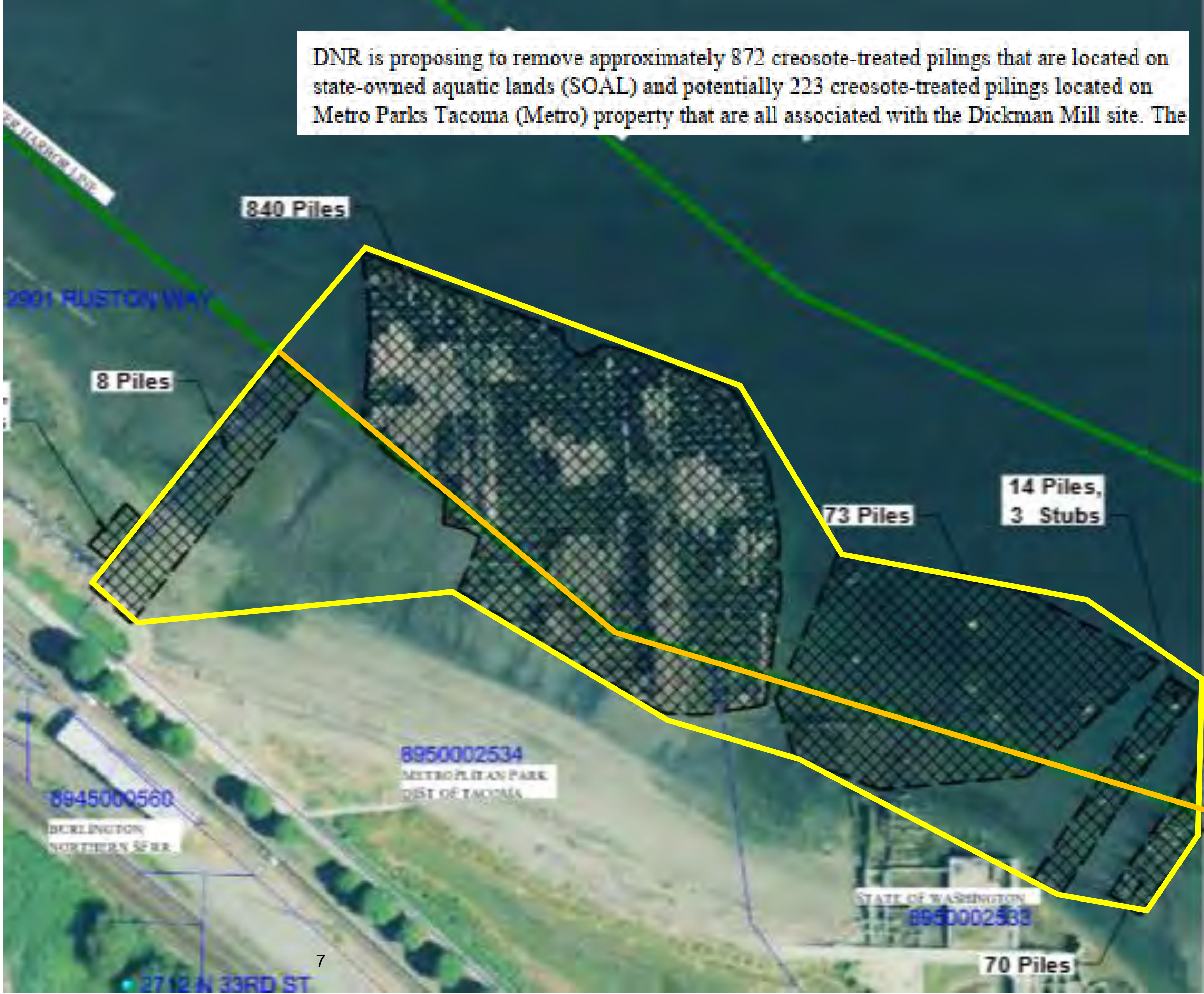
Area of Study

Pile Inventory (# of piles)

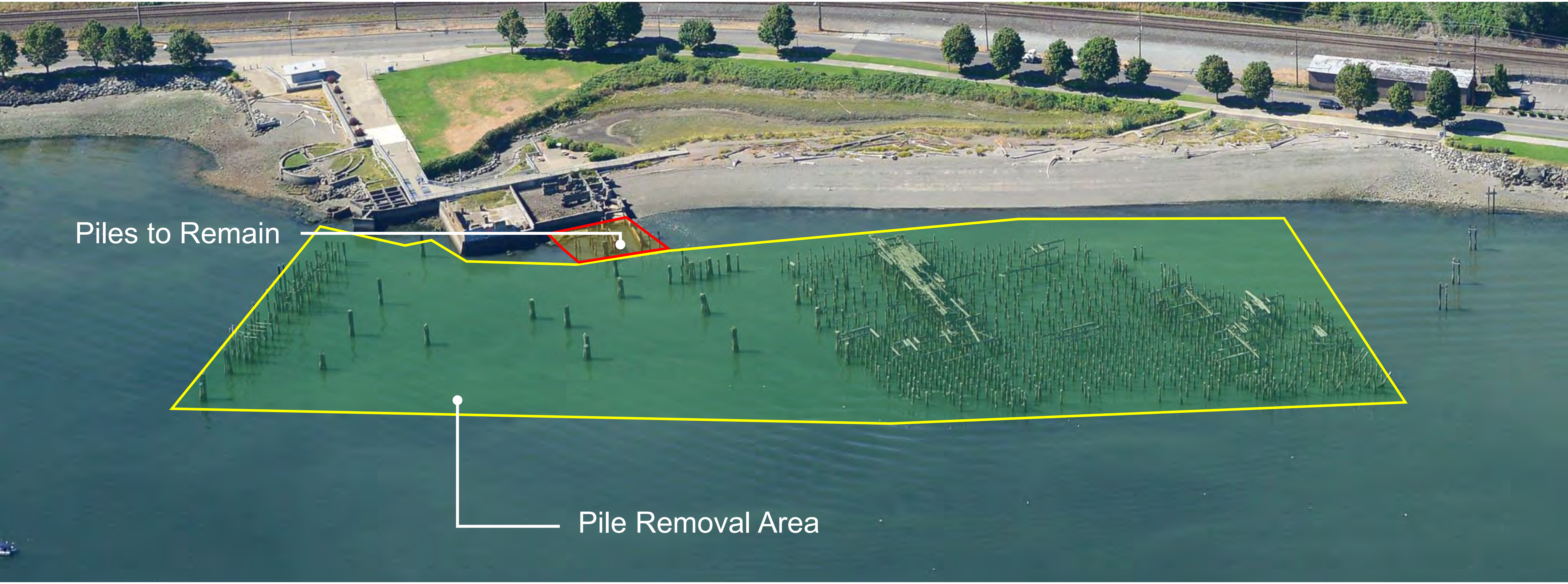
- 8
- 840
- 73
- 17
- 70
    - 1008

Scope of Work

- 872
- 223
    - 1008



Removal Areas

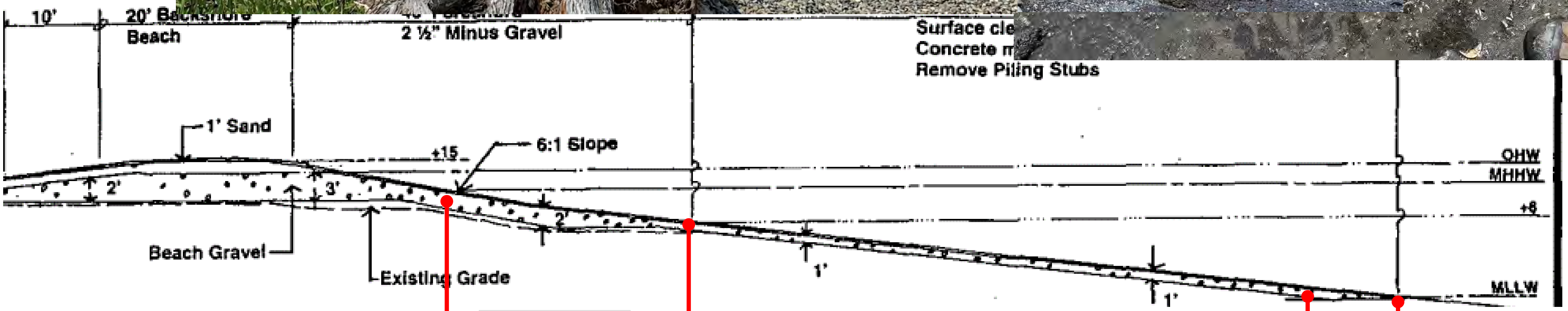


Type of Removal

Example Stubs to Potentially Remain

Site Observations

Beach



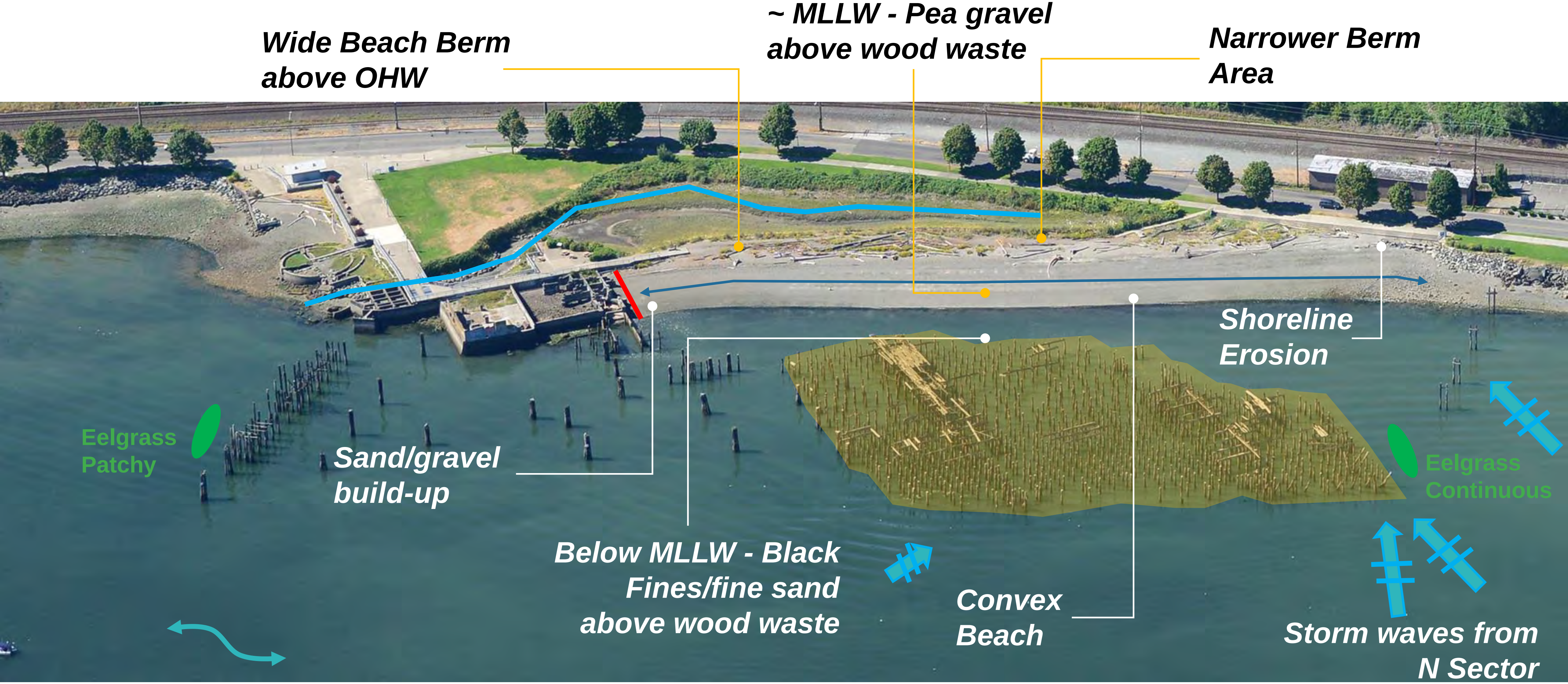
No/Deeper Wood Waste (not found)

Change in thickness

Shallow wood waste potential contaminants

Tie-in to existing beach profile

Site Observations



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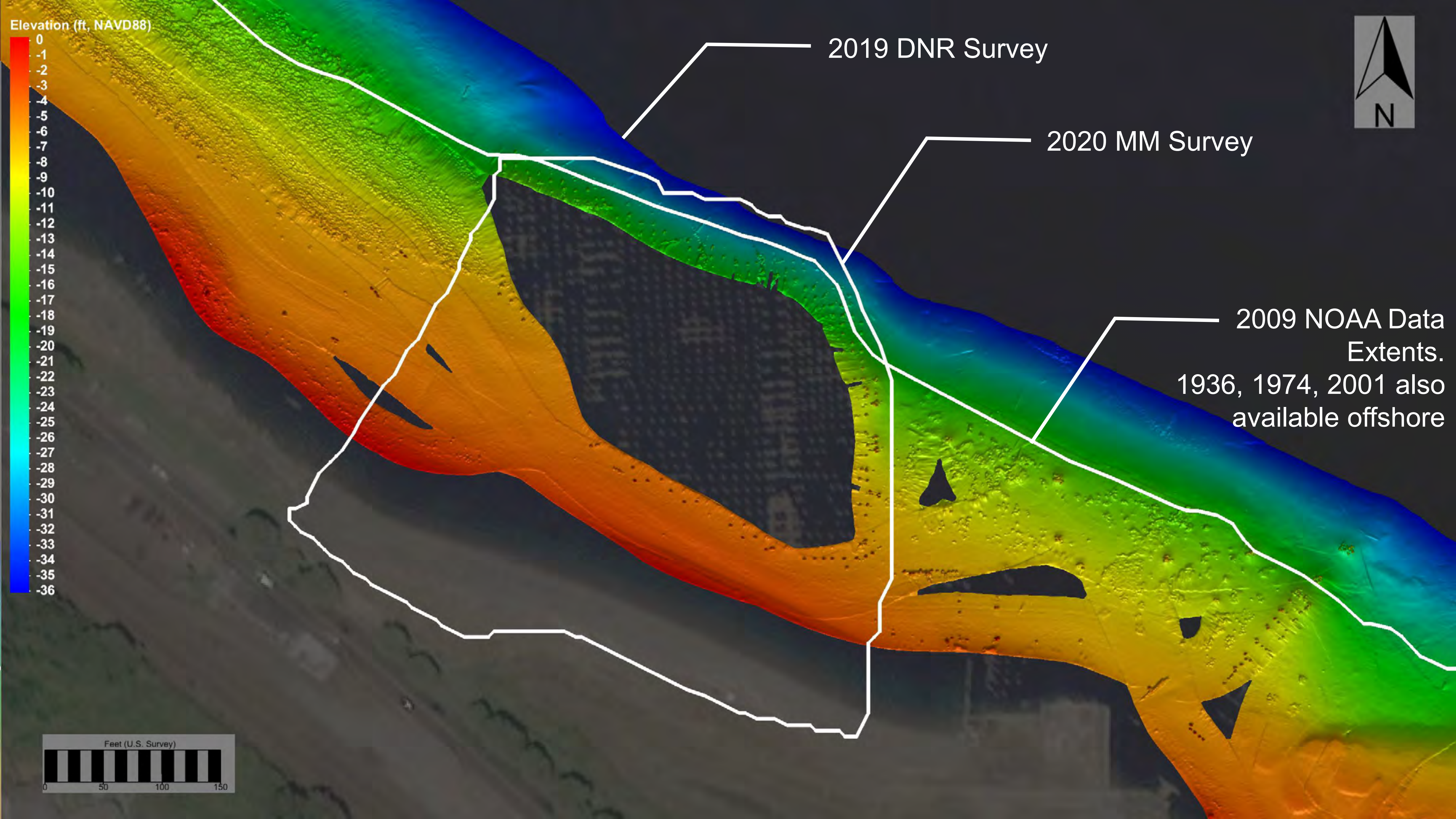
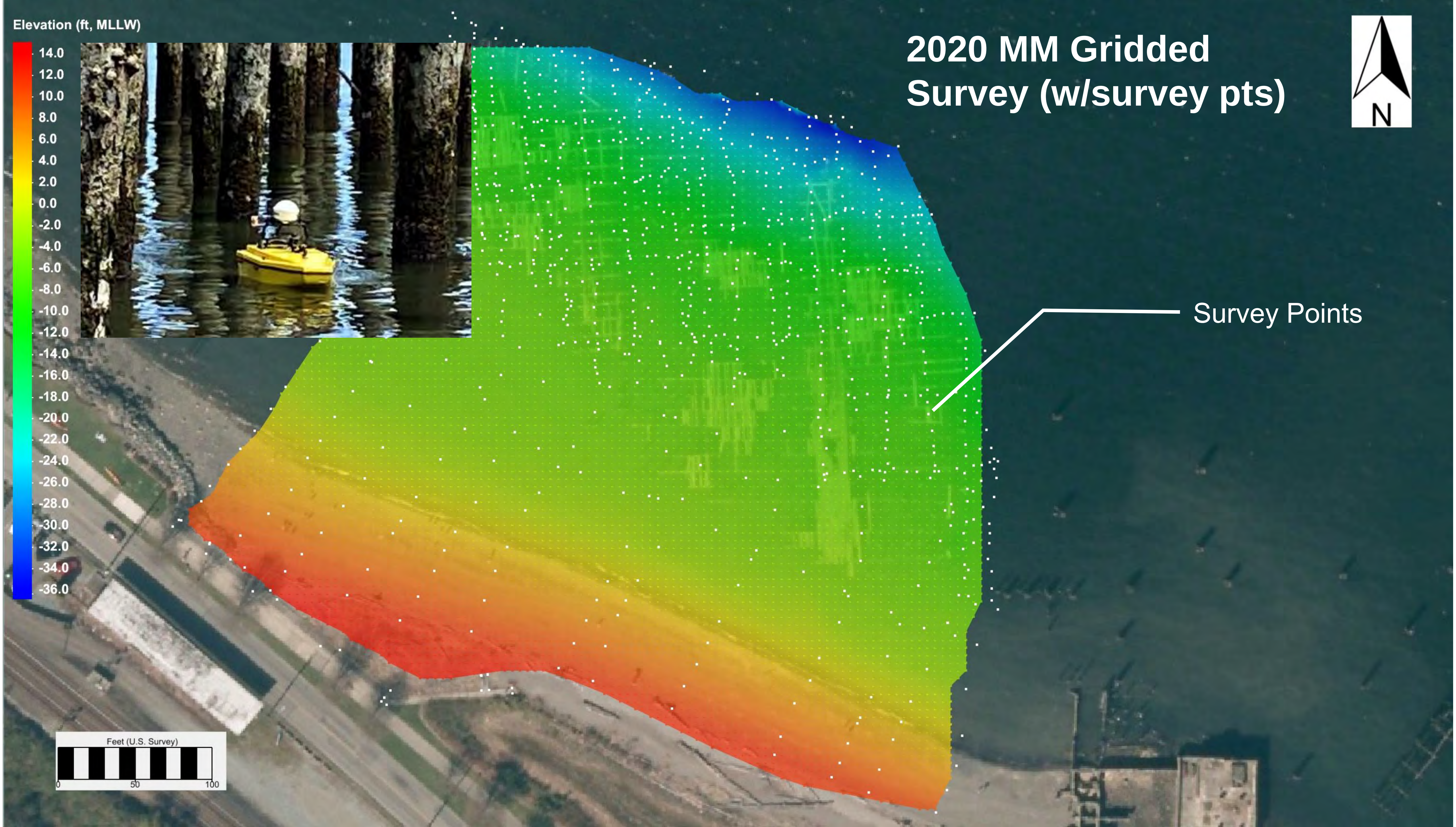
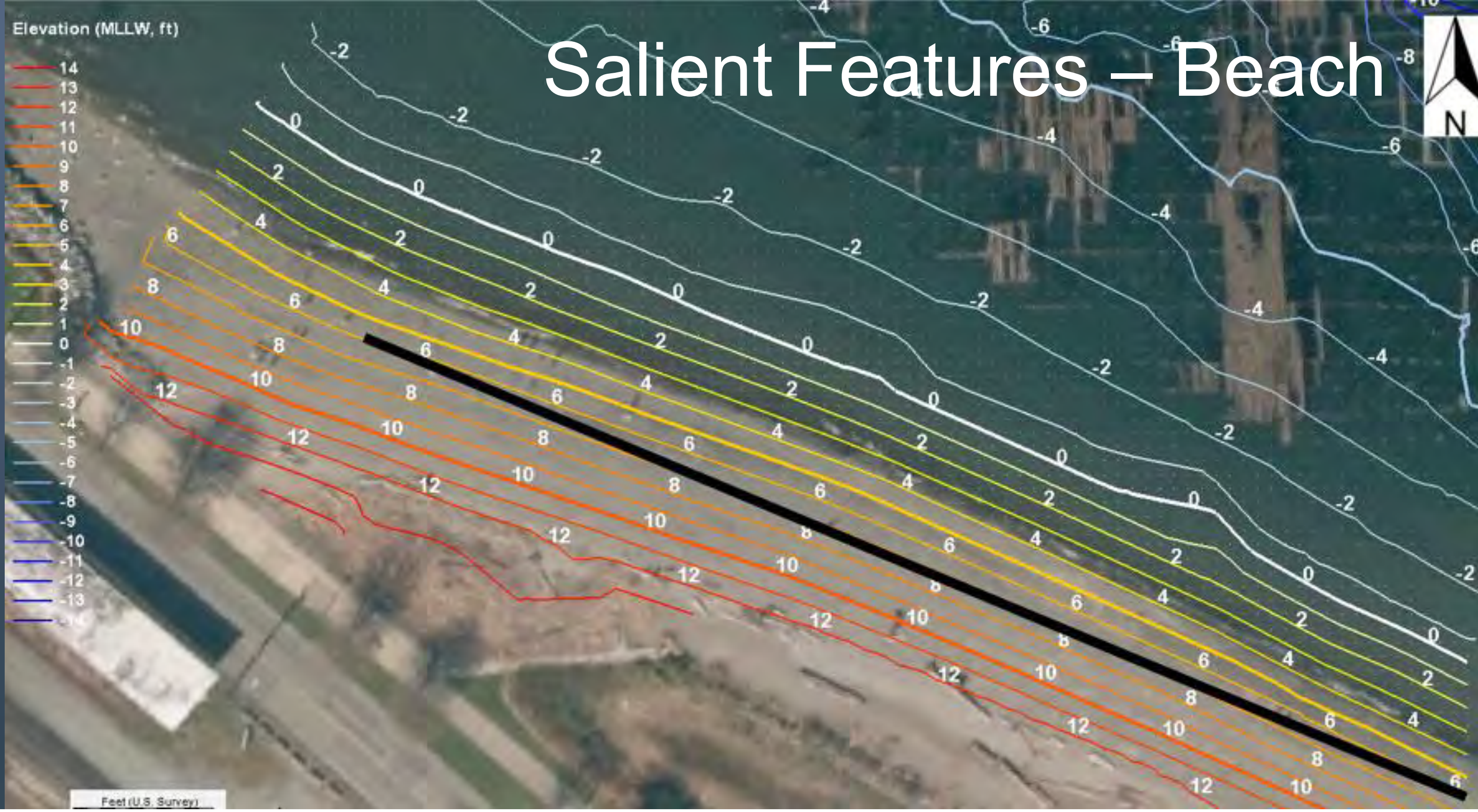
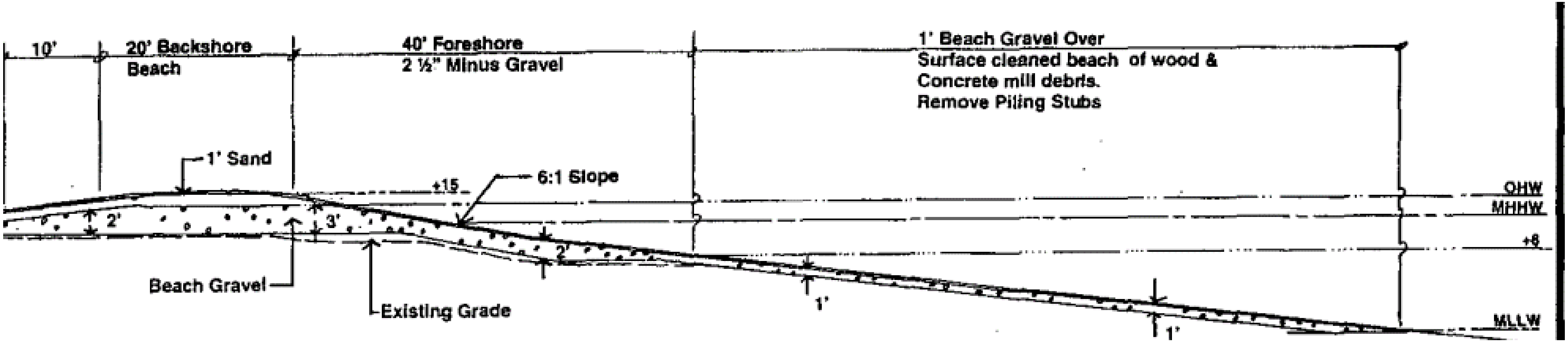
Site Assessments

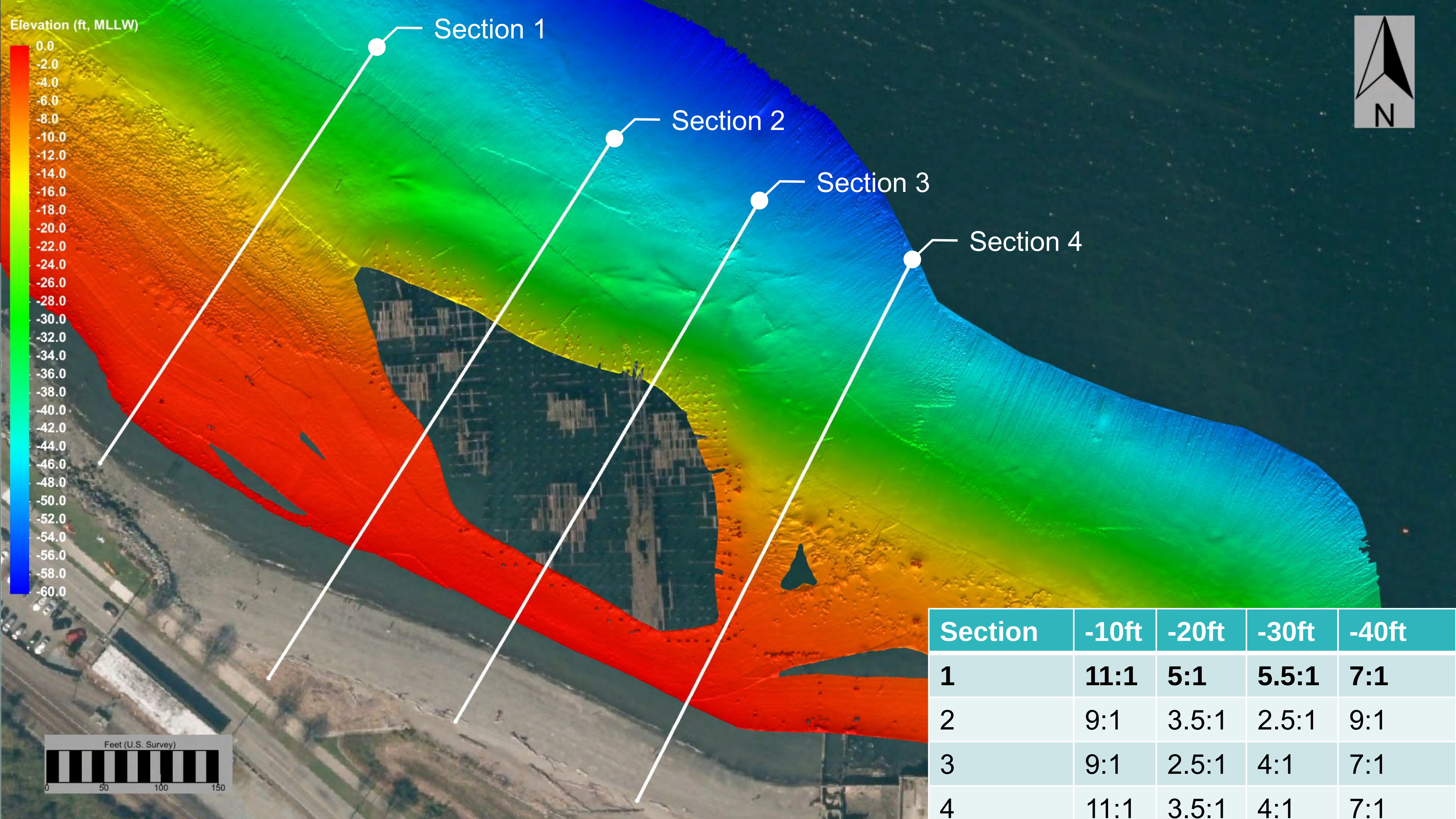

Elevation (ft, NAVD88)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
-15
-16
-17
-18
-19
-20
-21
-22
-23
-24
-25
-26
-27
-28
-29
-30
-31
-32
-33
-34
-35
-36
2019 DNR Survey
2020 MM Survey
2009 NOAA Data Extents.
1936, 1974, 2001 also available offshore
N
Feet (U.S. Survey)
0
50
100
150


2020 MM Gridded Survey (w/survey pts)
N
Survey Points
Elevation (ft, MLLW)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
-32.0
-34.0
-36.0
Feet (U.S. Survey)
0
50
100

Salient Features – Beach







Section	-10ft	-20ft	-30ft	-40ft
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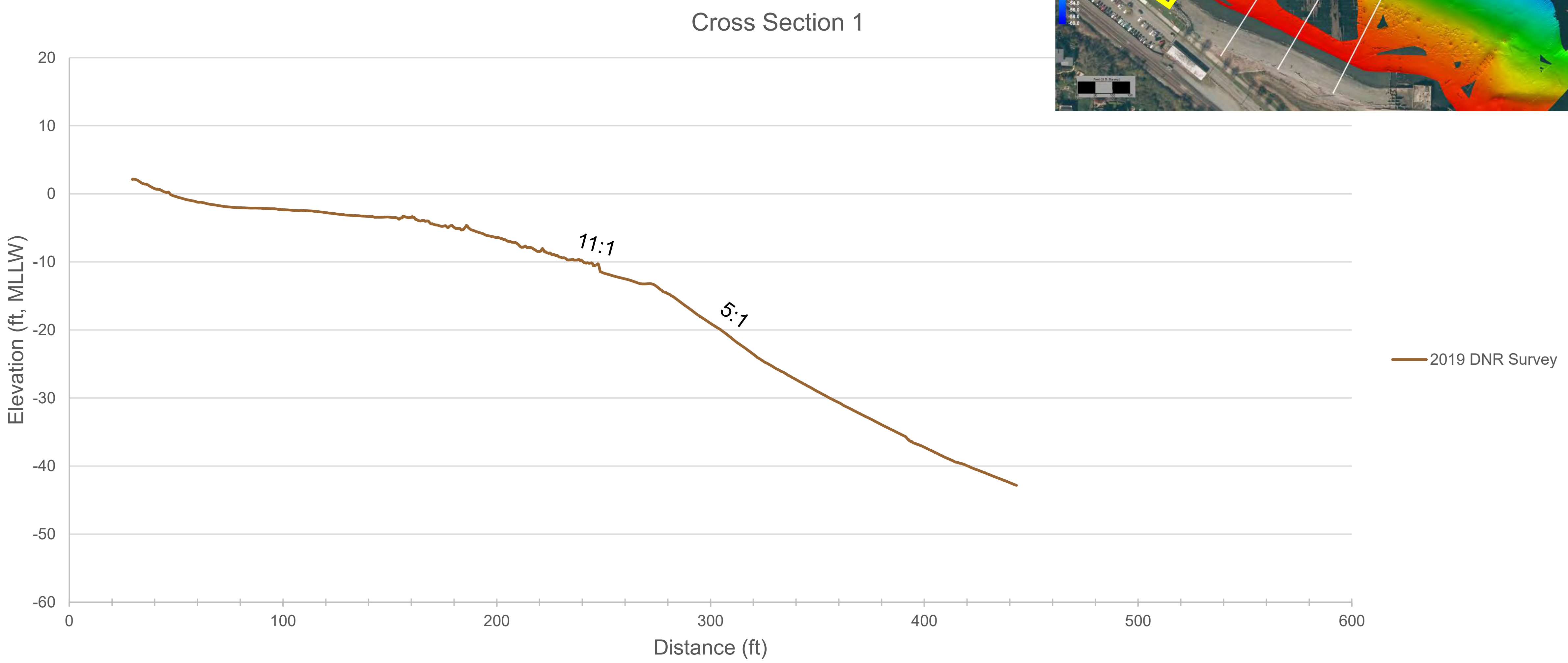
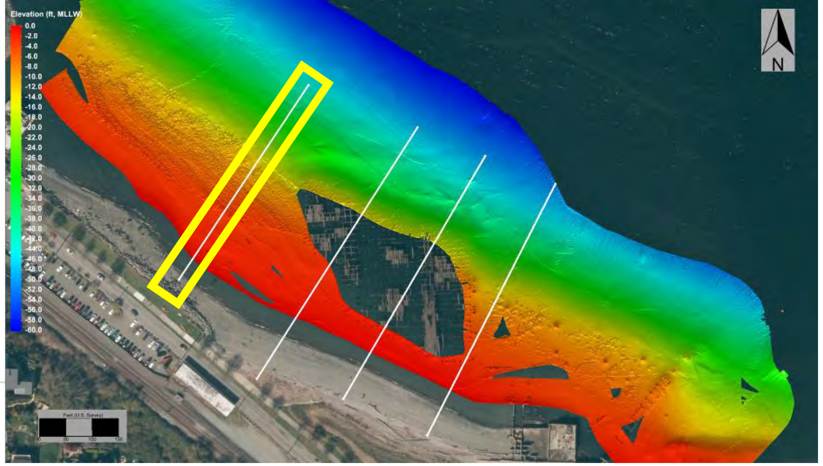
2	9:1	3.5:1	2.5:1	9:1
3	9:1	2.5:1	4:1	7:1
4	11:1	3.5:1	4:1	7:1

Survey: Section 1

North of Pile Field



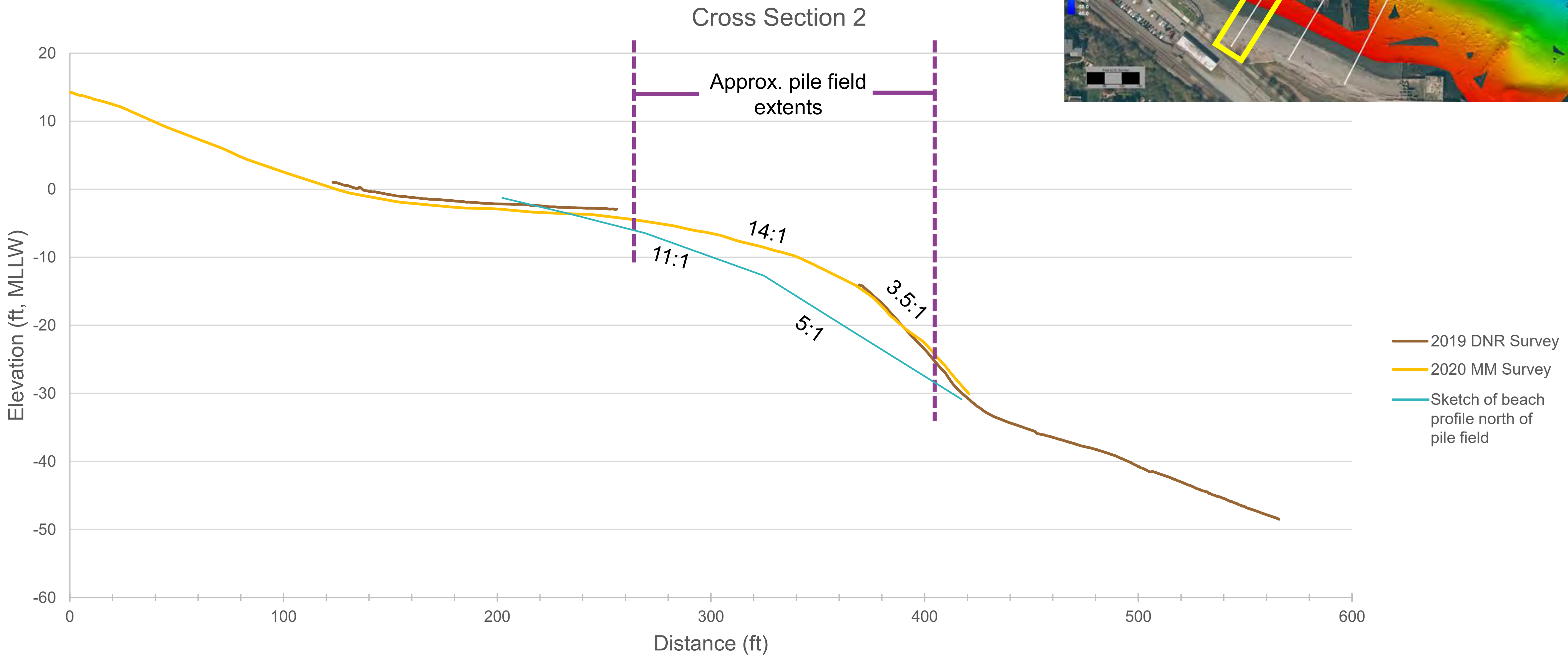


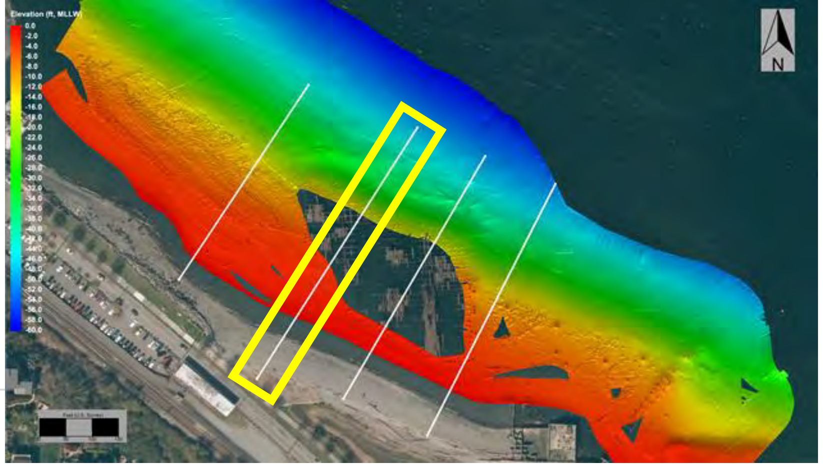
Mott MacDonald
Dickman Mill Pile Removal
Progress Update

August 5, 2020

Survey: Section 2

Within Pile Field





Coastal Processes Summary

1

Lower intertidal and subtidal profile over steepened

2

Intertidal shoreline profile at dynamic equilibrium

3

Tidal channel protective berm is wide, narrowing behind pile field

Conclusions & Risks

1

Risk of adjustment when subject to un-attenuated waves

2

Intertidal shoreline profile may adjust in un-attenuated waves

3

Tidal channel berm breaching appears to be a lower risk

Surface Photos

Within Pile Field

Edge of Pile Field

Dickman Mill Park (2017)

- LPAH and HPAH concentrations are exceeding the Commencement Bay Nearshore/Tideflats Superfund Site (CB N/T Site) chemical criteria.
  - Sources: Exceedances are likely attributable to ongoing degradation of creosote-treated piling in this area
- Other contaminants exceeding the CB N/T chemical criteria are present in more localized areas.
  - Sources: Attributable to degradation of the creosote-treated pilings and legacy releases from prior lumber mill and other industrial operations in the area.

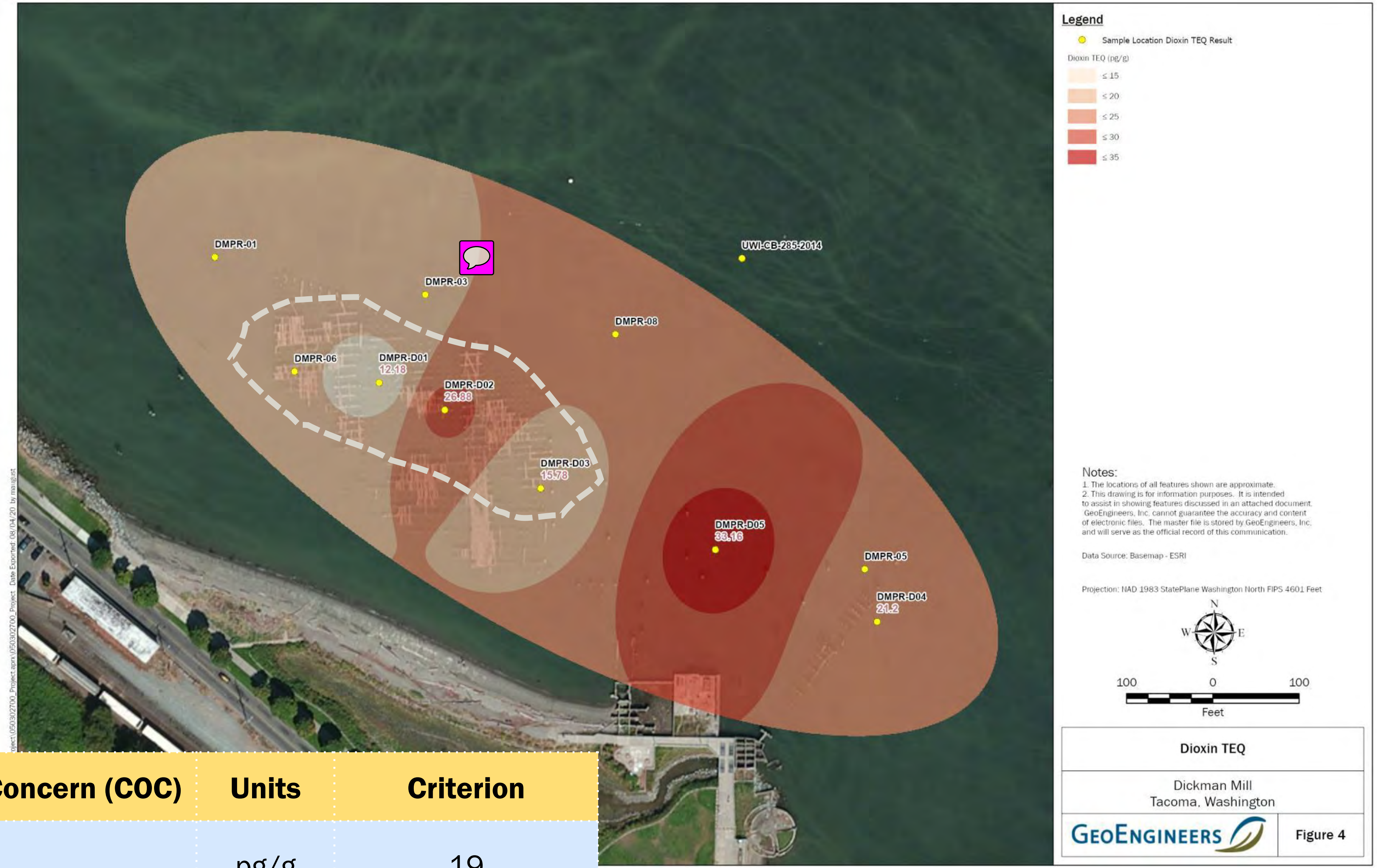
COC Summary

TABLE SUMMARY OF SWAC BY COC

SWAC = surface-area-weighted-average concentration, cPAH = carcinogenic polycyclic aromatic hydrocarbons, LPAH = low-molecular-weight polycyclic aromatic hydrocarbons, HPAH = high-molecular-weight polycyclic aromatic hydrocarbons

Contaminant of Concern (COC)	Units	SWAC Estimates	Criterion	Exceedance Factor
Dioxin TEQ	pg/g	21.7	19	1.1
cPAH TEQ	µg/Kg	5,285	78	68
Total LPAH	µg/Kg	21,766	5,200	4.2
Total HPAH	µg/Kg	233,751	12,000	13

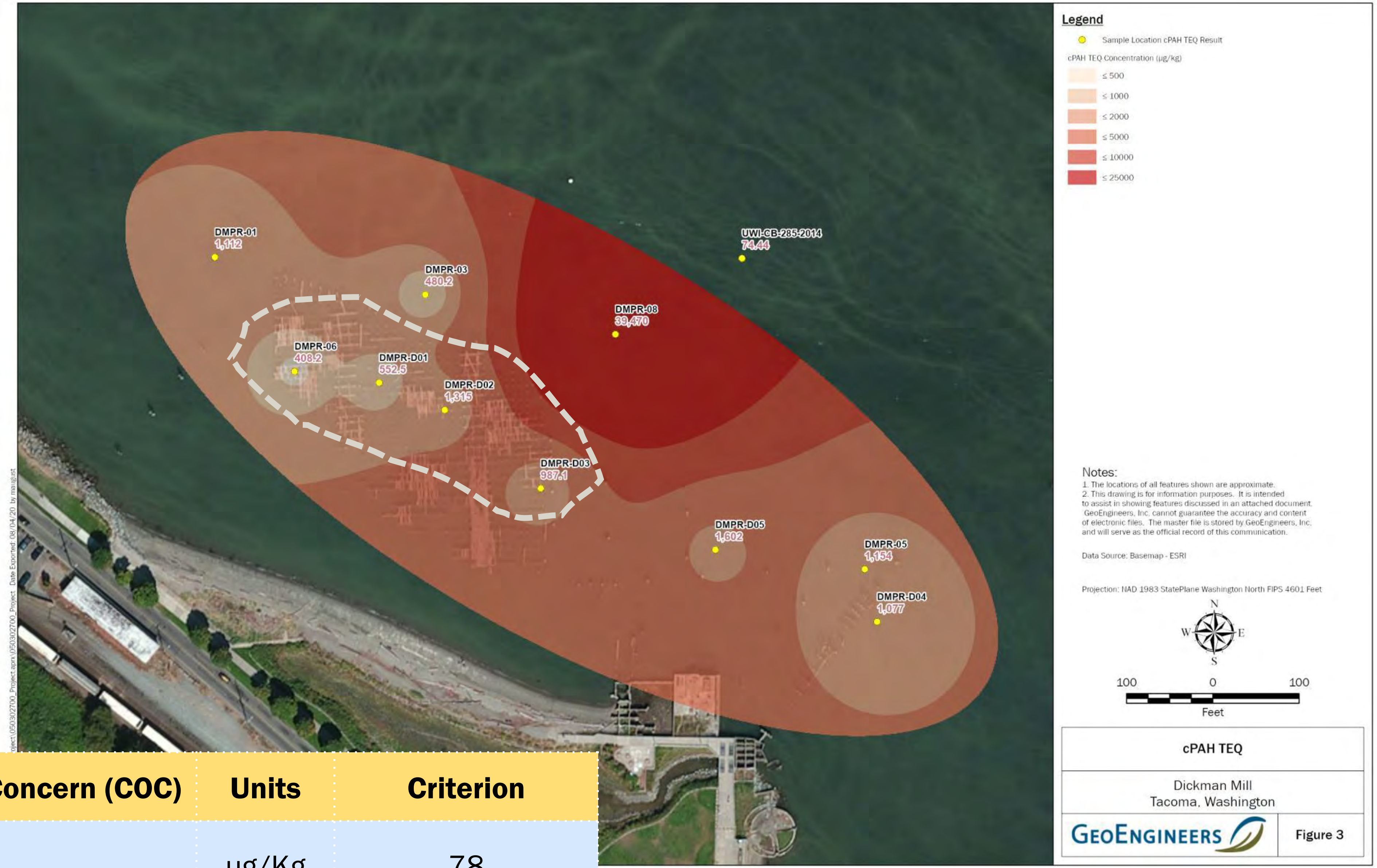
Dioxin TEQ



Contaminant of Concern (COC)	Units	Criterion
Dioxin TEQ	pg/g	19

ıgust 5, 2020

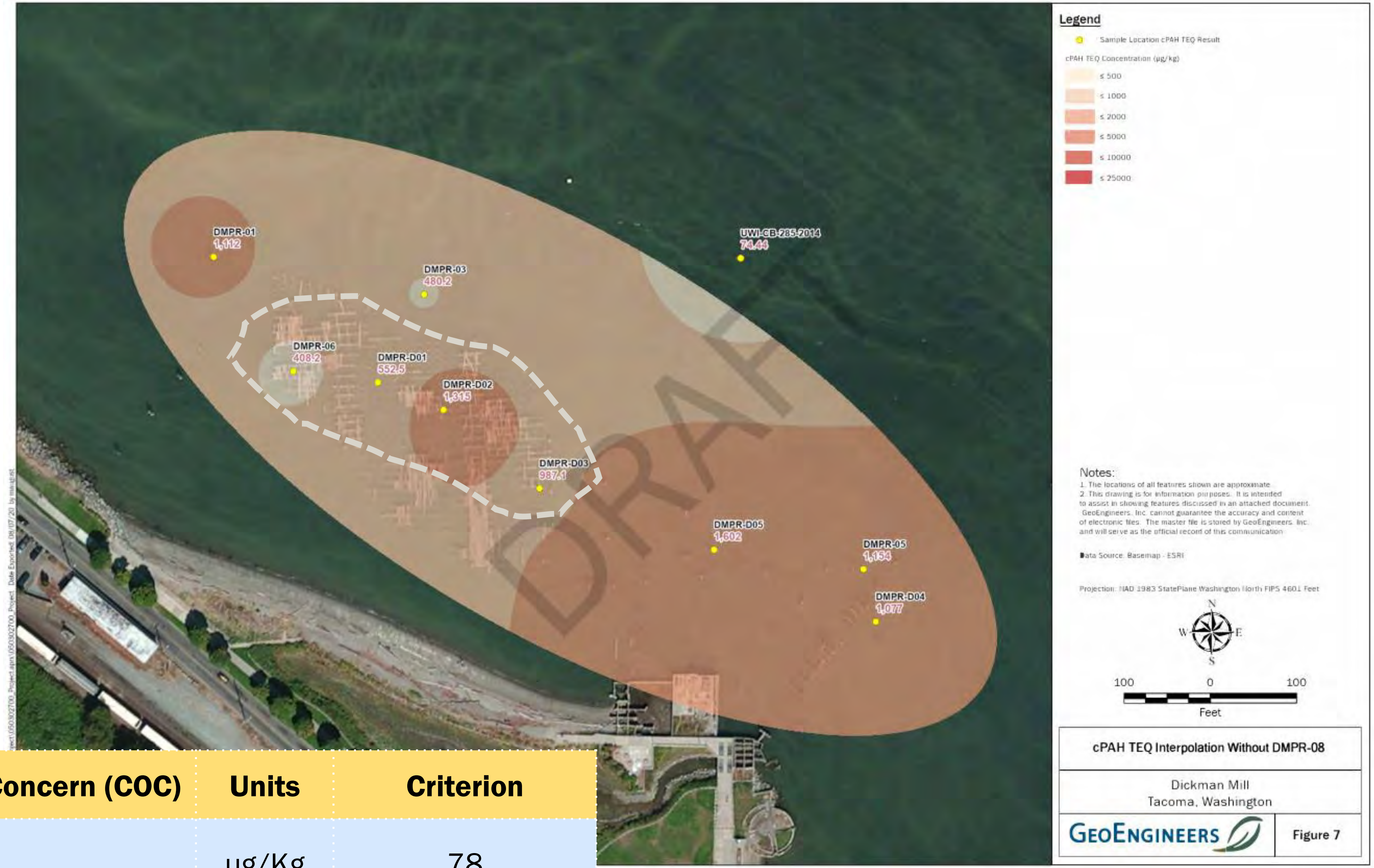
cPAH TEQ



Contaminant of Concern (COC)	Units	Criterion
cPAH TEQ	µg/Kg	78

ıgust 5, 2020

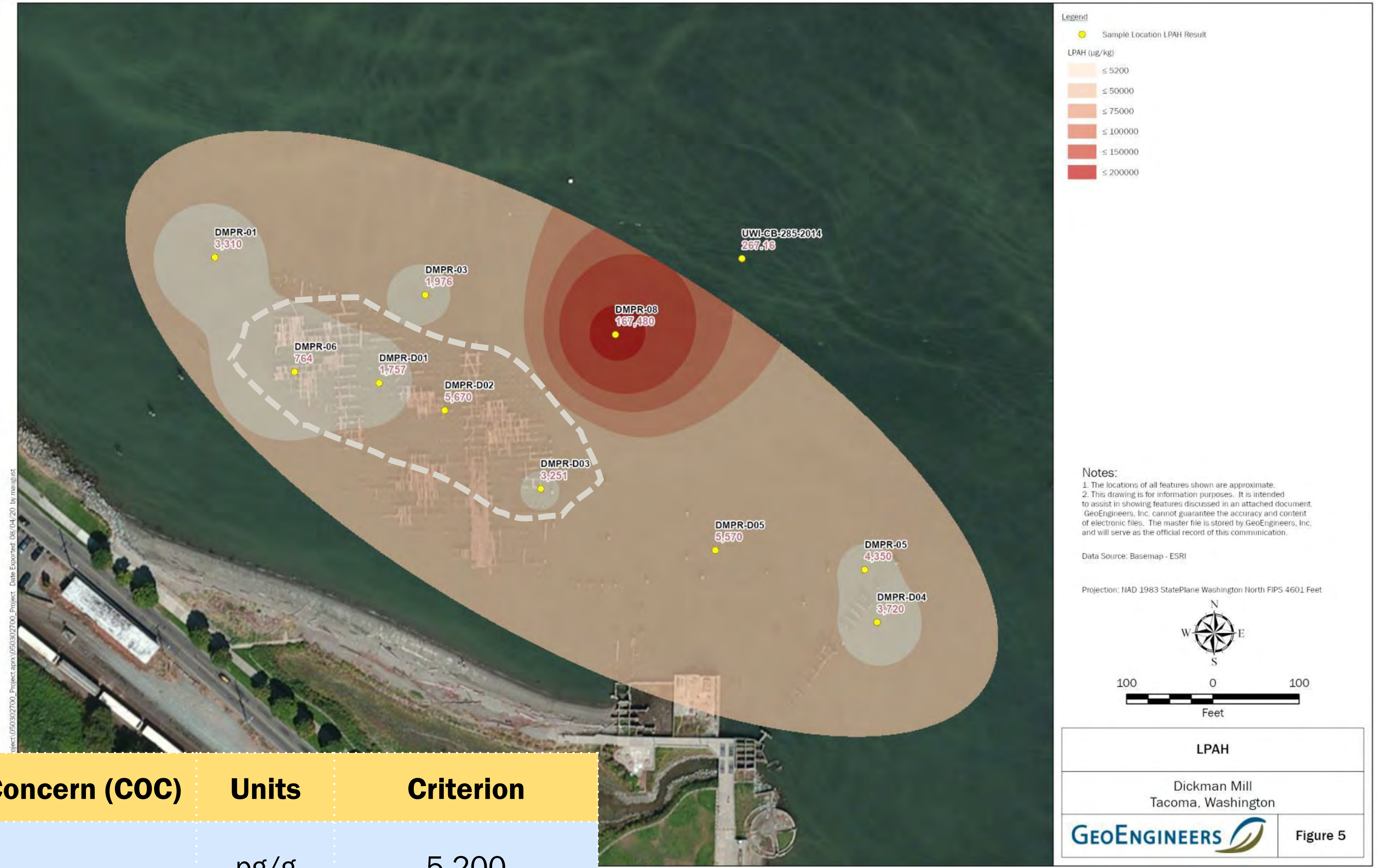
cPAH TEQ – Revised w/out DMPR-08



Contaminant of Concern (COC)	Units	Criterion
cPAH TEQ	µg/Kg	78

August 5, 2020

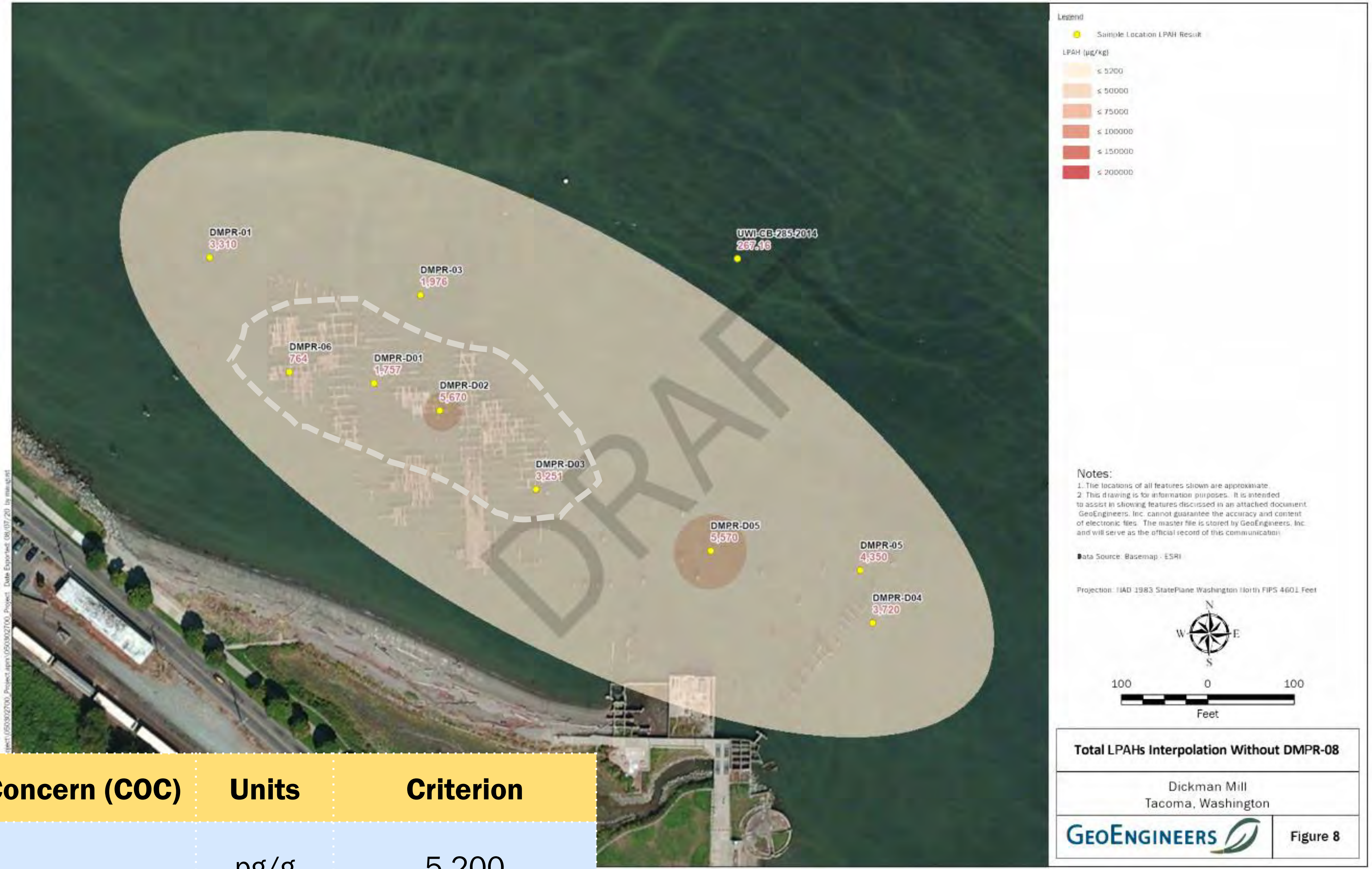
LPAH



Contaminant of Concern (COC)	Units	Criterion
Total LPAH	pg/g	5,200

ugust 5, 2020

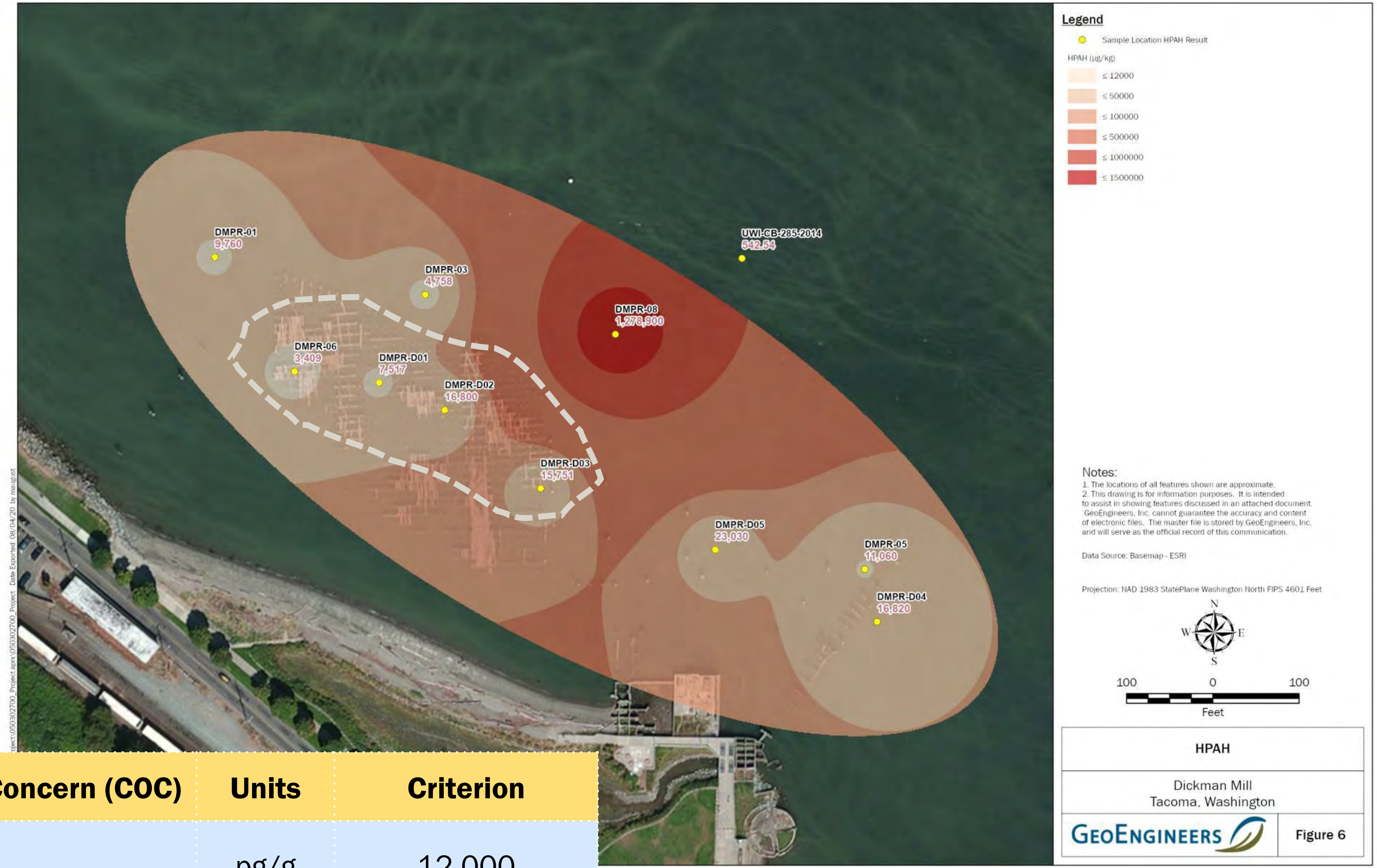
LPAH – Revised w/out DMPR-08



Contaminant of Concern (COC)	Units	Criterion
Total LPAH	pg/g	5,200

August 5, 2020

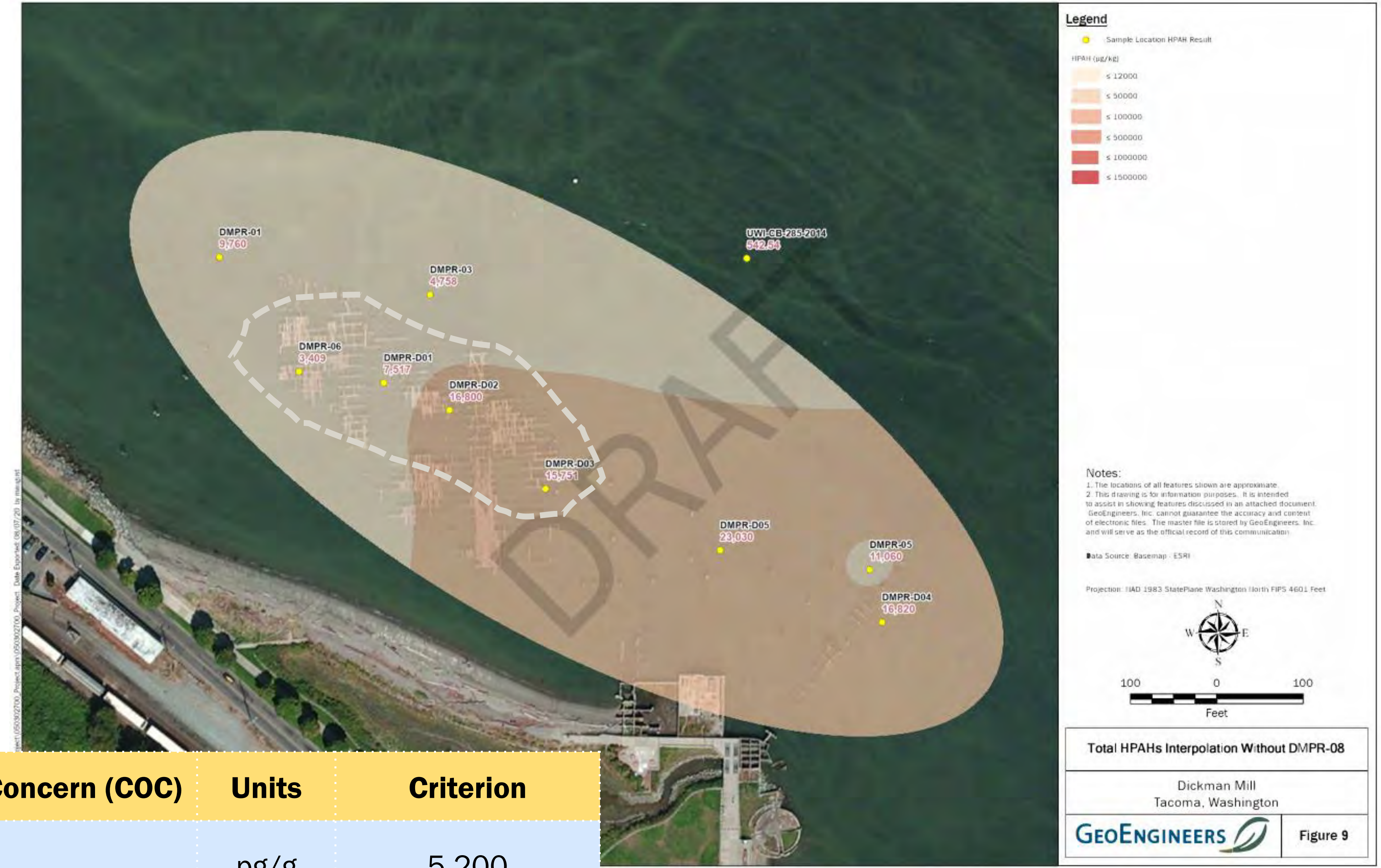
HPAH



Contaminant of Concern (COC)	Units	Criterion
Total HPAH	pg/g	12,000

ugust 5, 2020

HPAH – Revised w/out DMPR-08



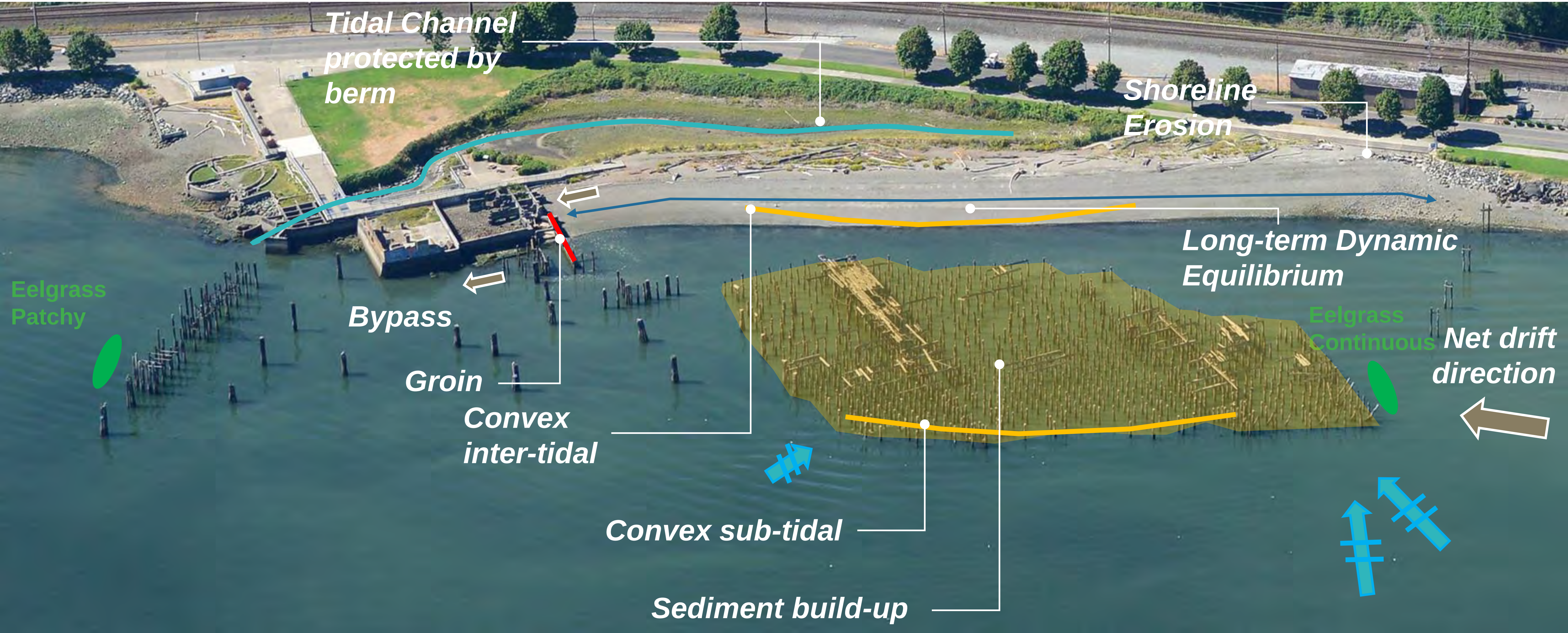
Contaminant of Concern (COC)	Units	Criterion
Total LPAH	pg/g	5,200

August 5, 2020

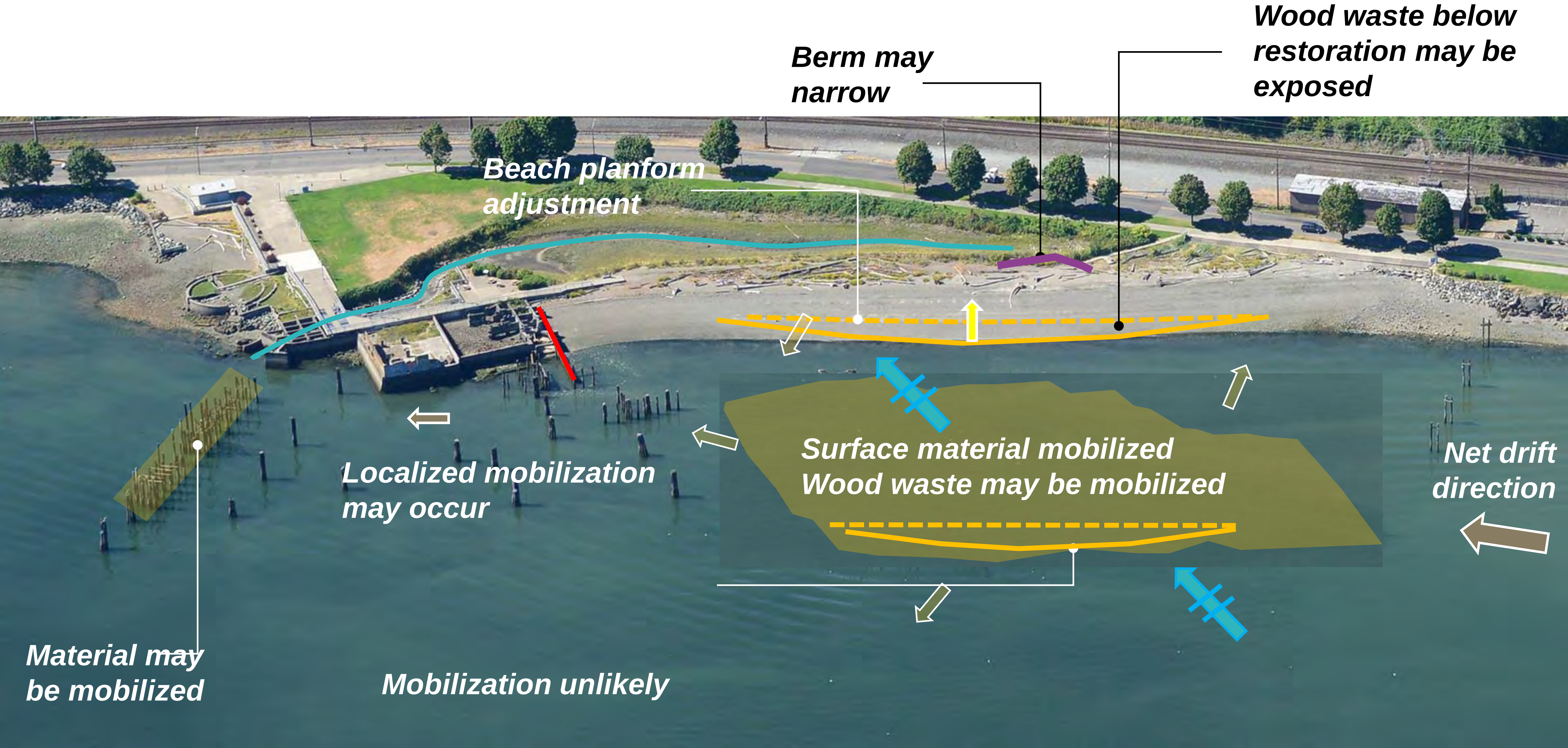
MOTT MACDONALD

Concept Site Model

DRAFT Site Condition Concept Model



DRAFT Post Removal Concept Model



Takeaways

DNR Objectives

Kickoff Meeting

Map contaminants of concern

Qualitatively assess risk of mobilization of contaminated sediments

Qualitatively assess the risks on adjacent areas after the piles are removed

DNR Objectives

Progress Update

Map contaminants of concern

- Surface concentrations exceed criteria within, and outside (offshore and shore parallel) of pile field.
- Subsurface COC concentrations not known.

Qualitatively assess risk of mobilization of contaminated sediments

- **Within pile field:** Removal will likely result in mobilization of mapped contaminants. Rate and extent of dispersion requires storm modeling. Dioxin appears to have lower likelihood of exceeding cleanup criteria offsite, whereas PAHs appear to have a higher likelihood if dispersed.
- **Offshore and shore parallel to pile field:** Removal appears unlikely to mobilize sediment, but verification needed.

Qualitatively assess the risks on adjacent areas after the piles are removed

- Wave energy likely to increase at restored beach.
- Restored beach planform and profile at risk of adjusting to new dynamic equilibrium; expose COCs below the restored beach?
- Tidal channel at lower risk depending on beach planform adjustment; increasing risk with SLR.

Next Steps

Discussion

Memorandum

Phase 2

Wind-wave and hydrodynamic analysis and modeling

Estimate site sediment mobility using empirical formulations

Sediment Transport Analysis and Modeling

Quantification of contaminant fate (SWAC)

Beach profile adjustment in storms

Thank you

Appendix B: Sediment Data Memorandum (GeoEngineers)

GEOENGINEERS

Memorandum

2101 4th Avenue, Suite 950, Seattle, Washington Suite 950, Telephone: 206.728.2674, Fax: 206.728.2732 www.geoengineers.com

To: Aaron Porter, PE and Shane Phillips, PE, Mott MacDonald, LLC

From: EH NM Emily Hurn, Nancy Musgrove, Jason Stutes PhD, GeoEngineers, Inc.

CC: Joseph O. Callaghan, GeoEngineers, Inc. JS

Date: December 14, 2020

File: 0503-027-00

Subject: Dickman Mill Coastal Engineering Assessment— Pile Study

This revised memorandum provides a technical summary of existing sediment data for the Dickman Mill Coastal Engineering Assessment - Pile Study, located at 2423 Ruston Way, on the western shore of Commencement Bay in Tacoma, Washington (Figure 1, Vicinity Map). The data presented in this memorandum are intended to support the evaluation of the potential for transport of sediment-bound contamination during piling removal. The focus of this review is the data immediately within and adjacent to the piling field offshore of the historical mill (Figure 2, Site Plan). The work is being performed for Mott MacDonald, LLC (Mott) on behalf of the Washington State Department of Natural Resources (WDNR).

STUDY AREA/SITE OBSERVATIONS

The site is located in the nearshore environment of Commencement Bay, adjacent to a former sawmill that operated between 1889 and 1977. Historically, the site contained a large wharf built over the water that has since deteriorated but many of the piles remain. Historical mill activities contributed to contamination in the upland and nearshore areas. The remaining creosote treated piles are suspected to be an ongoing source of contamination. Using aerial imagery, a polygon was drawn around the piles to establish the boundaries for our evaluation (shown on Figure 2) and what we refer hereafter as the “Study Area”.

A general field survey was performed June 8, 2020 to document current physical and biological characteristics of the Study Area. The shallow sediment observed during the survey was coarse-grained with a fine silt layer on top. There was shell hash from sessile invertebrate communities within the pile fields that has modified the sediment characteristics locally. Patches of bacterial mats and associated anoxia were noted at the sediment surface throughout the Study Area (Appendix A, Figure A-1). Signs of large infauna (burrows, siphon holes, etc.) were largely absent in areas surveyed, further supporting widespread anoxic conditions within the sediment. A large continuous eelgrass bed was noted west of the pile field (Appendix A, Figure A-2, Photograph 3) that abutted the pile perimeter (Appendix A, Figure A-2, Photograph 4). This suggests that eelgrass would likely occur in the pile field if not for the anoxia present. Isolated patches of eelgrass were also noted to the east of the pile field. Laminarian kelp was present at the base of most piles.

DATA REVIEW SUMMARY

GeoEngineers, Inc. (GeoEngineers) reviewed existing investigation reports provided by WDNR and compiled the electronically available data from Washington State Department of Ecology’s (Ecology) Environmental Information Management (EIM) database. The data submitted to the EIM database is subject to a quality assurance/quality control (QA/QC) data validation procedure prior to entry. Based on the listed “Study QA Assessment Level” in EIM, the data reviewed was either Level 3 (Data Verified and Assessed for Usability) or

Level 5 (Data Verified and Assessed for Usability in a Peer Reviewed Study Report). A secondary review was performed by GeoEngineers to assure that there were no transcription errors in the compiled data.

Available data were limited to surface sediment samples collected in the nearshore area adjacent to Ruston Way. For this review, only those samples falling within the piling field were used and were represented by two investigations conducted by WDNR in 2015. One additional sampling location (UWI-CB-285) used in a long-term monitoring program was included in our analysis as a far-field sample and is considered offsite. The surface sediment sampling locations data used in our analysis is summarized in Table 1 and shown on Figure 2.

TABLE 1. SAMPLING LOCATION

Sampling Location	Date Sampled
DMPR2015-01	05/20/2015
DMPR2015-03	05/20/2015
DMPR2015-05	06/03/2015
DMPR2015-06	05/20/2015
DMPR2015-08	05/20/2015
DMPR2015-D01	05/22/2015
DMPR2015-D02	05/22/2015
DMPR2015-D03	05/21/2015
DMPR2015-D04	05/21/2015
DMPR2015-D05	05/21/2015
UWI-CB-285	06/03/2014[a]

[a] This date represents the most recent of three sampling events at this location.

We reviewed the field logs and photos from the WDNR sampling event. A summary table of the relevant observations is provided in Table 2 below. Qualitative assessment of percent wood debris was noted with several samples described as having greater than 10 percent wood debris. DMPR2015-05 is described in the field log as having very fine wood particles and estimated at 50 percent wood debris. A slight sheen was observed in most samples, with heavy sheen observed in DMPR2015-D02.

TABLE 2. SUMMARY OF FIELD OBSERVATIONS

Sampling Location	Percent Wood Debris*	Sheen Observed?	Sheen Comments
DMPR2015-01	**15**	Yes	--
DMPR2015-03	2	Yes	--
DMPR2015-05	**50**	Yes	slight
DMPR2015-06	0	Yes	slight
DMPR2015-08	**40**	No	--
DMPR2015-D01	0	Yes	--
DMPR2015-D02	0	Yes	heavy
DMPR2015-D03	0	Yes	slight
DMPR2015-D04	**20**	Yes	slight

Sampling Location	Percent Wood Debris*	Sheen Observed?	Sheen Comments
DMPR2015-D05	1	No	--

* Percent wood debris is assumed to be a field estimate. **Bolded** values exceed 10 percent wood waste.

Relevant Grain-Size

Potential contaminants suspected at this site (polycyclic aromatic hydrocarbons or PAHs based on upland activities and the presence of creosote pilings) tend to adhere to fine particles, including organic carbon associated with sediment. The fine-grained fraction of surface sediment ranged from 9.3 to 34.3 percent fines with the organic carbon content of the sediment ranging from 1 to 16 percent. The percent fine-grained sediment in each sample is representative of coarse-grained sediment, in keeping with the field observations made in June 2020. However, the percent total organic carbon (TOC) range is greater than would typically be associated with coarser sediment (1 to 3 percent TOC). The higher percent TOC values may be indicative of other sources of organic carbon including plant material, wood debris or droplets of creosote.

Detailed grain-size data has been previously provided to Mott as an input to their coastal sediment transport model and is not repeated here. Percent fines and percent TOC values are provided in Table 4 below.

Study Area Surface Sediment Data

Data retrieved from the EIM database were compiled for analysis and group sums were calculated according to guidance in the Sediment Cleanup User's Guide (SCUM) (Ecology 2019). Data are compiled in Table 3, below.

TABLE 3. SUMMARY OF SURFACE SEDIMENT SAMPLE RESULTS

Sample ID	Dioxin TEQ (pg/g)	cPAH TEQ (µg/Kg)	Total LPAH (µg/Kg)	Total HPAH (µg/Kg)
DMPR2015-01	--	1,112	3,310	9,760
DMPR2015-03	--	480	1,976	4,758
DMPR2015-05	--	1,154	4,350	11,060
DMPR2015-06	--	408	764	3,409
DMPR2015-08	--	39,470	167,480	1,278,900
DMPR2015-D01	12	553	1,757	7,517
DMPR2015-D02	27	1,315	5,670	16,800
DMPR2015-D03	16	987	3,251	15,751
DMPR2015-D04	21	1,077	3,720	16,820
DMPR2015-D05	33	1,602	5,570	23,030
UWI-CB-285	--	74	267	543

Notes: TEQ = Toxic Equivalent, cPAH = carcinogenic polycyclic aromatic hydrocarbons, LPAH = low-molecular-weight polycyclic aromatic hydrocarbons, HPAH = high-molecular-weight polycyclic aromatic hydrocarbons, SMS = sediment management standards, pg/g = picograms per gram, µg/Kg = micrograms per kilogram

Identification of Contaminants of Concern

The surface sediment data were screened against the marine Sediment Management Standards (Chapter 173-204 Washington Administrative Code [WAC]) benthic[1] and bioaccumulation criteria to identify

[1] SCUM Table 8-1

contaminants of concern (COCs). For the protection of benthic community impacts, the Sediment Cleanup Objective (SCO), based on the Apparent Effect Thresholds (AETs) expressed on a dry-weight basis, rather than TOC-normalized criteria were used for the identification of COCs.

AETs were used as the screening values for COC identification because some of site TOC values fell outside of the range (0.5 to 3.5 percent) where TOC normalization is recommended. The purpose of TOC normalization is to better predict the bioavailable fraction (and thus potential toxicity) of an organic chemical in sediment; however, the statistical relationship between TOC and organic chemical concentrations becomes less predictive at higher TOC ranges. Dry-weight thresholds correlate well with benthic toxicity and are considered equivalent to the TOC-normalized criteria.

Screening for bioaccumulative COCs was based on Puget Sound regional background values for South Puget Sound (Ecology 2018). These screening values are expressed on a dry-weight basis.

Comparison of dry-weight and TOC-normalized data to criteria are provided in Table 4 below. The bolded values are those that exceed SMS criteria. Ecology guidance requires the use of the more conservative result; therefore, we used data based on dry-weight results in our assessment.

TABLE 4. COMPARISON OF DRY-WEIGHT VERSUS TOC-NORMALIZED DATA

Location	Fines (%)	TOC (%)	Dioxin TEQ (pg/g)	cPAH TEQ (µg/Kg)	LPAH (µg/Kg)	LPAH OC Normalized (mg/Kg)	HPAH (µg/Kg)	HPAH OC Normalized (mg/Kg)
DMPR2015-01	26.6	**10.2**	--	**1,112**	3,310	32	9,760	96
DMPR2015-03	22	2.26	--	**480**	1,976	87	4,758	211
DMPR2015-05	28.5	**16.7**	--	**1,154**	4,350	26	11,060	66
DMPR2015-06	9.3	0.901	--	**408**	764	85	3,409	378
DMPR2015-08	34.3	**3.54**	--	**39,470**	**167,480**	**4,731**	**1,278,900**	**36,127**
DMPR2015-D01	16.9	2.48	12.18	**553**	1,757	71	7,517	303
DMPR2015-D02	15.8	2.15	**26.88**	**1,315**	**5,670**	264	**16,800**	781
DMPR2015-D03	16.7	1.42	15.78	**987**	3,251	229	**15,751**	**1,109**
DMPR2015-D04	23.6	**8.02**	**21.20**	**1,077**	3,720	46	**16,820**	210
DMPR2015-D05	27.5	**3.58**	**33.16**	**1,602**	**5,570**	156	**23,030**	643
UWI-CB-285-2014	11.8	0.55	--	74	267	49	543	99
Screening Criteria		0.5-3.0	19	78	5,200	370	12,000	960

Notes:
values in **bold** exceed screening criteria,
pg/g = picograms per gram,
µg/Kg = micrograms per kilogram,
mg/Kg = milligrams per kilogram,
LPAH = low-molecular-weight polycyclic aromatic hydrocarbons,
HPAH = high-molecular-weight polycyclic aromatic hydrocarbons

Site Contaminants of Concern (COCs)

Following comparison of the maximum detected concentration for each analyte measured in Study Area sediment to its applicable criteria, dioxins (expressed as a toxic equivalent concentration or TEQ), carcinogenic polycyclic aromatic hydrocarbons (cPAHs; also expressed as a TEQ), low-molecular-weight PAHs (LPAHs) and high-molecular-weight PAHs (HPAHs) were identified as COCs.

SURFACE AREA WEIGHTED AVERAGE CONCENTRATION (SWAC)

To characterize representative concentrations of COCs within surface sediment, a surface-area-weighted average concentration (SWAC) for the Study Area was calculated for each COC. To calculate the SWAC for each COC, the individual points were used to interpolate concentrations across the Study Area using geographic information system (GIS) software. An inverse-distance-weighted (IDW) technique was used. The default settings for IDW analysis were used, with power equaling 2 and a variable search radius utilizing all available samples. A 1-foot grid was produced for each interpolated surface and the mean of the Study Area was recorded for each analyte (Table 5 below).

Attached are four interpolation figures that show the ranges of concentration by COC across the Study Area (Figures 3a, 4a, 5a and 6a). Except for one location, concentrations within the piling field surface sediment were within the same order of magnitude; concentrations at DMPR-08 are elevated relative to all other samples. SMS criteria are exceeded based on the SWAC for all COCs. The magnitude of the exceedances ranges from 1.1 (dioxin) to 68 (cPAHs) times greater than their respective criterion. Data were also interpolated using exceedance factor (EF) in addition to the dry-weight concentration and those figures are presented (Figures 3b, 4b, 5b and 6b). The EF for DMPR-08 for cPAHs, LPAHs and HPAHs is several orders of magnitude greater than the other sample locations. As a result, the EF interpolation for DMPR-08 was constrained and is noted in the associated figures. Another set of figures, 3c, 5c and 6c display the EF interpolation without DMPR-08. The far-field sample (UWI-CB285) suggests that sediment concentrations of PAHs drop off rapidly with distance from the piling field.

As shown on Figures 3a, 5a and 6a, one of the locations (DMPR-08) in the interpolated area has a concentration several orders of magnitude higher than all other samples for the various PAHs. This disproportionally skewed the results of the surface weighted averages relative to PAHs. Based on review of the field log and photo, this sample contained a high percentage of wood debris (40 percent) including a large chunk of wood visible in the sample photo. We performed additional statistical analyses limiting the effect of DMPR-08 and ultimately removed this outlier from the analysis. Table 5 lists SWACs for all COCs with DMPR-08 excluded from the calculations; all other parameters remained the same. Figures 7, 8 and 9 display the interpolation with DMPR-08 removed for cPAHs, total LPAHs and total HPAHs. As shown in Table 5, the SWAC remains above the criteria for cPAHs and dioxins while LPAH and HPAH averages are at or below cleanup criteria when DMPR-08 is not included.

TABLE 5. SWAC BY COC

Contaminant of Concern (COC)	Units	SWAC Estimates	SWAC Estimates without DMPR-08	Criterion	Exceedance Factor (all samples)	Exceedance Factor (without DMPR-08)
Dioxin TEQ	pg/g	21.7	21.7*	19	1.1	1.1
cPAH TEQ	µg/Kg	5,285	939	78	68	12
Total LPAH	µg/Kg	21,766	3,291	5,200	4.2	0.63
Total HPAH	µg/Kg	153,770	11,931	12,000	13	0.99

Notes:
SWAC = surface-area-weighted-average concentration, cPAH = carcinogenic polycyclic aromatic hydrocarbons, LPAH = low-molecular weight polycyclic aromatic hydrocarbons, HPAH = high-molecular-weight polycyclic aromatic hydrocarbons. *DMPR-08 was not analyzed for dioxin and therefore the SWAC does not change

DATA GAPS DISCUSSION

Based on our review of the existing data there are several data gaps that should be acknowledged as they may influence the outcome of the modeling of sediment contaminant transport. The most significant data gap is the lack of subsurface sediment data. A finer scale understanding of the distribution of contaminants over the depth of the pilings would allow a better assessment of the contaminant mass available for transport. Additionally, the distribution of contaminants by grain-size fraction would improve the assessment of the potential sediment plume size and travel distance during pile removal. The number of samples was also limited despite the large size of the Study Area (9.6 acres). Also, dioxins were only analyzed for a subset of the samples (n=5) and therefore the calculation of the SWAC is less accurate than other COCs, though there is good agreement between samples. Relative to PAHs in general, there is a large degree of variability within the data for each COC especially when considering the results from sample site DMPR-08. A finer scale understanding of the area surrounding that sample site may be necessary should sediment transport modeling indicate particles are mobile in that area.

REFERENCES

Washington State Department of Ecology (Ecology). 2019. Sediment Cleanup User's Manual (SCUM) Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC. Publication No. 12-09-57. Toxics Cleanup Program. Olympia, Washington. December. Original publication March 2015.

Washington State Department of Ecology (Ecology). 2018. South Puget Sound Regional Background. Final Data Evaluation and Summary Report. Publication No. 18-09-117. Toxics Cleanup Program. Olympia, Washington. May 2018.

Attachments:

Figure 1. Vicinity Map

Figure 2. Site Plan

Figure 3a. cPAH TEQ

Figure 3b. cPAH TEQ Exceedance Factor

Figure 3c. cPAH TEQ Exceedance Factor Without DMPR-08

Figure 4a. Dioxin TEQ

Figure 4b. Dioxin TEQ Exceedance Factor

Figure 5a. LPAH

Figure 5b. LPAH Exceedance Factor

Figure 5c. LPAH Exceedance Factor Without DMPR-08

Figure 6a. HPAH

Figure 6b. HPAH Exceedance Factor

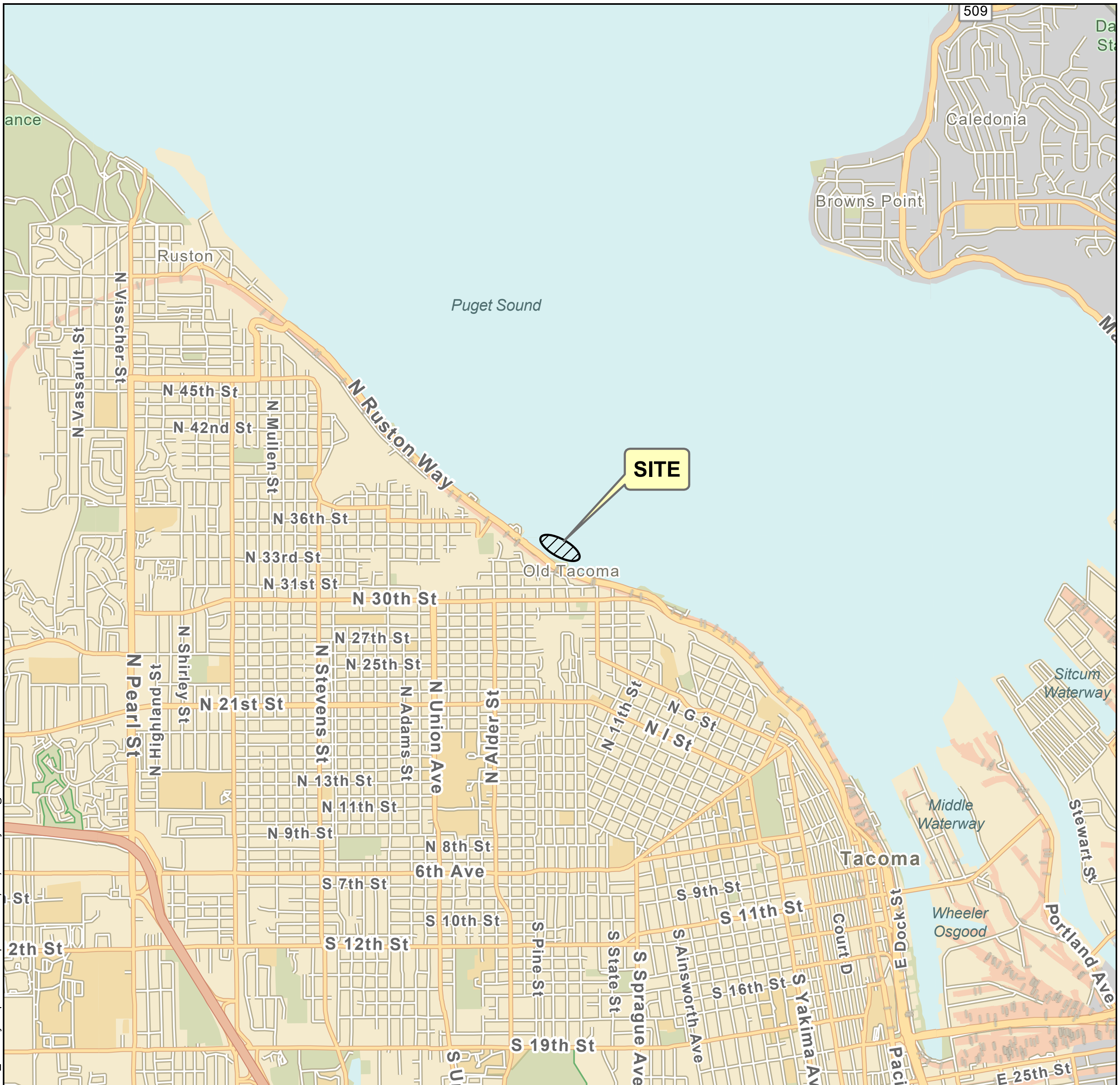
Figure 6c. HPAH Exceedance Factor Without DMPR-08

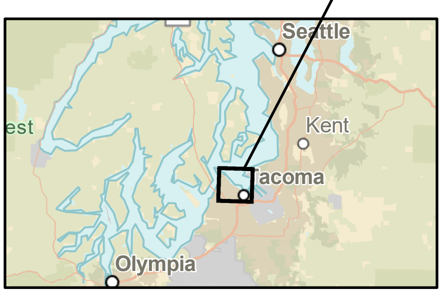
Figure 7. cPAH TEQ Interpolation Without DMPR-08

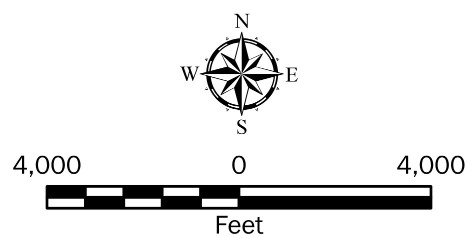
Figure 8. Total LPAHs Interpolation Without DMPR-08

Figure 9. Total HPAHs Interpolation Without DMPR-08

Appendix A. Site Photographs







Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI

Projection: NAD 1983 UTM Zone 10N

Vicinity Map

Dickman Mill
Tacoma, Washington

GeoEngineers

Figure 1

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Legend

- Sample Location
- Study Area Boundary

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI Aerial Imagery and Basemaps.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100
Feet

Site Plan

Dickman Mill
Tacoma, Washington

GeoEngineers | **Figure 2**

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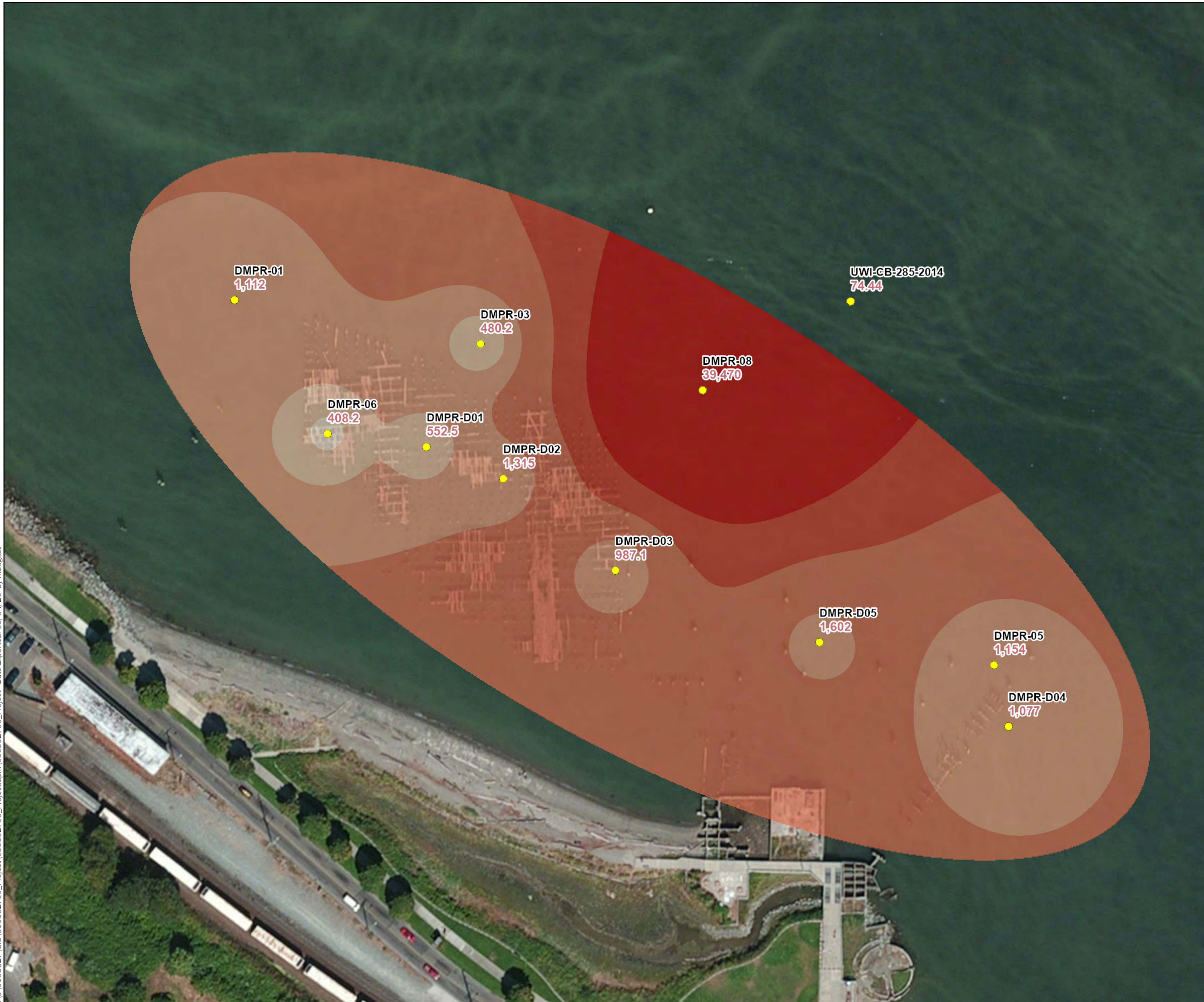

Legend

- Sample Location cPAH TEQ Result

cPAH TEQ Concentration (µg/kg)

- ≤ 500
- ≤ 1000
- ≤ 2000
- ≤ 5000
- ≤ 10000
- ≤ 25000

Notes:
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Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N
W E
S

100 0 100
Feet

cPAH TEQ

Dickman Mill
Tacoma, Washington

GEOENGINEERS

Figure 3a

P:\0\0503027\GIS\0503027000_Project\0503027000_Project.aprx\0503027000_Project Date Exported: 08/04/20 by maugust

Legend

Sample Location cPAH TEQ Result

cPAH TEQ Concentration (Exceedance Factor)

≤ 10

10 - 21

> 21

Estimated Extent of Sample DMPR-08

Notes:
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Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N
W E
S

100 0 100

Feet

cPAH TEQ Exceedance Factor

Dickman Mill
Tacoma, Washington

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Figure 3b

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Legend

Sample Location cPAH TEQ Result

cPAH TEQ Concentration (Exceedance Factor)

≤ 10

10 - 21

> 21

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

cPAH TEQ Exceedance Factor without DMPR-08

Dickman Mill
Tacoma, Washington

GeoEngineers

Figure 3c

Legend

Sample Location Dioxin TEQ Result

Dioxin TEQ (pg/g)

- ≤ 15
- ≤ 20
- ≤ 25
- ≤ 30
- ≤ 35

Notes:
1. The locations of all features shown are approximate.
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Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100

Feet

Dioxin TEQ

Dickman Mill
Tacoma, Washington

GEOENGINEERS

Figure 4a

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Legend

Sample Location Dioxin TEQ Result

Dioxin TEQ (Exceedance Factor)

<1

1- 2

>2

Notes:
1. The locations of all features shown are approximate.
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Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Dioxin TEQ Exceedance Factor

Dickman Mill
Tacoma, Washington

GEOENGINEERS

Figure 4b

P:\0\0503027\GIS\050302700_Project\050302700_Project.aprx\050302700_Project Date Exported: 10/23/20 by maugust

Legend

Sample Location LPAH Result

LPAH (µg/kg)

≤ 5200

≤ 50000

≤ 75000

≤ 100000

≤ 150000

≤ 200000

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N
W E
S

100 0 100

Feet

LPAH

Dickman Mill
Tacoma, Washington

GeoEngineers

Figure 5a

P:\0\0503027\GIS\050302700_Project\050302700_Project.aprx\050302700_Project Date Exported: 08/04/20 by maugust

Legend

- Sample Location LPAH Result

LPAH (Exceedance Factor)

- <1
- 1-2
- >2

Estimated Extent of Sample DMPR-08

Notes:
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Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100

Feet

LPAH Exceedance Factor

Dickman Mill
Tacoma, Washington

GEOENGINEERS

Figure 5b

P:\0\0503027\GIS\050302700_Project\050302700_Project.aprx\050302700_Project Date Exported: 10/23/20 by maugust

Legend

Sample Location LPAH Result

LPAH (Exceedance Factor)

<1

1-2

>2

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100

Feet

LPAH Exceedance Factor without DMPR-08

Dickman Mill
Tacoma, Washington

GEOENGINEERS

Figure 5c

P:\0\0503027\GIS\0503027OO_Project\0503027OO_Project.aprx\0503027OO_Project Date Exported: 12/09/20 by maugust

Legend

Sample Location HPAH Result

HPAH (µg/kg)

- ≤ 12000
- ≤ 50000
- ≤ 100000
- ≤ 500000
- ≤ 1000000
- ≤ 1500000

Notes:

1. The locations of all features shown are approximate.
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Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100

Feet

HPAH

Dickman Mill
Tacoma, Washington

GeoEngineers

Figure 6a

P:\0\0503027\GIS\050302700_Project\050302700_Project.aprx\050302700_Project Date Exported: 08/04/20 by maugust

Legend

- Sample Location HPAH Result

HPAH (Exceedance Factor)

- <1
- 1-2
- >2

- Estimated Extent of Sample DMPR-08

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100
Feet

HPAH Exceedance Factor

Dickman Mill
Tacoma, Washington

GEOENGINEERS

Figure 6b

P:\0\0503027\GIS\050302700_Project\050302700_Project.aprx\050302700_Project Date Exported: 10/23/20 by maugust

Legend

Sample Location HPAH Result

HPAH (Exceedance Factor)

<1

1-2

>2

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100

Feet

HPAH Exceedance Factor without DMPR-08

Dickman Mill
Tacoma, Washington

GEOENGINEERS

Figure 6c

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Legend

- Sample Location cPAH TEQ Result

cPAH TEQ Concentration (µg/kg)

- ≤ 500
- ≤ 1000
- ≤ 2000
- ≤ 5000
- ≤ 10000
- ≤ 25000

Notes:
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Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N E S W

100 0 100

Feet

cPAH TEQ Interpolation Without DMPR-08

Dickman Mill
Tacoma, Washington

GeoEngineers

Figure 7

P:\0\0503027\GIS\050302700_Project\050302700_Project.aprx\050302700_Project Date Exported: 08/07/20 by maugust

Legend

Sample Location LPAH Result

LPAH (µg/kg)

- ≤ 5200
- ≤ 50000
- ≤ 75000
- ≤ 100000
- ≤ 150000
- ≤ 200000

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100

Feet

Total LPAHs Interpolation Without DMPR-08

Dickman Mill
Tacoma, Washington

GeoEngineers

Figure 8

P:\0\0503027\GIS\0503027\00_Project\050302700_Project.aprx\050302700_Project Date Exported: 08/07/20 by maugust

Legend

Sample Location HPAH Result

HPAH (µg/kg)

≤ 12000

≤ 50000

≤ 100000

≤ 500000

≤ 1000000

≤ 1500000

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Basemap - ESRI

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

N W E S

100 0 100

Feet

Total HPAHs Interpolation Without DMPR-08

Dickman Mill
Tacoma, Washington

GEOENGINEERS

Figure 9

P:\0\0503027\GIS\050302700_Project\050302700_Project.aprx\050302700_Project Date Exported: 08/07/20 by maugust

APPENDIX A
Site Photographs

Photograph 1. Patches of anoxia and wood waste (sawdust) observed in the intertidal.

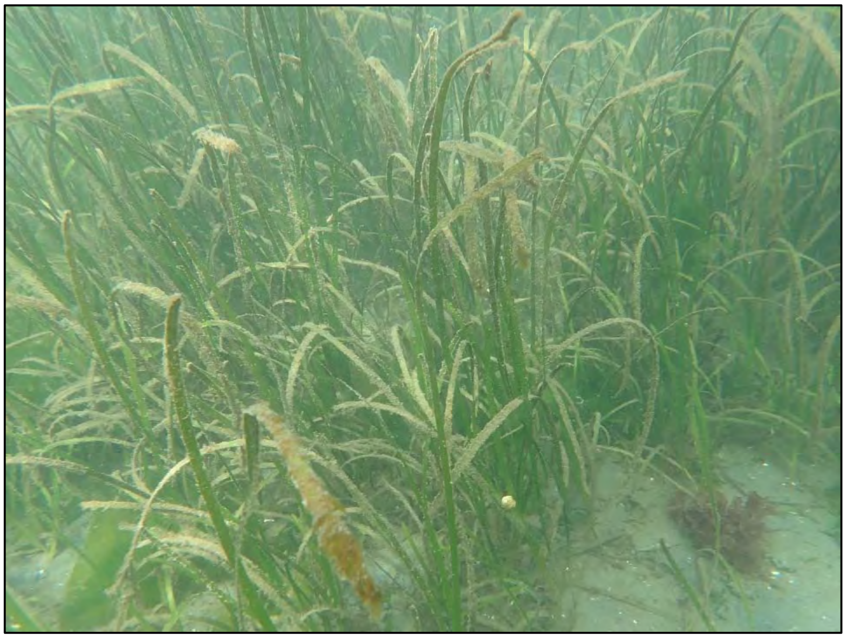
Photograph 2. Bacterial mats noted on sediment surface.

Site Photographs

Dickman Mill
Tacoma, Washington

GeoEngineers

Figure A-1



Photograph 3. Continuous eelgrass bed west of the pile field.

Photograph 4. Edge of eelgrass near pile field and example of laminarian kelp growing at the base of the pile.

Site Photographs

Dickman Mill
Tacoma, Washington

GeoEngineers

Figure A-2

Appendix C: Basis of Assessment

DRAFT Abbreviated Basis of Assessment

Project:	Dickman Mill Sediment Transport Study		
Our reference:	507101897		
Prepared by:	Aaron Porter	**Date:**	9/10/2020
Approved by:	Shane Phillips	**Checked by:**	Abigail Mitchell
Subject:	Abbreviated Basis of Analysis		

1 Purpose and Objectives

Dickman Mill is located along Ruston Way in Tacoma Washington, on Commencement Bay in the Puget Sound, as shown in Figure 1. DNR wishes to remove approximately 1,000 timber piles from the intertidal and nearshore areas at the site of the old Dickman Mill, but needs to assess the risk of releasing additional contaminants and the risk on nearby properties. DNR requested Mott MacDonald address these risks in a 2-step process – Task 1 as a qualitative assessment and Task 2 as a contingent quantitative modeling assessment. This abbreviated basis of analysis was developed by Mott MacDonald to align the project team on data sources, assumptions, and site conditions which are the basis for the Task 1 assessment.

This memorandum includes background coastal project data and project criteria.

Figure 1 - Project Site (Orange Box) Along Ruston Way

2 Project Data

Project data includes elevation data, datum conversions, wind data, substrate type, and contaminants data sources.

2.1 Elevation Data

Available bathymetric and topographic data was compiled into a database to develop a basemap and to detail the conditions at the site. The database includes both data provided by DNR and publicly available data, as summarized in Table 1. Data provided by DNR has been processed as is shown in Figure 2. Additional data within the pile-field in in progress and will aid in the assessment.

Table 1 Summary of Elevation Data

Source	Year	Description
NOAA	1936	Bathymetry: Digital Sounding Data
NOAA	1974	Bathymetry: Digital Sounding Data
NOAA	2001	Bathymetry: Digital Sounding Data
Puget Sound Lidar Consortium	2004	LiDar Topography: Public-domain high-resolution topography for the Pacific Northwest
NOAA	2009	Bathymetry: Hydrographic Survey
WA DNR	2017	Topography work performed by Sitts & Hill Engineers, Inc. Bathymetry work performed by Solmar Hydro
WA DNR	2019	Bathymetry: Hydrographic Survey
Mott MacDonald	2020	Bathymetry/Topography: RTK & Sounding Survey

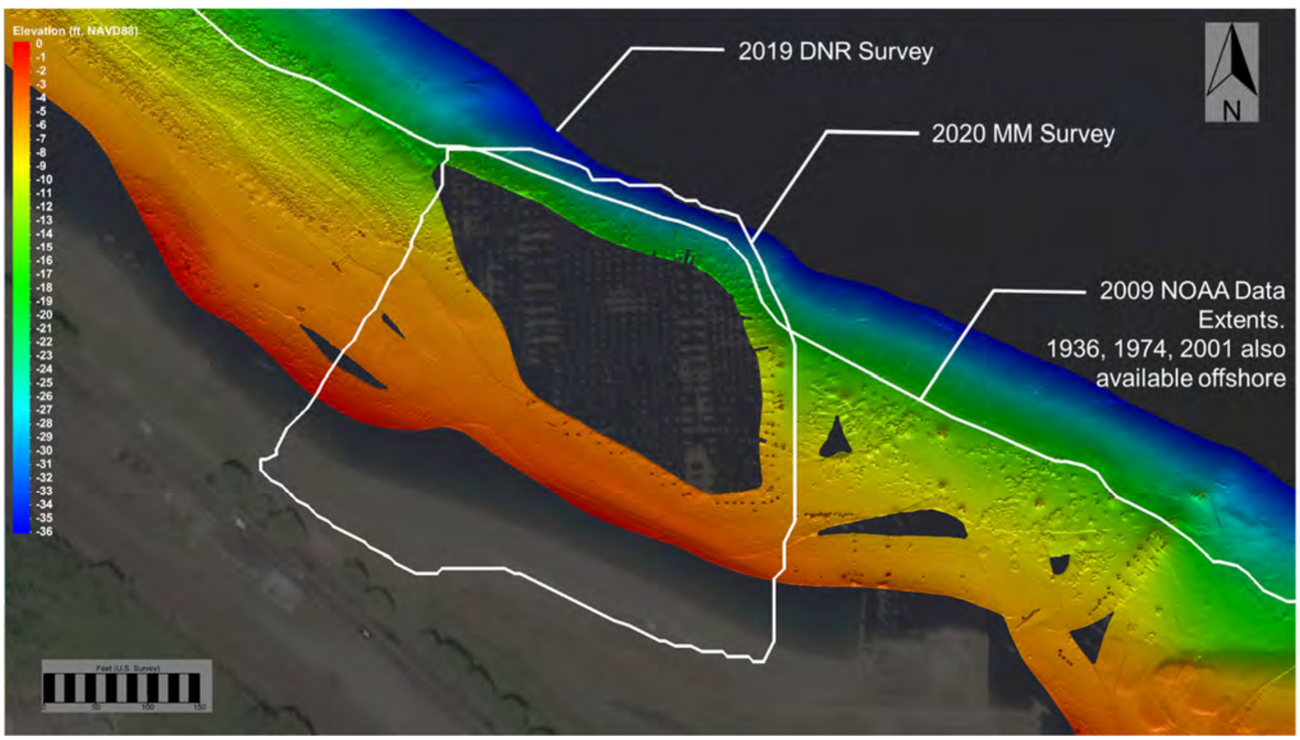


Figure 2 - DNR Provided Bathymetry. Publicly available data & 2020 MM survey extents are shown as white lines.

2.2 Datum Conversions

Datumn and water level information was obtained from the National Oceanic Atmospheric Administration (NOAA) Tides and Currents database. The water levels for the project site were develop using the NOAA vertical datum transformation tool, VDatum (version 4.1). Select datums and water levels are summarized in Table 2. These datums are slightly different from the Tacoma tide station (Tidal station No. 9446484, Tacoma, Washington) since the station is located 2.8 miles from the project site.

Table 2 Datum Conversions (VDatum 4.1)

Tidal Datum	Elevation Relative to NAVD88 (feet)
Mean higher high water	+9.16
National Geodetic Vertical Datum of 1929	+3.49
North American Vertical Datum of 1988	0
Mean lower low water	-2.75

2.3 Wind Data

Various nearby wind data sources were evaluated to develop a dataset representative of the winds at the project site. A wind rose and extreme wind speeds were provided in the 2019 Anchor QEA Targeted Coastal Engineering Analysis Memorandum. Anchor QEA used the Point Robinson wind station for their analysis. Based on our assessment and prior work in the area, the Point Robinson wind station may not be representative of the winds at the project site. Instead, a combination of wind stations was used to represent the wind at the project site. West Point wind station was selected to represent winds from the general Northwest to Northeast directions and Station EA located near Blair Waterway was selected to represent winds from the other directions.

2.4 Substrate Type

Substrate type is based on a combination of literature review and the site investigation.

- Pile Field
  - Appears to be combination of fines and fine sand. Substrate is colored black.
- Toe of Beach – Below MLLW
  - Appears to be combination of fines and fine sand. Substrate is colored black.
  - Wood waste and sawdust present on surface
  - Prior beach restoration extended to MLLW only.
- Intertidal – near MLLW
  - Pea gravel surface
  - Wood waste found ~6” below surface
- Upper beach – near MSL
  - Pea gravel surface
  - No wood waste found within 1-foot of surface
  - Restoration project plans indicate 2-ft. thickness of material placed above MSL.

2.5 Contaminants of Concern

See Appendix B.

3 Project Criteria

3.1 Project Area and Piles

The assumed project area was coordinated with DNR at the kickoff meeting, and is shown in Figure 3. Creosote treated pilings (piles) in the red area are assumed to be outside the removal assessment, and are adjacent or within the Dickman Mill structures, as shown on the right side of Figure 4. It is understood these piles were not included in the pile removal counts shown in Table 3, provided by DNR. During the site visit a number of pile stubs were observed just below MLLW, at a greater number documented in the DNR documentation. Removal of stubs requires a different extraction process than full pile removal. Example stubs are shown in the left panel of Figure 4. The size of the assessment area (area in which contaminants may be transported to) will be defined in Task 2.

Table 3 - Pile Inventory - To Be Removed

Pile Type	Count
Piles	1099 (approximate)
Stubs (0-4 ft from sediment)	72 (approximate)

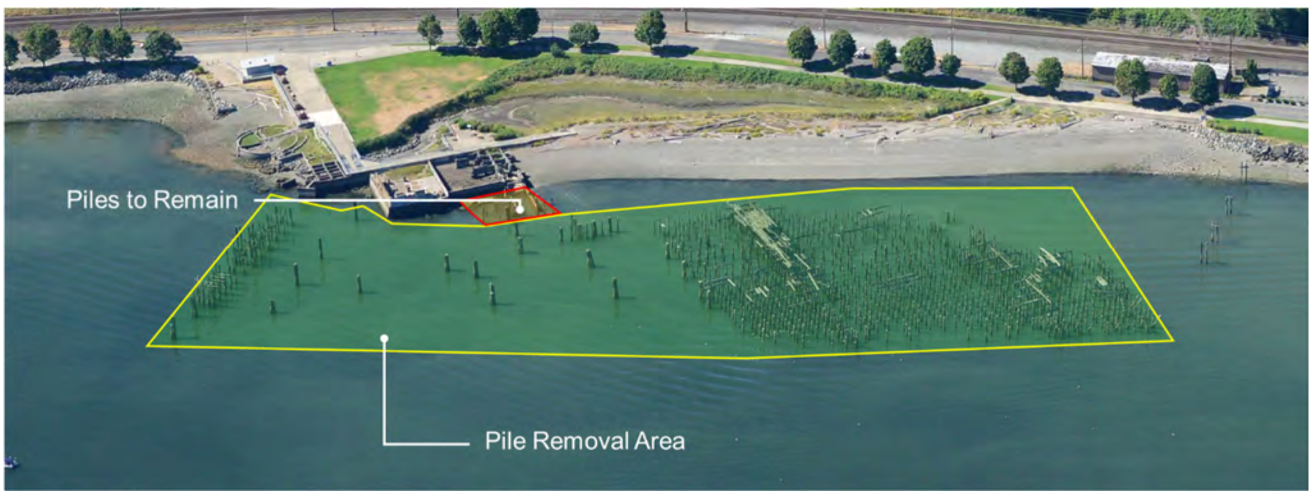


Figure 3 - Pile Removal Areas

Figure 4 - Pile Stubs to potentially remain (left) and Nearshore Piles to Remain (right)

3.2 Design Storm

The return period for the design storm has not been identified. MM anticipates a 50 to -year return period event would be applicable. MM and DNR to define storm conditions as part of quantitative assessment in Task 2.

3.3 Sea-level Rise

To assess the impacts of sea level rise (SLR) on the project, an estimate of potential SLR was established using local guidelines for SLR projections. In 2016 the City of Tacoma developed the Tacoma Climate Change Resilience Study which provided the estimates of SLR summarized in Table 4. Since then, the Washington Coastal Resilience Project has reported localized data on SLR projections which have become fundamental in SLR risk projections for Washington. The City of Tacoma website refers to the new report by the Washington Coastal Resilience Project for SLR values. A summary of the projected SLR values for 2050 and 2100 are provided in Table 4. The projected SLR values for this project will be coordinated with DNR.

SLR will be considered in the assessment as increasing water levels can result in a change to the dynamic equilibrium of the gravel beach. The incremental effect of the pile field removal will be assessed conceptually. A quantitative assessment of this effect may be addressed in Task 2.

Table 4 Sea Level Rise Projections Review

Source	SLR Estimate (2050)	SLR Estimate (2100)	Year Published
City of Tacoma/National Research Council	-1” to 19”	4” to 56”	2016
WA Coastal Resilience Project	90% Probability: 4.8” to 6”[1] 50% Probability: 8.4” to 9.6” 10% Probability: 13.2”	90% Probability: 12” to 16.8” 50% Probability: 21.6” to 27.6” 10% Probability: 33.6” to 39.6”	2018

[1] Range indicates SLR projections for High (RCP 8.5) to Low (RCP 4.5) emission scenarios. Projected SLR values are for 47.3°, -122.5°.

3.4 Coastal Processes

- Hydrodynamics
  - Waves
    - The design storm condition needs to be coordinated with DNR.
    - Significant wave height in more frequent storms (annual) are likely to be 1-2 feet. Extreme storm significant wave height are likely to be in the range of 2.5-4.0 feet.
    - Site specific modeling would need to be conducted in Task 2 to refine these estimates.
  - Currents
    - Nearby experience indicates ebb and flood tide currents of approximately 1 knot.
- Littoral Drift
  - Field indicators confirm net littoral drift direction appears to be from the NW to the NE.

3.5 Vessel Wake

Mott MacDonald used prior work in the area and empirical models developed by Bhowmik, Demissie and Guo (1982) and Bhowmik, Soong, Reichelt and Seddik (1991) to conceptually estimate vessel wake near the project site. Based on interpretation of these empirical results, the estimated vessel wake is estimate to from 0.5 ft. to 1.1 ft. in height with a period of 3 to 3.5 seconds. Refined analysis may be needed in Stage 2 to confirm vessel type, distance, speed, and probability of occurrence.

4 References

Bhowmik, N. G., Demissie, M., and Guo, C. Y. 1982. “Waves generated by river traffic and wind on the Illinois and Mississippi Rivers”. Report UILIWRC-82-167, Illinois State Water Survey, Champaign, IL.

Bhowmik, N. G., Soong, T. W., Reichelt, W. F., and Seddik, N. M. L. 1991. “Waves generated by recreational traffic on the Upper Mississippi River system,” Research Report 117, Department of Energy and Natural Resources, Illinois State Water Survey, Champaign, IL.

Patmont, C., Spooner, A., and Hummel, P. 2017. “Dickman Mill Park Expansion and Head Saw Project: Sediment Cleanup Plan”. Technical Memorandum. Anchor QEA. Prepared for Metro Parks Tacoma.

Appendix D: Site Observations Memorandum

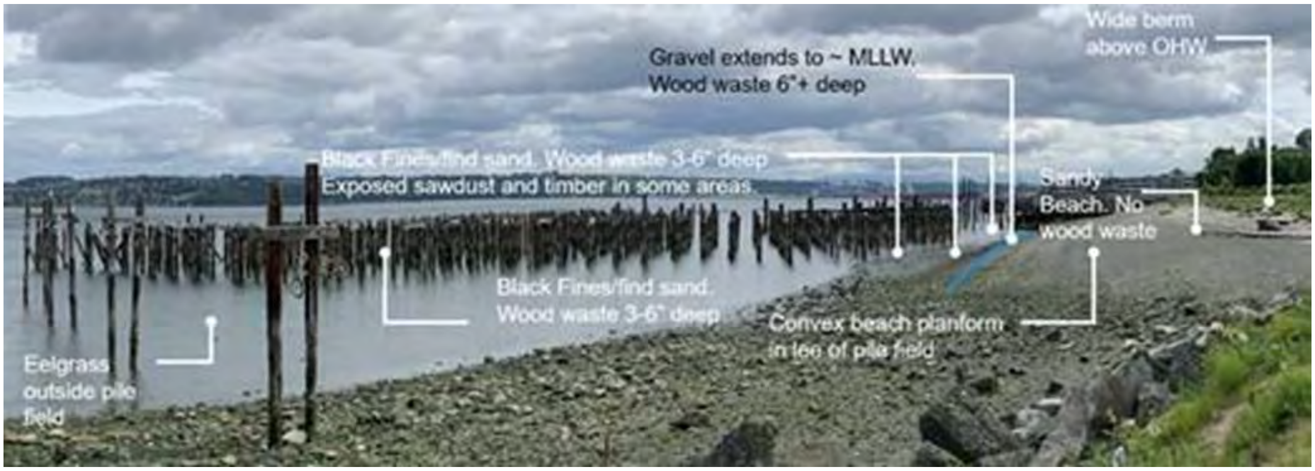
MOTT MACDONALD

Dickman Mill Site Observations Memorandum

Project:	Dickman Mill Sediment Transport Study		
Our reference:	507101897		
Prepared by:	Aaron Porter	**Date:**	Originally Sent 6/12/20
Approved by:	Shane Phillips	**Checked by:**	Abigail Mitchell
Subject:	Site Observations Summary		

The following is a summary of the MM/Geo Project Team site reconnaissance visit, extracted from an email sent by Shane Phillips to Monica Shoemaker on June 12, 2020

- Attendees: Shane Phillips (MM), Aaron Porter (MM), Jason Stutes (GEO)
- Date/Time: 6-8-20: 12-130pm
- Activities
  - Nearshore sediment and debris - review and photo document conditions at low tide.
  - 2 beach material grab samples taken – one near pile field on low tide terrace, one near gravel beach
  - Waded into and around pile field to observe sediments and habitat conditions, down to ~-4ft. MLLW
  - Observed pile conditions and low tide beach terrace slopes within and outside the pile field. Also observed density of the sediment covering within the pile field.
  - Dug holes at various locations on beach and near pile field to investigate depth of sawdust and wood waste
- Observations – Summary figure below
  - Eel grass present outside the pile field on the north side of site
  - Sediment within and near the pile field is largely fine sand, shell hash, and some fines
  - Excavation once dewatered showed a high concentration of sawdust and wood waste very near the surface (less than 1 foot) near the water line. No wood waste found within 1 foot of digging on the beach face.
  - Beach face is sand gravel mix and appears to be slightly convex (between the north revetment and south Dickman mill concrete structure). Convex shape may indicate pile field wave attenuation has affected beach shape.
  - Pile stubs are littered throughout the site at upper tidal elevations just shallower than the existing pile field and some scattered throughout the first and second bents. Need to confirm with DNR if those will be removed or left in place.
  - Berm between beach and tidal channel is wide and appears to be stable.
  - Loss of gravel beach fill was observed on the north side of site adjacent to the concrete steps (lowering could be as much as 2 to 3 ft from original construction).
- Next Steps
  - Incorporate site review findings into conceptual site model
  - Basis of analysis will include summary of assumed piles which need to be removed. Piles near concrete structure are clustered.
  - Beach topography needed to confirm shape of beach.
  - Coordinate date for field data collection (hydrographic survey within pile field).


Wide berm
above OHW
Gravel extends to ~ MLLW.
Wood waste 6"+ deep
Black Fines/find sand. Wood waste 3-6" deep
Exposed sawdust and timber in some areas.
Sandy
Beach. No
wood waste
Black Fines/find sand.
Wood waste 3-6" deep
Convex beach planform
in lee of pile field
Eelgrass
outside pile
field