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TECHNICAL MEMORANDUM

Date: 2/13/2025

TO: Josh Baldi, Division Director, Water and Land Resources Division (WLRD), Department of Natural Resources and Parks (DNRP)

FM: Wendy Eash-Loucks, Water Quality Planner, Project Manager III, WLRD, DNRP

RE: Marine Sediment Monitoring Program Update

cc: Josh Latterell, Science and Technical Support Section Manager, WLRD, DNRP
Diane McElhany, Environmental Laboratory Section Manager, WLRD, DNRP
Jeff Stern, Sediment Management Program Manager IV, Environmental and Community Services Section, WTD, DNRP
Debra Williston, Water Quality Planner/Project Manager IV, Environmental and Community Services Section, WTD, DNRP
Jeff Lafer, Water Quality Planner/Project Manager IV, Environmental and Community Services Section, WTD, DNRP

Purpose of Updating the Program

King County's marine ambient monitoring program gathers water, sediment, and biological data in the Central Basin of Puget Sound, including associated embayments such as Elliott Bay and Quartermaster Harbor. These data are used to evaluate status and trends of marine water and sediment quality, assess the general health of the Puget Sound marine environment within King County, and provide information for management decisions. The program also supports regional monitoring efforts such as the Puget Sound Ecosystem Monitoring Program (PSEMP). This update is focused on the sediment (chemistry and biological parameters) component of the program.

For over 30 years, King County has routinely collected sediment quality data from subtidal (offshore) and intertidal (beach) monitoring stations. Much of the funding provided for this work comes from King County's Wastewater Treatment Division (WTD). This work is not required by WTD's National Pollution Discharge Elimination System (NPDES) permit, but supplements assessments of waterbodies that receive discharges from treated wastewater and combined sewer overflows (CSOs). Required NPDES monitoring is not addressed by this program.

This supplemental marine sediment monitoring program has focused on understanding the ongoing status of sediment quality as well as the long-term trends in sediment chemistry in the Central Basin of Puget Sound. Benthos (invertebrates that live on or in the sediment) monitoring was added to subtidal sites in 2015 to help us better understand observed sediment-related effects on Puget Sound benthic habitat and community. Additionally, we have assessed sediment chemistry at beach locations inshore of wastewater facilities, CSOs, and stormwater outfalls as well as some locations further away from specific point sources. These data can supplement required monitoring data and help King County better understand how regional sediment quality relates to urban discharges, including CSOs and stormwater.

To date, these data have been useful for identifying areas with sediment contamination issues and for highlighting trends (such as decreases) in certain chemicals over time (King County 2022a). However, chemistry and physical data alone can only tell us so much about the status of the benthic habitat, and benthos data would be more useful if collected annually. Beyond the primary goals of this program, we would like to use these data to support other King County monitoring programs in the future. Therefore, we are updating the routine marine sediment monitoring program and suggest the following changes.

Updated Program Goals

By updating the Marine Sediment Monitoring Program, we aim to preserve our ability to detect trends and monitor the status of sediments in Puget Sound as outlined by the primary goals of the program described below. Additionally, we hope to use these data to support other King County monitoring programs in understanding the biological implications of sediment quality. Through these supporting goals, we aim to better understand how sediment chemistry and benthic community composition relate to the food-web via links with zooplankton, juvenile fish, and the seafood from Puget Sound that people eat. The updated program goals include:

Primary Subtidal Sediment Goals

- Evaluate sediment chemical concentrations relative to the marine sediment quality standards of Chapter 173-204 WAC (Ecology 2013) and compare those concentrations to Puget Sound-wide values.
- Evaluate the spatial and temporal variation of chemical concentrations among monitored sites.
- Assess the health of the benthic community at a subset of shallow and deep sites.

Supporting Subtidal Sediment Goals

- Use information about physical factors, water quality, and sediment chemistry to better understand spatial and temporal differences in the benthic community.
- Use sediment chemistry data (along with other factors) to better understand the potential relationship to fish and crab tissue chemical concentrations and further refine King County's marine tissue chemical exposure model (Figure 1).

- Use benthic community data to better understand the relationship between benthos, the planktonic stage of benthic invertebrates (in the form of zooplankton), and water quality, including their relationship to climate events such as marine heatwaves.
- Document what known benthic invertebrate prey items for juvenile salmon (e.g., yearling Chinook) are available at our shallow subtidal sites in Elliott Bay, though only a portion of their diet.

Intertidal Sediments Goals

- Evaluate sediment chemical concentrations relative to the marine sediment quality standards of Chapter 173-204 WAC (Ecology 2013).
- Continue to assess sediment chemistry concentrations and trends at historical beach sediment sampling locations inshore of wastewater facilities.

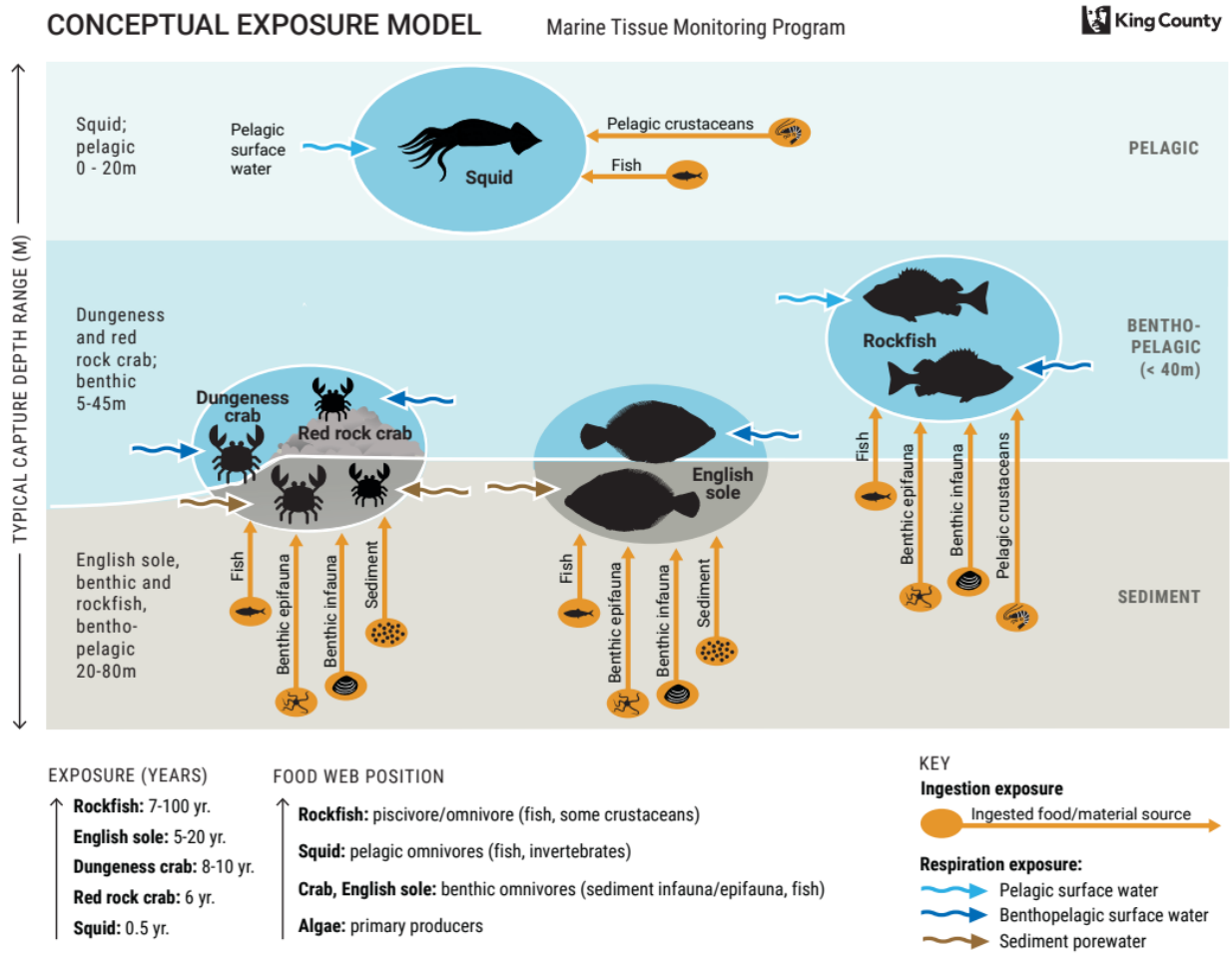

Figure 1. King County's Marine Tissue Monitoring Program conceptual exposure model. Marine sediment monitoring program updates could help refine this model for benthic species.

Monitoring Program Overview

The following information includes details on the design of the updated routine Marine Sediment Monitoring Program, highlighting what will change starting in 2025. For more

details on the former routine Marine Sediment Monitoring Program, refer to historical sampling and analysis plans (SAPs), including the most recent for each sampling area (King County 2020, 2022b, 2023).

Future sediment chemistry monitoring will be split into four types of sampling events: one each year on a 4-year rotation. These include sampling 1) subtidal Elliott Bay sites, 2) all intertidal sites, 3) subtidal Central Basin sites, 4) and a special project that will change with each rotation. The benthic community will be monitored at a subset of sites annually. Details on what sites and parameters will be monitored moving forward are included below and changes are highlighted (emphasized in **bold**). Any method changes are also included below; however, details on analytical methods will be updated in specific sampling event SAPs in the future.

Subtidal Chemistry Sampling: Elliott Bay

Subtidal sediment chemistry samples from Elliott Bay will be collected every 4 years (adjusted from every 2 years). Sediment sampling will continue to occur as close as possible to the last week of May or first week of June.

Sediment chemistry sampling in Elliott Bay will take place at eight sites (Table 1, Figure 2). These will be a mix of five shallow subtidal sites located near multiple point and non-point sources along the shoreline as well as three sites located further away from point sources in the middle of Elliott Bay. Seven of these sites have been monitored since at least 2007, **one new site (Duwamish Head) will be added** to pair with a crab tissue sampling site and one site (KSZY01 at Piers 90/91) will be dropped. The **Pier 90/91 site will be dropped** due to overlap with the Washington State Department of Ecology's long-term monitoring site 40012 at Smith Cove and ongoing sampling by the Port of Seattle to investigate sediment contamination at Terminal 91. Both efforts render our continued sampling at the Pier 90/91 site redundant.

The new Elliott Bay site is:

- **Duwamish Head (DWMHD1)**—this site is located off Duwamish Head, approximately 15 m deeper than where crab samples are collected (Figure A-1).

The parameters measured at Elliott Bay sites will include the chemicals of concern listed within the marine Sediment Management Standards (SMS) as well as conventional parameters, additional nutrients, metals, and organics. **Parameters that will be dropped from the program include total 4-nonylphenol and coprostanol (due to their lack of detections) as well as nickel and tin, which are not significant pollutants in Puget Sound. Selenium will be added** because, while various selenium species can protect fish against mercury toxicity and accumulation (Dang and Wang 2011), it can also be toxic. Selenium is also a chemical of concern that is monitored in effluent per NPDES permit requirements. Selenium will be dropped from future

monitoring efforts if not detected. The parameters[1] that will be monitored moving forward include:

- Conventionals: particle size distribution (PSD), total organic carbon (TOC), total solids
- Nutrients: ammonia* and total sulfide*
- Metals: aluminum*, arsenic, cadmium, chromium, copper, iron*, lead, mercury, **selenium***, silver, and zinc
- Organics: polycyclic aromatic hydrocarbons (PAHs), phthalates, phenols, chlorinated semi-volatile organic compounds, polychlorinated biphenyls (PCBs), miscellaneous polar and non-polar organics, butyltins*, chlorinated pesticides*, and polybrominated diphenyl ethers* (PBDEs)[2].

Table 1. Elliott Bay subtidal sampling site information, including which sites will be dropped and added.

Status	Locator	Site Name	Latitude	Longitude	Year Added	Approx Depth (m)	Sampling Depth (cm)	Paired Sampling
Drop	KSZY01	Piers 90/91	47.62544	-122.38163	2007	20	0-2	None
Maintain	LTAA02*	Grain Terminal	47.62304	-122.37093	2007	25	0-10	Fish
Maintain	LSCW02*	Elliott Bay W. Deep	47.61194	-122.39083	1991	180	0-10	None
Maintain	LTCA02	Elliott Bay Central	47.61000	-122.37194	1991	130	0-2	None
Maintain	LTDF01*	Elliott Bay Waterfront	47.60778	-122.34611	1988	35	0-2 & 0-10	Fish
Maintain	LTED04	Elliott Bay E. Central	47.60364	-122.35651	1992	90	0-2	Water
New	DWMHD1	Duwamish Head	47.60046	-122.39012	2025	20	0-10	Crab
Maintain	LTGF01*	Harbor Island	47.58984	-122.35239	2007	30	0-10	Fish
Maintain	LSHZ08	Seacrest Park	47.58925	-122.37841	2007	25	0-10	Crab

*Benthos sampling site

If extra sampling material is available, we will continue to provide Dr. Julie Masura (University of Washington [UW] Tacoma) with sediment to support student research on microplastics. Additional material, as requested and available, will be provided to Dr. Cheryl Greengrove (UW Tacoma) for analysis of the cysts of the harmful algae *Alexandrium*.

Historically, subtidal sediments have been collected from the top 2 cm of the seafloor (i.e., the most recently deposited sediments) at these routine monitoring sites. This depth was targeted because the original program goals focused on status and trends, and sampling was established before current sediment management standard guidelines directed the use of the top 10 cm as the typical biologically active zone of marine sediments in Puget Sound. Moving forward, **four sites with long-term**

[1] * = non-SMS chemicals
[2] A complete list of individual organic parameters will be listed in future SAPs.

monitoring data (three in Elliott Bay and one that is part of the Central Basin sampling rotation) will continue to have the top 2 cm of sediment analyzed to preserve our ability to analyze long-term chemistry trends. **The top 10 cm of sediment will be collected from all other sites** because that depth is more biologically relevant due to how benthic invertebrates and fish (which bury themselves in and eat organisms associated with the sediment) interact with surface sediments. Sampling the top 10 cm also matches the methods used for NPDES permit-required monitoring. **Sediment from the Elliott Bay Waterfront site will be sampled from the top 2 cm and top 10 cm** because that site will be used for time-series and biological analyses. Table 1 and Figure 2 indicate the sediment sampling depth for each Elliott Bay site.

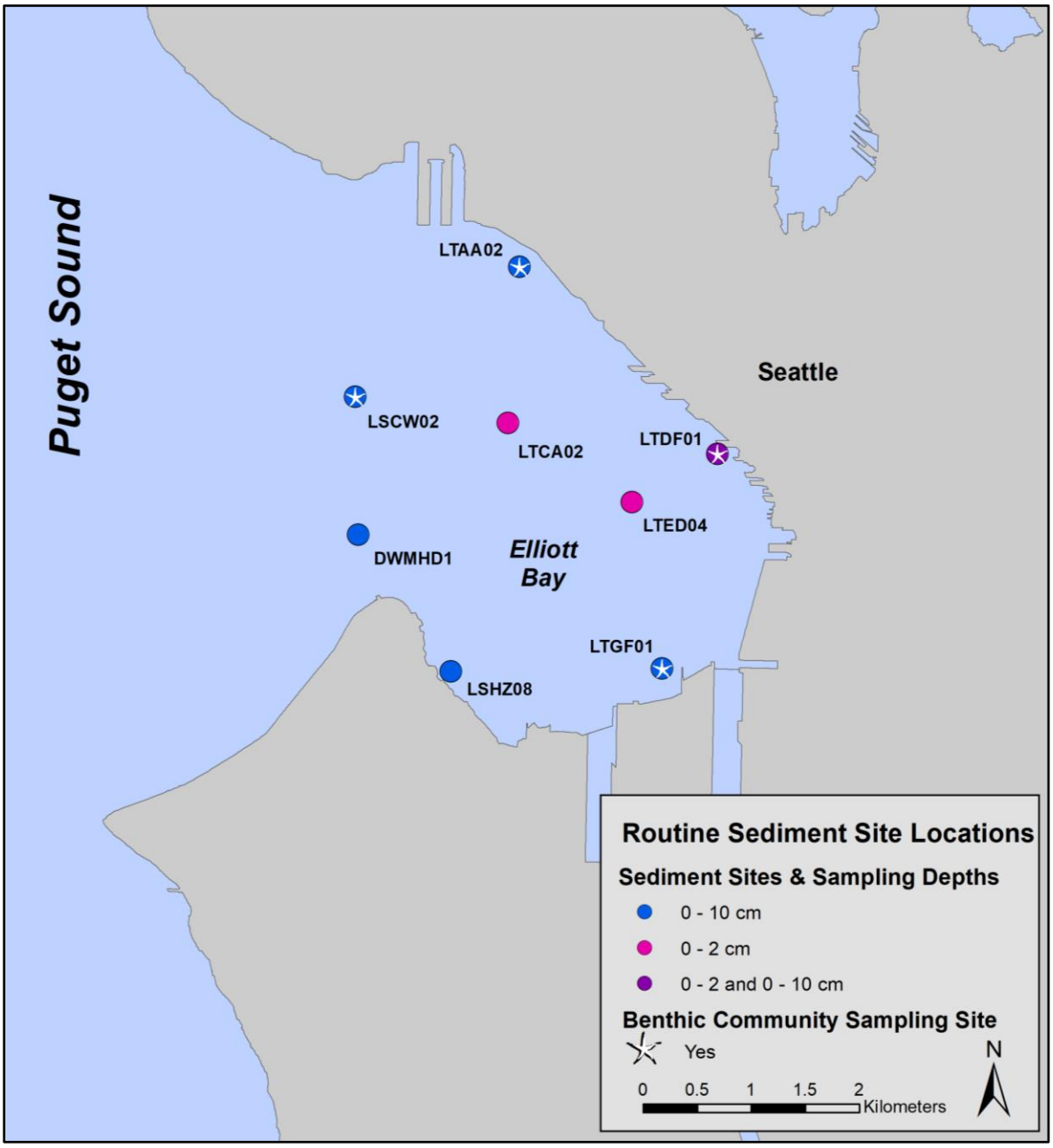

Figure 2. Elliott Bay subtidal sediment monitoring station locations.

Subtidal Chemistry Sampling: Central Basin

Subtidal sediment chemistry samples from Central Basin sites outside of Elliott Bay will be collected every 4 years (adjusted from every 5 years). Sediment sampling will continue to occur as close as possible to the last week of May or first week of June.

Subtidal sediment chemistry samples will be collected from ten sites in the Central Basin outside of Elliott Bay (Table 2, Figure 3). These include a mix of deep stations far away from point sources and shallow subtidal sites located near multiple point and non-point sources. Five sites have been monitored since at least 2007 and **five are new sites that are paired with English sole and/or crab tissue monitoring sites. The Fauntleroy Cove site (LSVV01) will be dropped** due to a history of low chemical concentrations (King County 2022a).

New Central Basin sites include:

- **Shilshole (SHLSHL1)**—this site is located off Shilshole Bay Marina between the target centroid for the English sole trawling site and where crab pots are typically deployed at both ends of the marina (Figure A-2).
- **Alki North Shelf (ALKNS1)**—this site is located along the north shelf of Alki about 250 m west-south-west of the target centroid for the English sole trawling site in a location not as steep as the trawl line (Figure A-3).
- **Tramp Harbor (TRMPH1)**—this site is located in Tramp Harbor approximately 15 m deeper than where crab pots are typically deployed (Figure A-4).
- **Outer Quartermaster Harbor (QMHOH1)**—this site is located in outer Quartermaster Harbor at the target centroid for the English sole trawling site (Figure A-5).
- **Redondo Pier Offshore (RDNDP1)**—this site is located off the Redondo Pier approximately 6 m deeper than where crab pots are typically deployed and within a resting (not currently harvested) Puyallup Tribe geoduck bed within the Poverty Bay Shellfish Protection District (Figure A-6).

The parameters measured at subtidal Central Basin sites will be the same as those monitored at subtidal Elliott Bays sites. Therefore, **parameters that will be dropped from the program include total 4-nonylphenol, coprostanol, nickel, and tin while selenium will be added.** The parameters[3] that will be monitored moving forward include:

- Conventionals: PSD, TOC, total solids
- Nutrients: ammonia* and total sulfide*
- Metals: aluminum*, arsenic, cadmium, chromium, copper, iron*, lead, mercury, **selenium***, silver, and zinc

[3] * = non-SMS chemicals

- Organics: PAHs, phthalates, phenols, chlorinated semi-volatile organic compounds, PCBs, miscellaneous polar and non-polar organics, butyltins*, chlorinated pesticides*, and polybrominated diphenyl ethers* PBDEs[4].

If extra sampling material is available, we will continue to provide Dr. Julie Masura (UW Tacoma) with sediment to support student research on microplastics. Additional material, as requested and available, will be provided to Dr. Cheryl Greengrove (UW Tacoma) for analysis of the cysts of the harmful algae *Alexandrium*.

Table 2. Central Basin subtidal sampling site information, including which sites will be dropped and added.

Status	Locator	Site Name	Latitude	Longitude	Year Added	Approx Depth (m)	Sampling Depth (cm)	Paired Sampling
Maintain	KSBP01*	Jefferson Head	47.74396	-122.42817	1981, 2007	280	0-10	Water, Zooplankton
New	SHLSHL1	Shilshole	47.68579	-122.41129	2027	30	0-10	Fish, Crab
Maintain	KSRU03	Outer Salmon Bay	47.66796	-122.40564	2007	10	0-10	None
New	ALKNS1	Alki North Shelf	47.58345	-122.41428	2027	50	0-10	Fish
Maintain	LSML01	West Seattle	47.56333	-122.44333	1985	250	0-2	None
Drop	LSVV01	Fauntleroy Cove	47.52476	-122.39769	2007	12	0-2	Water
New	TRMPH1	Tramp Harbor	47.41325	-122.43259	2027	25	0-10	Crab
Maintain	MSVK01	Inner Quartermaster Harbor	47.39844	-122.45167	2007	6	0-10	Water
Maintain	NSEX01*	East Passage	47.35862	-122.38708	2007	175	0-10	Water, Zooplankton
New	QMHOH1	Outer Quartermaster Harbor	47.37000	-122.48000	2027	20	0-10	Fish
New	RDNDP1	Redondo Pier Offshore	47.34923	-122.32705	2027	30	0-10	Crab

*Benthos sampling site

Like Elliott Bay sites, subtidal sediments have been collected from the top 2 cm of the seafloor at these routine Central Basin monitoring sites. **One Central Basin site (LSML01) will continue to have the top 2 cm of sediment analyzed** to preserve our ability to analyze long-term chemistry trends similar to the three sites in Elliott Bay. **The top 10 cm of sediment will be collected from all other sites**. Table 2 and Figure 3 indicate the sampling depth for each site.

[4] A complete list of individual organic parameters will be listed in future SAPs.

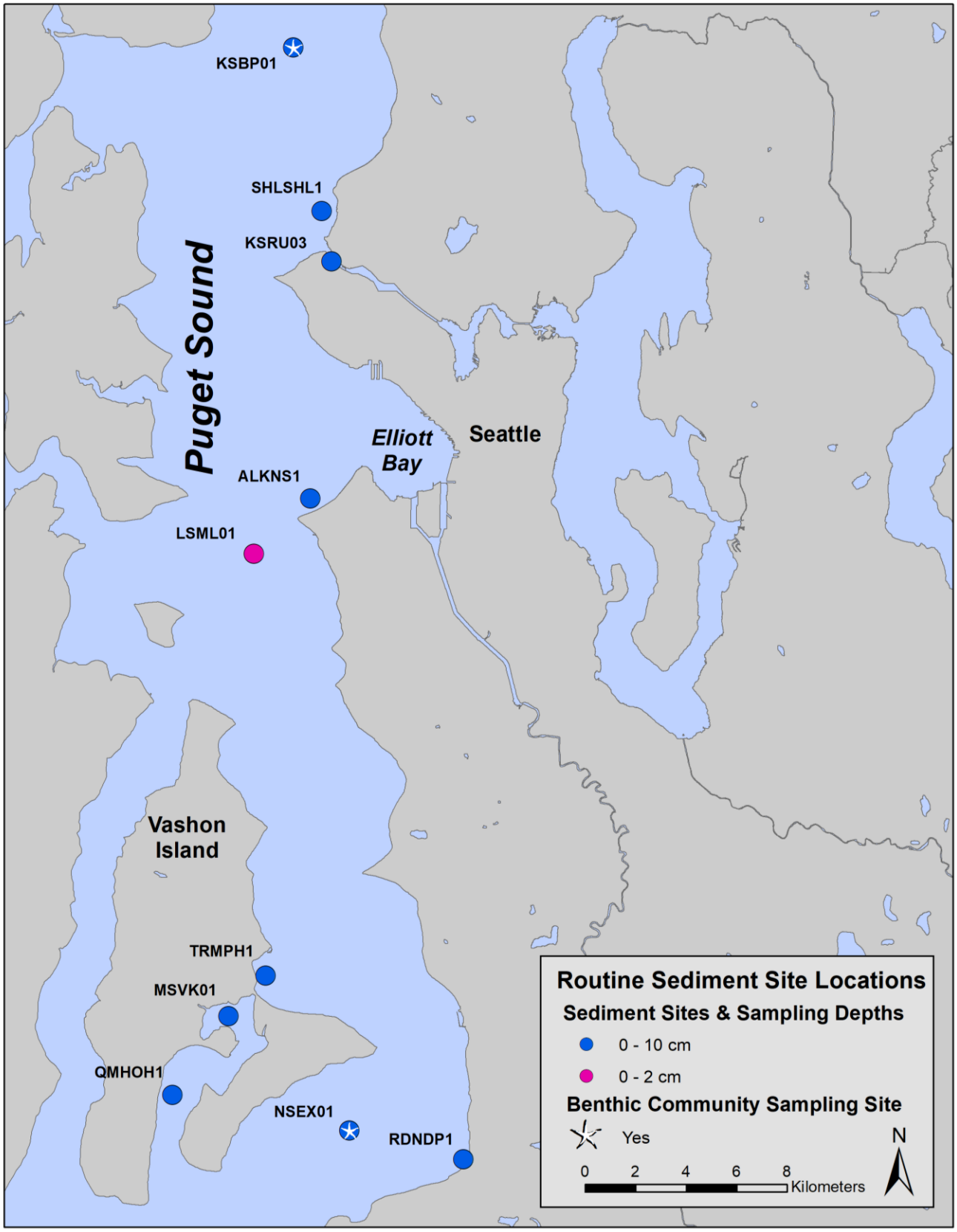

Figure 3. Central Basin subtidal sediment monitoring station locations.

Subtidal Benthos Sampling

Subtidal benthos sampling frequency will be increased from every 2 or 5 years to annually. This change will be made to allow us to track inter-annual variation at sites to 1) determine the impacts of physical drivers (such as marine heatwaves) on the benthos and 2) to better understand the dynamics between the planktonic larvae of benthos (in zooplankton) and the benthic community. **The number of sites sampled for benthos will be reduced to six subtidal sites** (three shallow [~30 m] sites in Elliott Bay where juvenile salmonids like yearling Chinook salmon migrate and English sole are collected, and three deep depositional sites). Four of these sites are in Elliott Bay (Table 1) and two are in Central Basin (Table 2). We will continue to collect three replicates from each site using past methods with one exception. To reduce our impact of collecting multiple grabs annually from a single location, we will **increase the target sampling radius from 6 meters to 10 meters. We will evaluate after 5 years if we think oversampling is limiting the ability to evaluate program goals for benthos.**

Intertidal Sediment Sampling

Intertidal sediment sampling will be reduced because these sandy intertidal sediments have historically had few exceedances of SMS (King County 2022a) and the greatest value of this program has come from the ability to identify potential impacts, or the absence of impacts, to beach sediments from wastewater facilities (see Updated Program Goals). For these reasons, **the number of intertidal sites sampled will be reduced from 16 to 7**. We will continue to monitor seven sites to maintain current assessment levels of beach locations, particularly those inshore of wastewater facilities. These sites include locations near the Richmond Beach pump station, the Carkeek and Alki wet weather treatment stations, the West Point treatment plant's emergency bypass outfall, and the Vashon treatment plant. Additionally, one site on the south side of West Point in Discovery Park and one located at Golden Gardens Park in between the West Point and Carkeek sites will be maintained to assist with comparisons to nearby sites (Table 3, Figure 4).

Table 3. Intertidal sampling site information, including which sites will be dropped.

Status	Locator	Site Name	Latitude	Longitude	Year Added	Paired sampling
Drop	ITEDWARDSPT	Edwards Point	47.80363	-122.39505	2010	None
Maintain	JSVW04	Richmond Beach	47.77389	-122.39194	1987	Water
Drop	ITCARKEEKP	Carkeek Point	47.71260	-122.37905	2010	Water
Maintain	KSHZ03	Carkeek, Piper's Creek	47.71254	-122.37958	1987	Water
Maintain	KSLU03	Golden Gardens	47.69194	-122.40528	1987	Water
Maintain	KSSN04	West Point N.	47.66241	-122.43391	1987	Water
Maintain	KSSN05	West Point S.	47.66116	-122.43408	1987	Water
Drop	KSYV02	Magnolia CSO	47.63224	-122.39868	1985	Water
Maintain	LSKS04	Alki Point S.	47.57295	-122.41564	2010	None
Drop	LSVW01	Fauntleroy Cove	47.52378	-122.39397	1985	Water

Status	Locator	Site Name	Latitude	Longitude	Year Added	Paired sampling
Drop	MTEC01	Seahurst Park	47.47814	-122.36353	1989	None
Maintain	MSJL01	Vashon Outfall	47.45369	-122.44422	2002	Water
Drop	MTLD03	Normandy Park	47.44249	-122.35743	1999	Water
Drop	MSXK01	Burton Acres	47.39008	-122.44681	2010	Water
Drop	NTFK01	Redondo Beach	47.34950	-122.32400	2010	Water, Crab
Drop	NSJY01	Dumas Bay	47.32611	-122.38408	2010	Water

Moving forward, the parameters measured at intertidal sites will be limited to the chemicals with marine standards in the SMS. The exceptions are conventional parameters and the crustal metals aluminum and iron, which can be used for understanding the patterns of other metals that are more indicative of anthropogenic sources. For that reason, **PBDEs and the metals nickel, manganese, and selenium will be dropped**. The parameters[5] we will continue to monitor include:

- Conventionals: PSD, TOC, and total solids
- Metals: aluminum*, arsenic, cadmium, chromium, copper, iron*, lead, mercury, silver, and zinc
- Organics: PAHs, phthalates, phenols, chlorinated semi-volatile organic compounds, PCBs, and miscellaneous polar and non-polar organics[6].

Like other parts of the program, **sampling for intertidal sediment chemistry will occur every 4 years** (adjusted from every 5 years). Sampling will continue to occur in August. The top 5 cm of sediment will continue to be sampled to capture the most recently deposited sediments. Surface samples at intertidal sites target the top 5 cm (in contrast to top 2 cm) because the surface 2 cm is typically filled with small rocks, which must be removed prior to analyzing samples.

Sampling methodology will be adjusted moving forward to be more representative of sediment conditions along the beach where the site is located rather than at a single location. Previously, samples were collected from about a 0.5 m^2 area located at the +6.5 ft mean lower low water (MLLW) level near the prescribed sampling location. In the future, **ten hand cores will be collected 1 meter apart along a 10 meter transect at +6.5 ft MLLW (centroid at site location); these cores will be composited into one sample per site.**

[5] * = non-SMS chemicals
[6] A complete list of individual organic parameters will be listed in future SAPs.

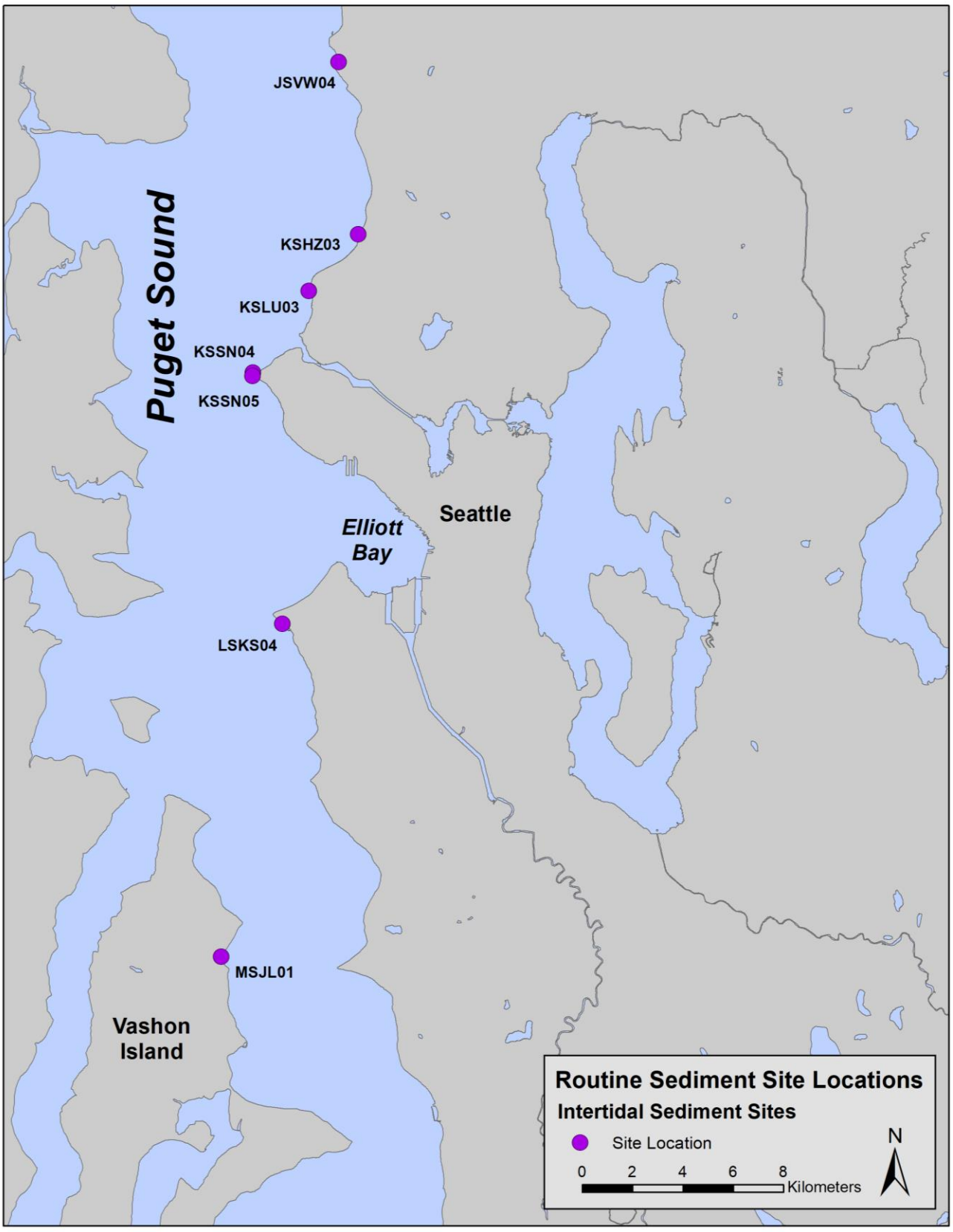

Figure 4. Map of intertidal sediment monitoring stations.

Special Projects

Every fourth year will be available to complete a "special project" that is outside of the routine sediment sampling rotation. Depending on the project, funding could come from program operating funds, grants, or a combination of both. These special projects will be designed to answer a specific question that is related to, but outside the scope of, the core Marine Sediment Monitoring Program. Conversations with King County staff provided a list of potential questions to address with special projects, some of which may involve coordinating with other monitoring efforts:

- How does intertidal sediment chemistry vary along a tidal gradient (e.g., from extreme low to extreme high tide line)? Differences could have implications for organisms that spawn in/on beach sediment, such as sand lance.
- What is the tissue body burden of the benthic community along the Seattle waterfront where juvenile salmon are feeding?
- What are the 6PPD-quinone (6PPDQ) concentrations in King County marine environments that receive stormwater inputs, such as Elliott Bay?
- Do per- and polyfluoroalkyl substances (PFAS) exist at detectable concentrations in the Central Basin and, if so, at what concentrations?
- Would a sediment core confirm trends detected from long-term Elliott Bay surface sediment monitoring? If so, could occasional coring replace routine surface sediment monitoring to track natural recovery in deep Elliott Bay?
- Do benthic communities differ between sites that are compliant with best practices for shoreline armoring, those that are non-compliant, and natural shorelines?
- Do we see effects of ocean acidification on the benthic community?
- What endocrine disrupting chemicals that could have toxicological effects on fish/crab, such as 17α-ethinylestradiol, 17β-estradiol, and estrone, are present in Elliott Bay sediments? Does the presence or absence of these chemicals in sediment help explain vitellogenin patterns seen in fish?

The list above is only a reflection of current study questions proposed through input provided in 2024. The question addressed during each special project rotation may differ from the ones listed above and will be dependent on new information learned, current King County priorities, and resources available.

Schedule

The sampling schedule, to be repeated every 4 years, is presented in Table 4. This rotation will allow for the Elliott Bay or Central Basin sediment sampling events to align with English sole tissue sampling every other year (English sole sampling occurs biennially on odd years). Crab tissue sampling, which happens every 4 years and will next occur in 2026, will always be offset from subtidal sediment monitoring. However, these datasets should still be comparable because the top 10 cm of sediment will be collected at these sites, which should incorporate several years of deposition.

Table 4. Site sampling schedule rotation to be repeated every 4 years*.

Sampling Years	Elliott Bay	Intertidal	Central Basin	Special Project
2025 / 2029	✓			
2026 / 2030		✓		
2027 / 2031			✓	
2028 / 2032				✓

*Benthic community samples will be collected annually from a subset of six sites.

Considered but Not Adopted

During the process of updating the Marine Sediment Monitoring Program, I consulted with many potential data users, largely within King County's Department of Natural Resources and Parks (acknowledged below). These discussions also led to other ideas and options that ultimately did not make it into the final list of changes for the program. Those considerations are briefly summarized below.

Movement of site LTED04—We identified that long-term monitoring site LTED04 is located within the Army Corps of Engineers Elliott Bay Disposal Site. The spreading of dredge material could influence sediment conditions at LTED04. However, recent monitoring data from LTED04 indicate this site is outside the boundary of the area identified as having trace layers of dredge material (DNR 2024). Therefore, we did not relocate LTED04. However, we should continue to consult future dredge site reports to assess whether to continue monitoring at this site.

Drop Butyltins—Butyltins, can be used for thermal and UV-stabilization of polyvinyl chloride (PVC) products and were historically used in anti-fouling boat paint due to their toxicity to many marine invertebrate species (in the form of tributyltin). These chemicals can be bioaccumulated in animals such as molluscs, crustaceans, and fish (Laughlin 1996). No Sediment Management Standards exist for butyltins, and tributyltin use was banned for small vessels starting in the 1980s and for all vessels worldwide in 2003. However, we still detect these chemicals at sites adjacent to areas of heavy vessel usage such as ports and shipyards (King County 2022a). Additionally, we have seen concentrations of tributyltin above the screening level of 73 µg/kg dry weight that was set by the Puget Sound Dredge Disposal Analysis (Ecology 2021) and above EPA's screening level for Puget Sound (1.255 mg/kg organic carbon) (EPA 1996). Therefore, we will continue to monitor butyltins until we see values consistently fall below these screening levels at all sites.

Drop Chlorinated Pesticides—In our marine subtidal sediment data, most of the chlorinated pesticides we analyze are rarely detected. The exception is dichlorodiphenyltrichloroethane (DDT) and its degradation products, which we commonly detect (King County 2022a). However, King County does detect several of these chlorinated pesticides in tissue samples. The chemicals detected most commonly in tissues (and crab tissues in particular) include dichlorodiphenyldichloroethylene

(DDE), heptachlor epoxide, and beta-BHC (β-BHC) (King County, Toxicology and Contaminant Assessment Unit, pers. Comm. 2024). For this reason, we will continue to monitor and evaluate these chemicals in marine sediments.

Acknowledgements

This update of the Marine Sediment Monitoring Program could not have happened without the insight and input of many people who provided input on how to best use our marine sediment data moving forward. For their invaluable contributions I would like to thank Kimberle Stark, Taylor Martin, and Gregory Ikeda (Marine and Sediment Assessment Group), Chelsea Mitchell and Jennifer Lanksbury (Toxicology and Contaminant Assessment Unit), Erin McCabe (Laboratory Project Manager), Bob Kruger and Christopher Barnes (Sediment Field Team Leads), Diane McElhany (Laboratory Manager), Jeff Stern, Debra Williston, and Jeff Lafer (Wastewater Treatment Division's Environmental Programs Section), Todd Hunsdorfer (Stormwater Services), Kollin Higgins (Watershed and Ecological Assessment Unit), Beth LeDoux (Lakes, Streams, Sound, and Ground Unit Supervisor), Jenée Colton (Toxicology and Contaminant Assessment Unit Supervisor), and Josh Latterell (Science and Technical Support Section Manager). I'd also like to thank Sandra Weakland and Dany Burgess (Department of Ecology, Marine Monitoring Unit) for their continued support and collaboration on all things marine sediment-related in Puget Sound.

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Appendix A

New sediment site maps

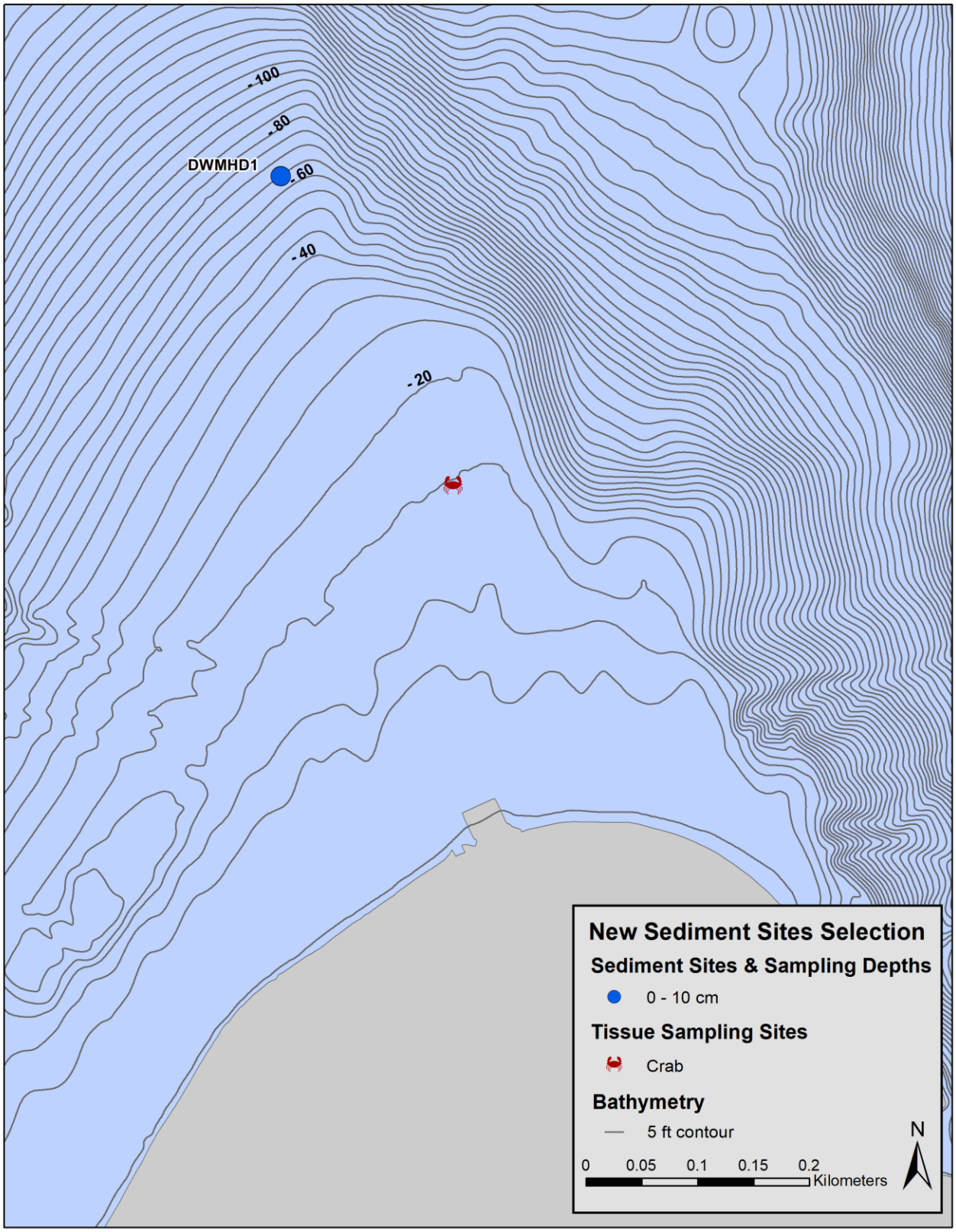

Figure A-1. Location of new Duwamish Head site (DWMHD1) and associated crab sampling location.

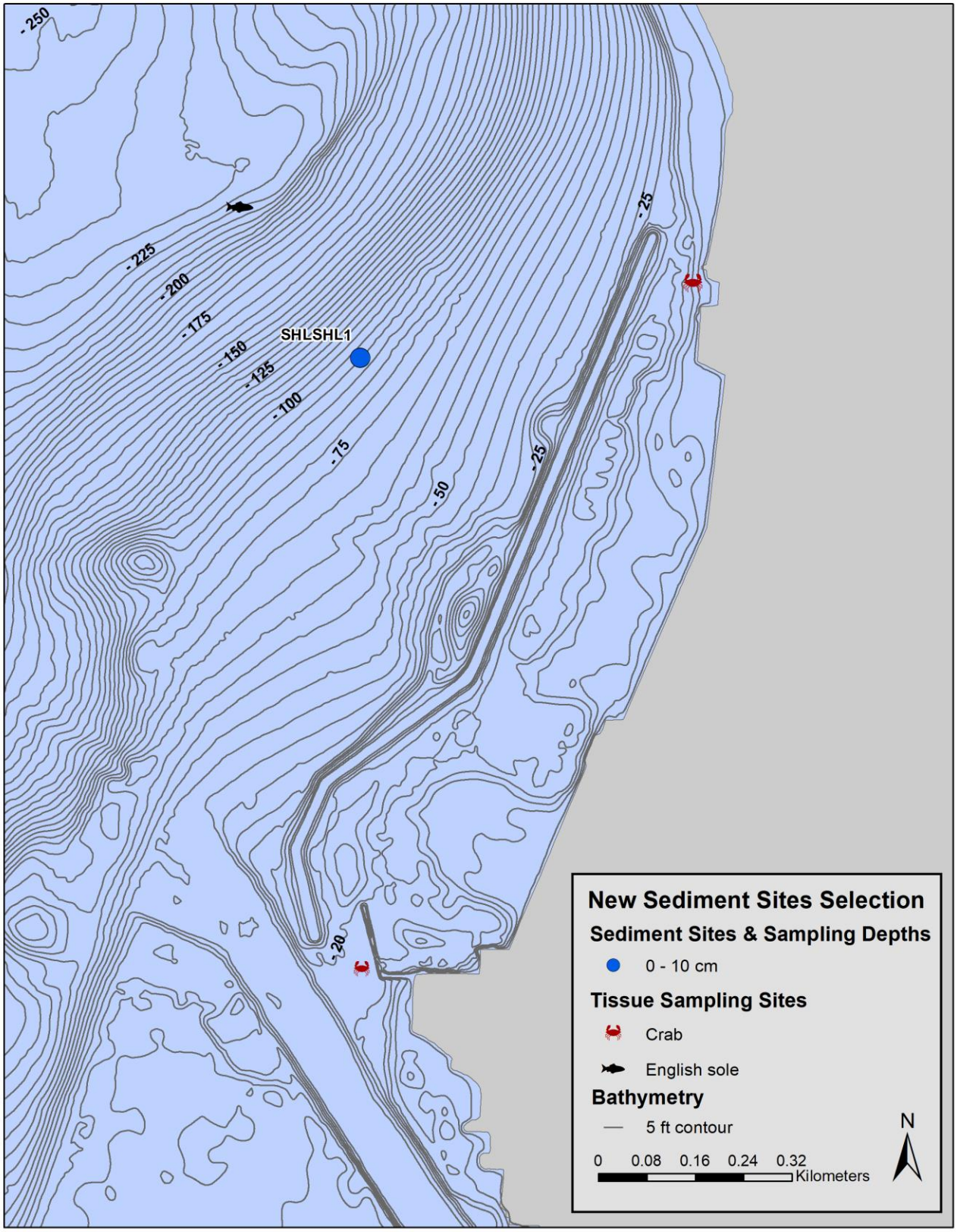

Figure A-2. Location of new Shilshole site (SHLSHL1) and associated English sole sampling location.

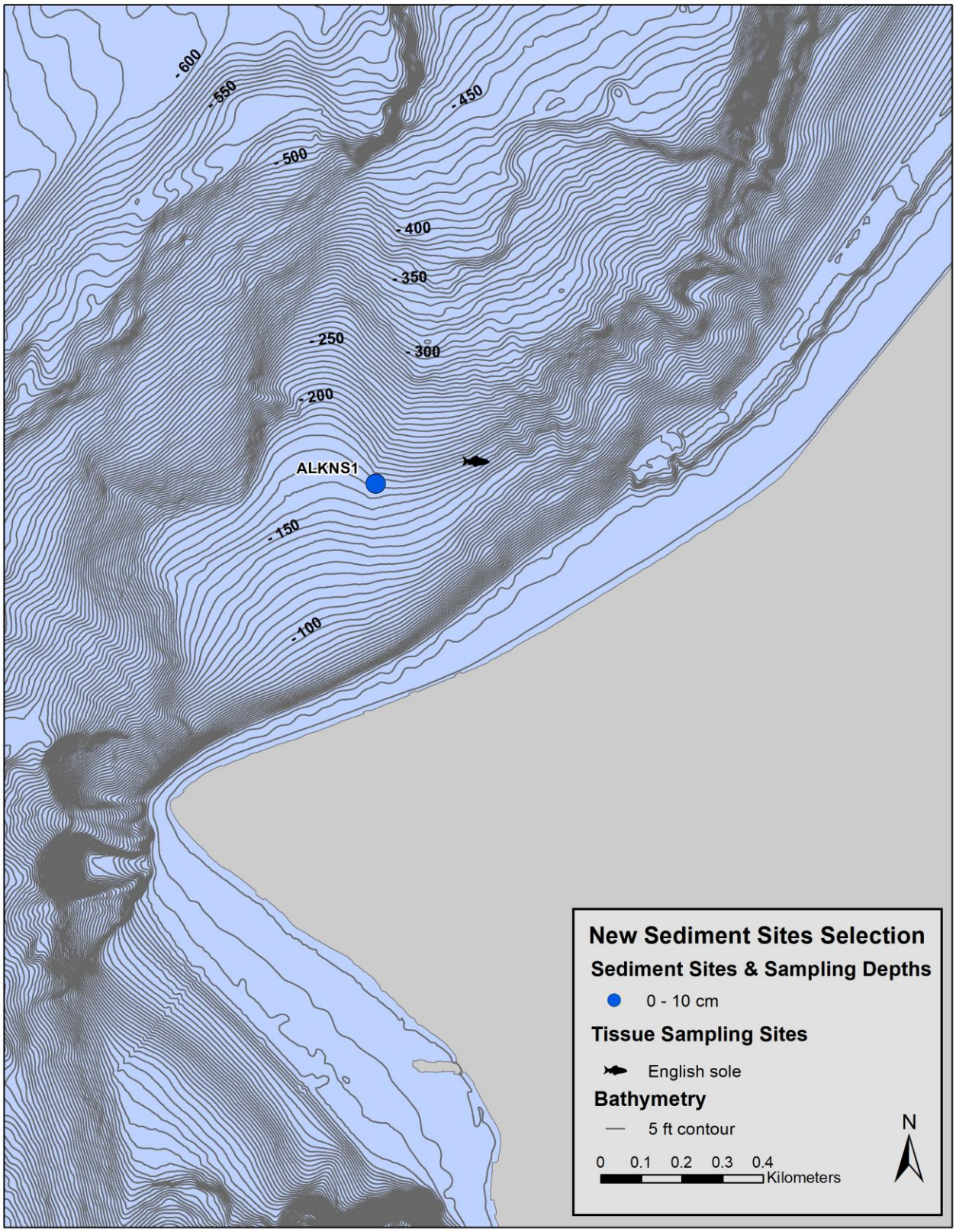

Figure A-3. Location of new Alki North Shelf site (ALKNS1) and associated English sole sampling location.

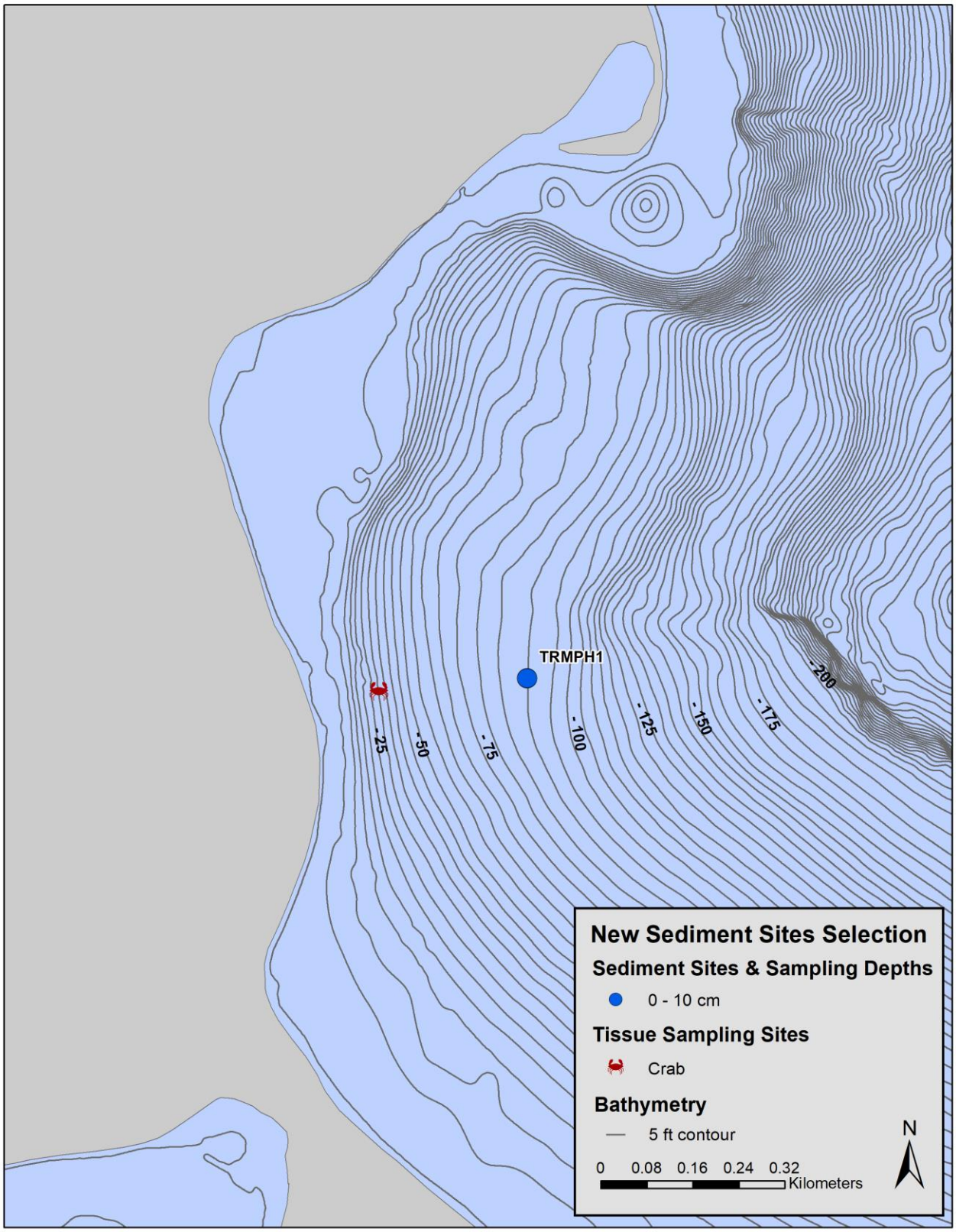

Figure A-4. Location of new Tramp Harbor site (TRMPH1) and associated crab sampling location.

Figure A-5. Location of new Outer Quartermaster Harbor site (QMHOH1) and associated English sole sampling location.

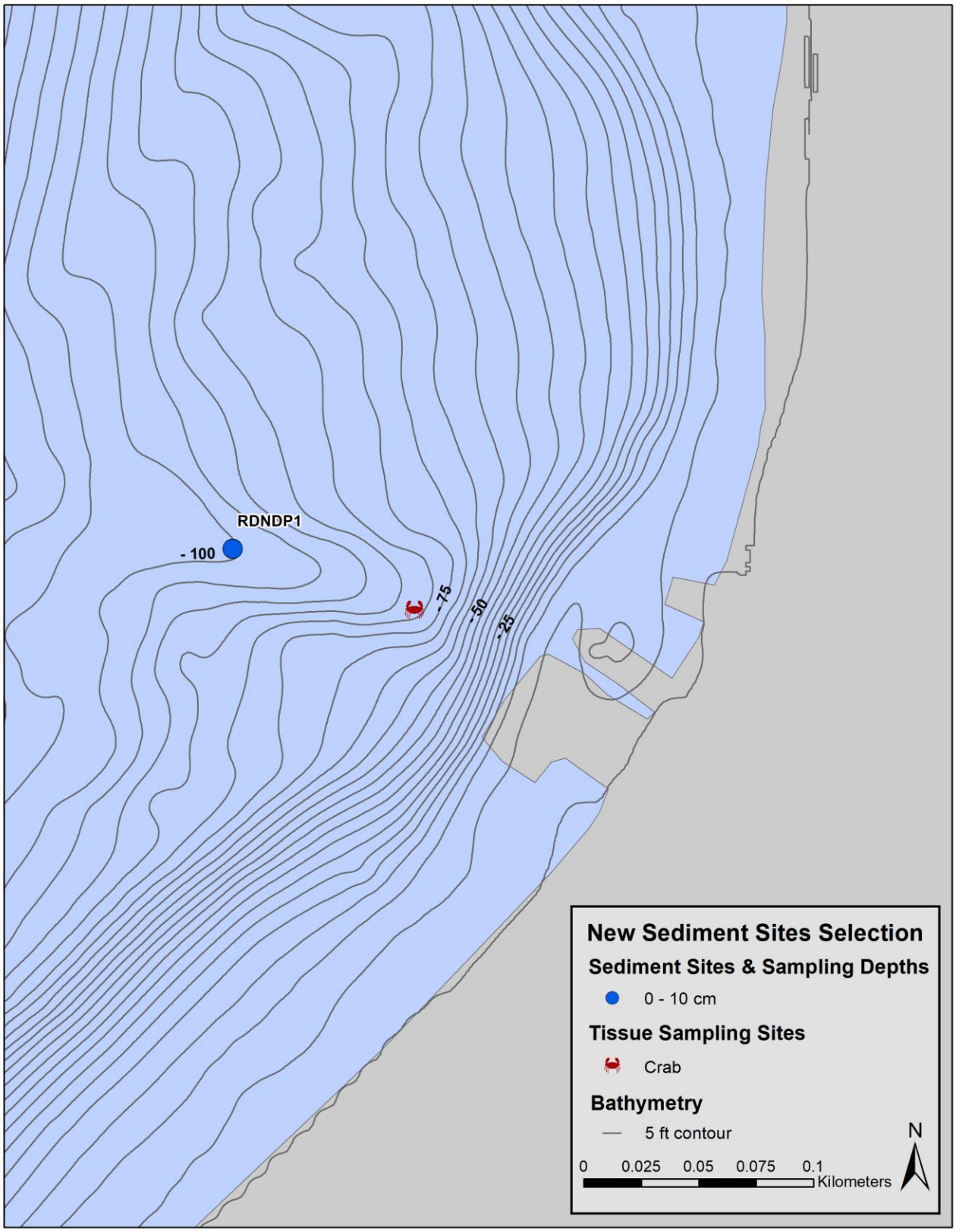

Figure A-6. Location of new Redondo Pier Offshore site (RDNDP1) and associated crab sampling location.