APPENDIX L – ALTERNATIVES SCREENING

EAST WATERWAY OPERABLE UNIT FEASIBILITY STUDY

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TABLE OF CONTENTS

List of Tables

List of Figures

1 INTRODUCTION

This appendix presents the focused screening of potential remedial alternatives for the East Waterway (EW) Operable Unit Feasibility Study (FS) in accordance with Environmental Protection Agency (EPA; 1988) Remedial Investigation/FS guidance. Screening of remedial technologies and alternatives was previously performed in the EPA-approved *Final Remedial Alternative and Disposal Site Screening Memorandum* (Screening Memo; Anchor QEA 2012) to meet requirements for alternatives screening under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This additional screening evaluation has been performed at the request of, and in coordination with, EPA to screen a wide array of potential alternatives to understand the influence of different cleanup components on effectiveness, implementability, and cost, to select a representative set of alternatives for detailed analysis in Sections 8, 9, and 10 of the FS. This appendix presents the information as follows:

- **Alternative Components** (Section 2) develops the logic for the matrix of alternatives.
- **Comparison of Alternatives** (Section 3) compares the alternatives for effectiveness, implementability, and cost.
- **Screening of Alternatives** (Section 4) presents the rationale and list of alternatives retained for detailed evaluation in the FS.

2 ALTERNATIVE COMPONENTS

Three components were varied to develop the remedial alternatives: the remedial action levels (RALs; also discussed in FS Section 6), the remedial technology assignments in the open-water areas, and the remedial technology assignments in limited access areas. The alternatives were generated by modifying these three components one at a time to understand the effect of each. The components and the resulting suite of alternatives are explained in the following sections.

2.1 Remedial Action Levels

RALs are the point-based concentrations above which sediment is remediated and are one of the components modified to produce the array of remedial alternatives. FS Table 6-2 and Section 6.2.2 present the RALs included in this screening. The RALs were developed in Section 6 to achieve outcomes relative to the site-specific remedial action objectives (RAOs). Key risk driver contaminants of concern (COCs) have the same RAL for all alternatives, with the exception of total polychlorinated biphenyls (PCBs), which has three different RALs. Because only the total PCBs RAL is varied among the alternatives, the RAL sets are denoted by each total PCB RAL. The three sets of screening RALs are shown in Table 2-1.

Table 2-1
Remedial Action Levels for Technology Development

RAL Set Denotation	Total PCBs RAL	RALs for Other Chemicals	Area Remediated
(12)	12 mg/kg OC	See FS Table 6-1 (same for all alternatives)	121 of 157 acres
(7.5)	7.5 mg/kg OC		132 of 157 acres
(5.0)	5.0 mg/kg OC		140 of 157 acres

Notes:
FS – Feasibility Study
mg/kg – milligrams per kilogram
OC – organic carbon
PCB – polychlorinated biphenyl
RAL – remedial action level

2.2 Remedial Technologies

The remedial technologies are additional components that were modified to produce the array of alternatives. The remedial technologies were screened in Section 7 for potential application in specific areas of the EW, called Construction Management Areas (CMAs;

FS Table 7-3). For the purpose of alternative development, the CMAs are grouped into "open-water," which are areas with relatively unrestricted access for remediation, and "limited access areas," which are areas that are difficult to access with typical remediation equipment, and include both the underpier areas and the low bridge areas of the Sill Reach (FS Figure 7-1). The open-water remedial technologies are discussed in Section 2.2.1 herein, and the limited access area remedial technologies are discussed in Section 2.2.2.

2.2.1 Open-water Remedial Technologies

The open-water CMAs have been grouped based on areas with similar characteristics that affect remediation, including structural restrictions, waterway use, habitat, and water depth requirements (FS Section 7.7). Based on these characteristics, remedial technologies were screened for applicability in each area (FS Section 7.8). This section uses the CMA groups and the retained technologies to form three open-water technology options (labeled 1, 2, and 3) that provide a range of potential remediation approaches. The open-water technology options generally increase in the amount of sediment removal from Option 1 through Option 3; however, all open-water technology options rely primarily on dredging due to site use and navigational water depth restrictions in most of the open-water areas of the waterway. Table 2-2 presents the technology options for the open-water CMAs.

Table 2-2
Open-water Technology Options for Alternatives Development

Open-water Option	Navigation Channel and Berth Areas (110 acres)[1]	Shallow Main Body (22 acres)[1]	Nearshore (8 acres)[1]	West Seattle Bridge (2 acres)[1]
	CMAs: - *Federal Navigation Channel – South* - *Federal Navigation Channel – North* - *Deep Draft Berth Areas (T-18, T-30, T-25)* - *Slip 27 Channel* - *Slip 36/T-46 Offshore* - *T-30 Nearshore* - *Junction Reach* - *Communication Cable Crossing*	*CMAs:* - *Shallow Main Body – North and South* - *Former Pier 24 Piling Field*	*CMAs:* - *Mound Area/Slip 27 Shoreline* - *Coast Guard Nearshore*	*CMA:* - *Sill Reach – West Seattle Bridge*
1	• Removal • Partial Removal with ENR-nav • ENR-nav	• Partial Removal and Cap	• Partial Removal and Cap	• ENR-sill
2	• Removal	• Partial Removal and Cap	• Partial Removal and Cap	• ENR-sill
3	• Removal	• Removal	• Partial Removal and Cap	• Removal

Notes:
1. The area for the CMAs represents the total area of the CMAs. The remediation area within the CMAs depends on the RAL set used for the alternative.

CMA – Construction Management Area
ENR – enhanced natural recovery
RAL – remedial action level
T – Terminal

2.2.2 Limited Access Area Remedial Technologies

The limited access areas of the EW include the underpier CMAs and the two low bridges on the Sill Reach; these are referred to as the "limited access area CMA groups" for simplicity. These areas present particular challenges for remediation and, as such, have a different range of technology options for this alternative screening (FS Section 7.8). The retained technologies in these areas have been put together in six different limited access area technology options (labeled A through E, plus a variant of C called C+). These options generally increase in cost from Option A through Option E. Table 2-3 presents the six limited access area technology options.

Table 2-3
Limited Access Area Technology Options for Alternatives Development

Limited Access Area Option	Underpier (15 acres)[1] *CMA:* *– Underpier areas*	Sill Reach – Low Bridges (2 acres)[1] *CMAs:* *– Spokane Street Bridge* *– Railroad Bridge*
A	• MNR	• MNR (subtidal) • ENR-sill (intertidal)
B	• In situ Treatment	• ENR-sill
C	• Removal for PCBs or Hg > CSL • In situ treatment elsewhere	• ENR-sill
C+	• Removal ***followed by in situ treatment*** for PCBs or Hg > CSL • In situ treatment elsewhere	• ENR-sill
D	• Removal	• ENR-sill
E	• Removal followed by in situ treatment	• ENR-sill

Notes:
1. The area for the CMAs represents the total area of the CMAs. The remediation area within the CMAs depends on the RAL set used for the alternative.

CMA – Construction Management Area
CSL – cleanup screening level
ENR – enhanced natural recovery
Hg – mercury
MNR – monitored natural recovery
PCB – polychlorinated biphenyl
RAL – remedial action level

2.3 Suite of Alternatives for Screening

From the three open-water technology options, the six limited access area technology options, and the three RAL sets, 16 combinations were established in coordination with EPA to support the comparison of each of the varied components. These 16 site-wide remedial alternatives are listed below and depicted in Figures 2-1 through 2-16. RALs are the same in all alternatives except for total PCB, which vary as noted below.

- No Action
- 1A(12)
- 1B(12)
- 1C+(12)
- 2A(12)
- 2B(12)
- 2C(12)
- 2C+(12)
- 3B(12)
- 3C+(12)
- 3D(12)
- 2C+(7.5)
- 3C+(7.5)
- 3E(7.5)
- 2C+(5.0)
- 3D(5.0)
- 3E(5.0)

Alternatives Key:

Open-water

1 – Removal with capping and ENR where applicable

2 – Removal with capping where applicable

3 – Maximum removal

Limited Access Area

A – MNR

B – In situ treatment

C – Removal for PCBs or Hg > CSL; in situ treatment elsewhere exceeding RALs

C+ – Removal ***followed by in situ treatment*** for PCBs or Hg > CSL; in situ treatment elsewhere exceeding RALs

D – Diver-assisted hydraulic dredging

E – Diver-assisted hydraulic dredging followed by in situ treatment

RALs

(12) – 12 mg/kg OC for PCBs plus the RALs for other chemicals

(7.5) – 7.5 mg/kg OC for PCBs plus the RALs for other chemicals

(5.0) – 5.0 mg/kg OC for PCBs plus the RALs for other chemicals

3 COMPARISON OF ALTERNATIVES

This section presents the focused screening of alternatives based on the CERCLA criteria of effectiveness, implementability, and cost. When considered together, the criteria support the comparison of cost-effectiveness for the alternatives. The approach used for this focused screening is to employ the tools that have been developed for the FS (e.g., predictive models, and cost and construction duration estimating tools) as the key metrics that are most representative of screening criteria of effectiveness, implementability, and cost. Focusing on these key metrics supports understanding of the differences among the alternatives, how the components used in developing the alternatives influences each alternative, and selection of an appropriate range of technologies and cost-effective alternatives to be retained for the detailed analysis of alternatives (FS Sections 9 and 10). Effectiveness and implementability criteria described in this screening should not be confused with similar CERCLA criteria defined in detail in FS Sections 9 and 10; the criteria and metrics presented in this appendix are for the alternatives screening only. The following sections describe the metrics and the ratings used in the screening for effectiveness, implementability, and cost of each alternative.

3.1 Effectiveness Screening Metric

The effectiveness screening metric includes short-term effectiveness, long-term effectiveness, and reduction in toxicity due to treatment (EPA 1988). For this screening analysis, the alternatives were rated based on the predicted site-wide spatially-weighted average concentrations (SWACs) for total PCBs and associated estimated human health risks based on seafood consumption. This is a key metric for the effectiveness screening metric because total PCBs is one of the important risk drivers at the site, contributing most to site-wide risk for RAOs 1, 3, and 4 (human health seafood consumption, benthic toxicity, and ecological risk, respectively). In addition, total PCBs SWACs provide an indication of the risk reduction trends for other COCs that are generally co-located with PCBs and contribute less to risk (FS Section 9). The PCB SWAC calculation also takes into account reduction in bioavailability due to in situ treatment, and therefore addresses reduction in toxicity due to treatment per EPA guidance on evaluating effectiveness. Finally, SWAC calculations include the contribution of mixing of subsurface sediments, and therefore incorporates the effect of subsurface contamination into SWAC predictions into the assessment of effectiveness.

Other metrics that are used to evaluate short-term and long-term effectiveness in the detailed evaluation of alternatives are included in FS Sections 9 and 10 for each of the alternatives retained for detailed analysis.

The PCB SWACs should be interpreted with consideration for the overall accuracy of the analysis. FS Appendix J presents a sensitivity analysis to understand the effect of varying input values for each parameter; the predicted SWACs in that analysis vary by up to approximately +/-40%, depending on the parameter varied (e.g., see Figure 4b of FS Appendix J). Analytical variability also effects the range of certainty for both the pre-construction baseline conditions and the long-term measurement of alternative performance. Because of these modeling and analytical constraints, differences in SWACs of less than 5 to 10 micrograms per kilogram (μg/kg) should be interpreted with caution.

Also note that the differences in predicted risk are considerably less than the differences in SWAC because small variations in sediment concentrations do not directly translate into different risk outcomes and, in part, because of the levels of PCBs present in surface water that contribute to elevated risk (see FS Section 9.2.4 and SRI Section 6 [Windward and Anchor QEA 2014]).

To understand the effect of each of the three remedial alternative components (RALs, open-water technology option, and limited access area technology option) on predicted PCB SWACs, it is helpful to analyze these components in isolation, as performed in the following sections.

3.1.1 Effect of Varying RALs

The effect of the PCB RAL on the predicted site-wide SWACs can be shown by isolating alternatives that that use the same open-water technology option and same limited access area technology option but different PCB RAL. Figure 3-1 shows the predicted site-wide SWACs over time for Alternatives 2C+(12), 2C+(7.5), and 2C+(5.0) to demonstrate the effect of changing the RAL only. The predicted SWACs over time are almost identical for the alternatives, and the differences are not meaningful and are well within the uncertainty of the analysis. The predicted excess cancer risks over time are identical (Table 3-1). Based on this information, reducing the RAL below 12 milligrams per kilogram of organic carbon (mg/kg OC) results in additional remediation area without improving effectiveness of the remediation. A RAL lower than 12 mg/kg OC for PCBs does not improve effectiveness because the RAL of 12 mg/kg OC along with the other COC RALs already results in the remediation of the majority of the waterway. In addition, other factors have a larger influence on the SWAC than the RAL, such as the estimated post-construction surface sediment concentration, the concentrations of incoming sediment, and remediation option used in limited access areas.

3.1.2 Effect of Varying Open-water Technology Option

Similar to the RAL analysis above, the effect of the open-water technology option on the predicted site-wide SWACs can be shown by isolating alternatives that utilize the same limited access area technology option and PCB RAL, but have different open-water technology options. Figure 3-2 shows the predicted site-wide SWACs over time for Alternatives 1B(12), 2B(12), and 3B(12) to demonstrate the effect of changing the open-water technology option only (figure shown with the same y-axis range as Figure 3-1 for comparison). The curves are almost identical for the alternatives, and the differences are not meaningful and are well within the uncertainty of the analysis. The predicted excess cancer risks over time are identical (Table 3-1). Varying the open-water technology group did not have a large effect on the site-wide SWACs for the remedial alternatives because the range of technology options in the open-water areas of the EW is limited by site use considerations. Dredging is the primary remedial technology used in all technology options because other remedial technologies are limited by navigational depth requirements and propwash forces in the EW. Within this narrow range of technology options, increasing of the amount of removal in the open-water area results in a narrow range of SWAC outcomes and no change in health risks, and thus does not change effectiveness screening metric outcomes.

3.1.3 Effect of Varying Limited Access Area Technology Option

The component that explains most of the variation between the alternatives is the limited access area technology option. Figure 3-3 shows the predicted SWAC over time for one alternative with each of the six limited access area technology options (figure shown with the same y-axis range as Figures 3-1 and 3-2 to facilitate comparison). These options generally fall into three groups based on predicted SWAC. Limited Access Area Technology Options A and D have higher year 0 post-construction SWACs. Limited Access Area Technology Option D is predicted to show improvement over time, whereas Limited Access Area Technology Option A is predicted to show improvement over time but to sustain higher concentrations overall. Alternatives with Limited Access Area Technology Options B and C+ track similarly over time, and Limited Access Area Technology Option C begins with year 0 concentrations somewhat higher than Options B and C+ but then tracks similarly to each of them over time. Limited Access Area Technology Option E has a lower predicted SWAC than the other technology options. However, if model and analytical uncertainties are considered, Options B, C, C+, D, and E have similar outcomes after year 5 post-construction.

3.1.4 Cumulative Effect on Effectiveness Screening Metric

The cumulative effect of the three components for all alternatives (i.e., open-water technology option, limited access technology option, and RAL) is presented in Table 3-1. For all alternatives, the table presents the PCB SWACs predicted by the box model (FS Section 5 and Appendix J) and associated excess cancer risks for Adult Tribal reasonable maximum exposure scenarios for seafood consumption (RAO 1). The results are presented for the average of 0 to 40 years following construction.

Table 3-1
Effectiveness – Box Model Results for Total PCBs

Alternative	Average for 0 to 40 years Following Construction		
	SWAC for Total PCBs (µg/kg Considering Bioavailability)[a,b]	Adult RME Excess Cancer Risk from PCBs (Considering Bioavailability)	Rating
No action	300	6×10^{-4}	Poor
1A(12)	99	3×10^{-4}	Fair
1B(12)	62	2×10^{-4}	Good
1C+(12)	58	2×10^{-4}	Good
2A(12)	99	3×10^{-4}	Fair
2B(12)	62	2×10^{-4}	Good
2C(12)	61	2×10^{-4}	Good
2C+(12)	58	2×10^{-4}	Good
3B(12)	62	2×10^{-4}	Good
3C+(12)	58	2×10^{-4}	Good
3D(12)	62	2×10^{-4}	Good
2C+(7.5)	56	2×10^{-4}	Good
3C+(7.5)	56	2×10^{-4}	Good
3E(7.5)	52	2×10^{-4}	Good
2C+(5)	56	2×10^{-4}	Good
3D(5)	61	2×10^{-4}	Good
3E(5)	51	2×10^{-4}	Good

Notes:
a. SWACs are rounded to 2 significant digits. The PCB SWACs should be interpreted with consideration for the overall accuracy of the analysis. FS Appendix J presents a sensitivity analysis to understand the effect of varying input values for each parameter; the predicted SWACs in that analysis vary by up to approximately +/-40%, depending on the parameter varied. See Section 3-1 of this appendix.
b. Alternatives that use in situ treatment were estimated to result in a 70% reduction in bioavailability in those areas (see FS Section 7.2.7.1.1). The calculated SWACs include a reduction in concentration due to in situ treatment, when used.

µg/kg – micrograms per kilogram
FS – Feasibility Study
PCB – polychlorinated biphenyl
RME – reasonable maximum exposure
SWAC – spatially-weighted average concentration

The results in Table 3-1 summarize the factors discussed in Sections 3.1.1 through 3.1.3 herein. For the purpose of this screening, the average PCB SWAC in the years 0 to 40 following construction has been selected as the key metric for evaluating effectiveness because it summarizes the complex box model results into a single value. In addition, human health risks are based on exposures over long durations, and therefore an average SWAC over a longer timeframe is a single way of bringing in several factors affecting effectiveness into a single metric.

The alternatives have been rated by the effectiveness screening metric based on a three-tiered scale: poor, fair, and good. The alternatives have been rated based on the predicted Adult Tribal reasonable maximum exposure (RME) excess cancer risk (considering bioavailability) associated with the 40-year average SWACs. The "poor" rating was assigned to the No Action Alternative, with Adult Tribal RME excess cancer risk of 6×10^{-4} (average PCBs SWAC of 300 µg/kg). The "fair" rating was assigned to Alternatives 1A(12) and 2A(12), with Adult Tribal RME excess cancer risk of 3×10^{-4} (average PCBs SWAC of 99 µg/kg). A "good" rating was assigned to the remaining alternatives with Adult Tribal RME excess cancer risk of 2×10^{-4} (average PCBs SWAC of 51 to 62 µg/kg).

3.2 Implementability Screening Metric

Generally, all of the alternatives are both technically and administratively feasible to implement. The alternatives screened in this appendix all rely primarily on removal and will have feasibility challenges associated with: 1) dredging large quantities of sediment in an active container terminal area; 2) permitting and constructing transloading operations over the course of up to 14 construction seasons; and 3) transporting and disposing of large quantities of sediment in a landfill. In this evaluation, the construction timeframe is used as one indicator for the degree of implementation challenges expected for each alternative in open-water areas, because the technical and administrative challenges are expected to scale with the number of construction seasons mobilized. Landfills with sufficient capacity for dredged material are located in Eastern Washington and Eastern Oregon.

In addition, limited access area remediation has additional technical challenges beyond those in the open-water. In particular, the implementation of underpier diver-assisted hydraulic dredging will be challenging to implement due to dredging below active shipping terminals, uncertainty in removing sediment from riprap surfaces, diver safety, and barge dewatering and treatment of the sediment slurry. In addition, the outcome of diver-assisted dredging is highly uncertain for this work. For this screening evaluation, the construction timeframe for diver-assisted hydraulic dredging is used as another indicator for the degree of implementability challenges during remediation. Additional criteria are used to evaluate implementability under the CERCLA criteria evaluation in the analysis and comparison of alternatives in FS Sections 9 and 10; this appendix evaluates implementability for the alternative screening only.

Table 3-2 presents the implementability rating of the alternatives. Implementability considered both the total construction timeframe and the underpier diver-assisted hydraulic dredging timeframes for the alternatives; however, diver-assisted hydraulic dredging was the key differentiating factor due to having greater implementability challenges than remediation in open water areas. The No Action Alternative is rated "excellent" for implementability because no construction is performed. Alternatives that have construction durations of 10 years or less and no duration of underpier hydraulic dredging (Alternatives 1A(12), 1B(12), 2A(12), and 2B(12)) are rated "good" because they will be easier to implement than the other alternatives. Alternatives with 12 years or less of construction but only estimated to have 2 years of diver-assisted hydraulic dredging (Alternatives 1C+(12), 2C(12), 2C+(12), 3C+(12), 2C+(7.5), 3C+(7.5), and 2C+(5.0)) are rated "fair" because they require the mobilization of extensive underpier hydraulic dredging, but do not require divers to work the EW for a decade. The alternatives that require more than 10 years of diver-assisted hydraulic dredging (Alternatives 3D(12), 3E(7.5), 3D(5), and 3E(5.0)) score "poor" because of the dangerous and challenging nature of the work and the high uncertainty in the overall effectiveness of diver-assisted dredging, relative to other limited access area technologies.

Table 3-2
Implementability Screening Metric

Alternative	Construction Timeframe (years)	Underpier Dredging Timeframe (years)	Rating for Implementability
No Action	0	0	Excellent
1A(12)	9	0	Good
1B(12)	9	0	Good
1C+(12)	9	2	Fair
2A(12)	10	0	Good
2B(12)	10	0	Good
2C(12)	10	2	Fair
2C+(12)	10	2	Fair
3B(12)	10	0	Good
3C+(12)	10	2	Fair
3D(12)	13	11	Poor
2C+(7.5)	11	2	Fair
3C+(7.5)	11	2	Fair
3E(7.5)	13	12	Poor
2C+(5)	12	2	Fair
3D(5)	14	12	Poor
3E(5)	14	12	Poor

3.3 Cost Screening Metric

Alternative costs were estimated by using the cost estimate in FS Appendix E. Costs are presented in Table 3-3 and include construction costs (e.g., mobilization and dredge material disposal), non-construction costs (e.g., oversight and permitting), long-term monitoring, tax, and contingency. The costs are broken up into cost ranges for the purpose of assigning alternative rankings.

The No Action Alternative is rated "excellent" because it includes monitoring costs only. Alternatives with costs between $250 and $285 million (Alternatives 1A(12), 1B(12), 1C+(12), 2A(12), and 2B(12)) were rated "good" because they have mid to low costs compared to the other alternatives. Alternatives with costs between $290 and $350 million (Alternatives 2C(12), 2C+(12), 3B(12), 3C+(12), 2C+(7.5), 3C+(7.5), and 2C+(5.0)) were rated "fair" because they have mid to high costs compared to the other alternatives. Finally, alternatives with costs between $370 and $440 million (Alternatives 3D(12), 3E(7.5), 3D(5.0), and 3E(5.0)) were rated "poor" because they are more expensive that the other alternatives.

Table 3-3
Cost

Alternative	Cost ($ Million)	Rating
No Action	$0.95	Excellent
1A(12)	$256	Good
1B(12)	$264	Good
1C+(12)	$277	Good
2A(12)	$276	Good
2B(12)	$284	Good
2C(12)	$296	Fair
2C+(12)	$297	Fair
3B(12)	$298	Fair
3C+(12)	$310	Fair
3D(12)	$377	Poor
2C+(7.5)	$326	Fair
3C+(7.5)	$333	Fair
3E(7.5)	$411	Poor
2C+(5.0)	$345	Fair
3D(5.0)	$426	Poor
3E(5.0)	$435	Poor

4 SCREENING OF ALTERNATIVES

Table 4-1 summarizes the results of the alternative ratings for the screening metrics for effectiveness, implementability, and cost, and presents the screening decision and rationale for each alternative. Nine alternatives have been retained (including No Action) for detailed analysis, and seven alternatives have been eliminated.

Table 4-1 provides a summary of the category ratings for the alternatives that went into the screening decision. For some of the alternatives, a finer-scaled cost-benefit analysis is helpful to better demonstrate the differences between the alternatives; Figure 4-1 presents a scatter plot of the alternatives (excluding the No Action Alternative) with the predicted PCBs SWACs (averaged over years 0 through 40 post-construction), plotted against cost. The dashed line indicates the boundary representing the lowest SWAC at any given cost. Generally, alternatives that are closer to the knee of the dashed line have been retained for the analysis because they are likely to be more effective per unit cost. The alternatives that are further from knee of the line are more likely to be screened out because they are less effective per unit cost. However, the reader should note that the graph does not present implementability or predicted risk outcomes, which are also considered in the screening decision.

The alternatives retained for detailed analysis were generally selected to provide a wide spread of the screening metrics for implementability and cost, while emphasizing alternatives with more favorable effectiveness ratings. The purpose of this analysis is not to select a preferred alternative, but rather to identify a representative and manageable range of alternatives for detailed analysis in FS Section 9, and comparison in FS Section 10.

Alternative 1A(12) was retained for detailed analysis as the least costly alternative.
Alternative 3E(7.5) was retained to represent the maximum removal alternative.
Alternative 3E(5.0) was screened out because the additional cost over 3E(7.5) did not result in an improved effectiveness screening metric. As discussed in Section 3.1.1, modeling results showed that lowering the PCBs RAL to 5.0 mg/kg OC does not lower the predicted SWACs and associated risks, yet these alternatives result in increased implementability challenges and costs.

Table 4-1
Summary of Alternative Screening Metrics Ratings and Final Screening Results

Alternative	Effectiveness	Implementability	Cost	Screening	Rationale
No Action	Poor	Excellent	Excellent	**Retained**	Retained as a National Contingency Plan requirement
1A(12)	Fair	Good	Good	**Retained**	Retained as the least costly alternative (excluding No Action) in the suite of alternatives
1B(12)	Good	Good	Good	**Retained**	Retained due to relatively high cost-effectiveness
1C+(12)	Good	Fair	Good	**Retained**	Retained due to relatively high cost-effectiveness
2A(12)	Fair	Good	Good	Eliminated	Eliminated due to similar effectiveness and implementability as less costly Alternative 1A(12)
2B(12)	Good	Good	Good	**Retained**	Retained due to relatively high cost-effectiveness
2C(12)	Good	Fair	Fair	Eliminated	Eliminated due to reduced cost-effectiveness compared to Alternative 2C+(12) (Figure 4-1)
2C+(12)	Good	Fair	Fair	**Retained**	Retained due to fair cost-effectiveness
3B(12)	Good	Good	Fair	**Retained**	Retained due to fair cost-effectiveness and good implementability ranking
3C+(12)	Good	Fair	Fair	**Retained**	Retained due to fair cost-effectiveness
3D(12)	Good	Poor	Poor	Eliminated	Eliminated due to poor implementability and cost
2C+(7.5)	Good	Fair	Fair	**Eliminated**	Eliminated based on similar effectiveness as less costly alternatives; however, the alternative is retained per EPA directive because it is identical to Alternative 2C+(12) in the detailed analysis except with a lower RAL (7.5)
3C+(7.5)	Good	Fair	Fair	Eliminated	Eliminated due to similar effectiveness and implementability compared to less costly Alternative 3C+(12)
3E(7.5)	Good	Poor	Poor	**Retained**	Retained as the costliest alternative in the suite of alternatives to provide an end-case; also retained to maintain a representative limited access area option (Option E in the detailed evaluation of alternatives)
2C+(5.0)	Good	Fair	Fair	Eliminated	Eliminated due to similar effectiveness compared to less costly Alternative 2C+(12)
3D(5.0)	Good	Poor	Poor	Eliminated	Eliminated due to lower effectiveness compared to less costly Alternative 3E (7.5) and poor implementability and cost
3E(5.0)	Good	Poor	Poor	Eliminated	Eliminated due to similar effectiveness compared to less costly Alternative 3E(7.5)

Notes:
EPA – U.S. Environmental Protection Agency
RAL – remedial action level

Limited Access Area Technology Groups C and D employ diver-assisted hydraulic dredging without being followed by in situ treatment. Alternatives with these limited access area technology groups were all screened out because they result in limited reductions in SWAC (and resulting health risks) due to residual sediment remaining following hydraulic dredging but have large costs and implementability challenges and safety risks associated with diver-assisted dredging. Instead, Limited Access Area Technology Groups C+ and E, which employ some diver-assisted hydraulic dredging followed by in situ treatment, were retained for some alternatives.

Other alternatives were screened out based on their relative effectiveness, implementability, and cost screening metrics. Alternative 2A(12) was costlier than 1A(12), without providing additional effectiveness rating or improved implementability rating. Alternatives 2C+(7.5), 3C+(7.5), and 2C+(5.0) did not have higher effectiveness of implementability ratings when compared to less costly Alternatives 2B(12), 1C+(12), and 2C+(12).

The remaining suite of alternatives are Alternatives 1A(12), 1B(12), 1C+(12), 2B(12), 2C+(12), 3B(12), 3C+(12), 3E(7.5), and the No Action Alternative.

5 REFERENCES

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Windward and Anchor QEA, 2014. Supplemental Remedial Investigation. East Waterway Operable Unit Supplemental Remedial Investigation/Feasibility Study. Final. January 2014.

FIGURES

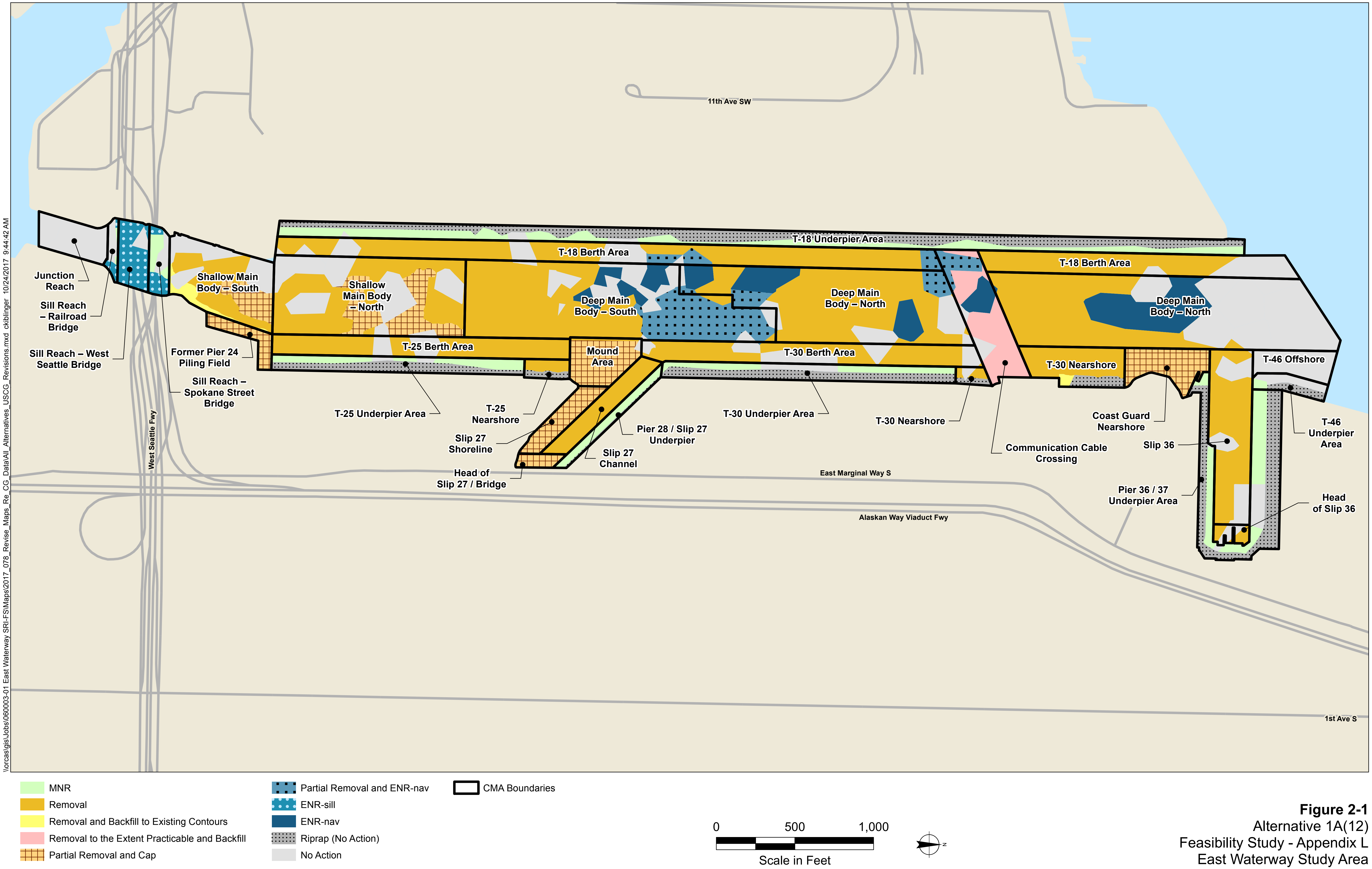

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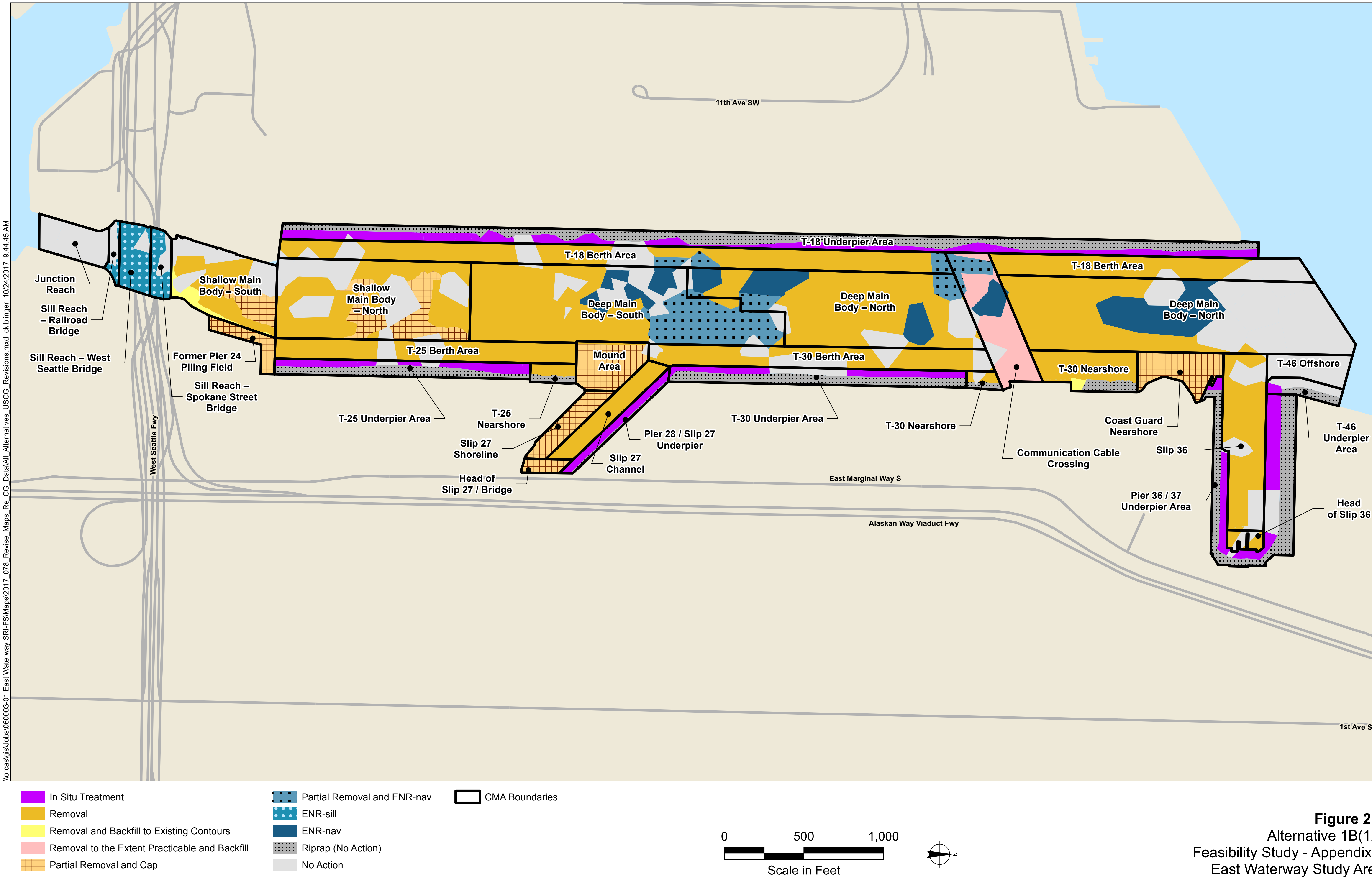
Figure 2-1
Alternative 1A(12)
Feasibility Study - Appendix L
East Waterway Study Area



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Alternative 1B(12)
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East Waterway Study Area

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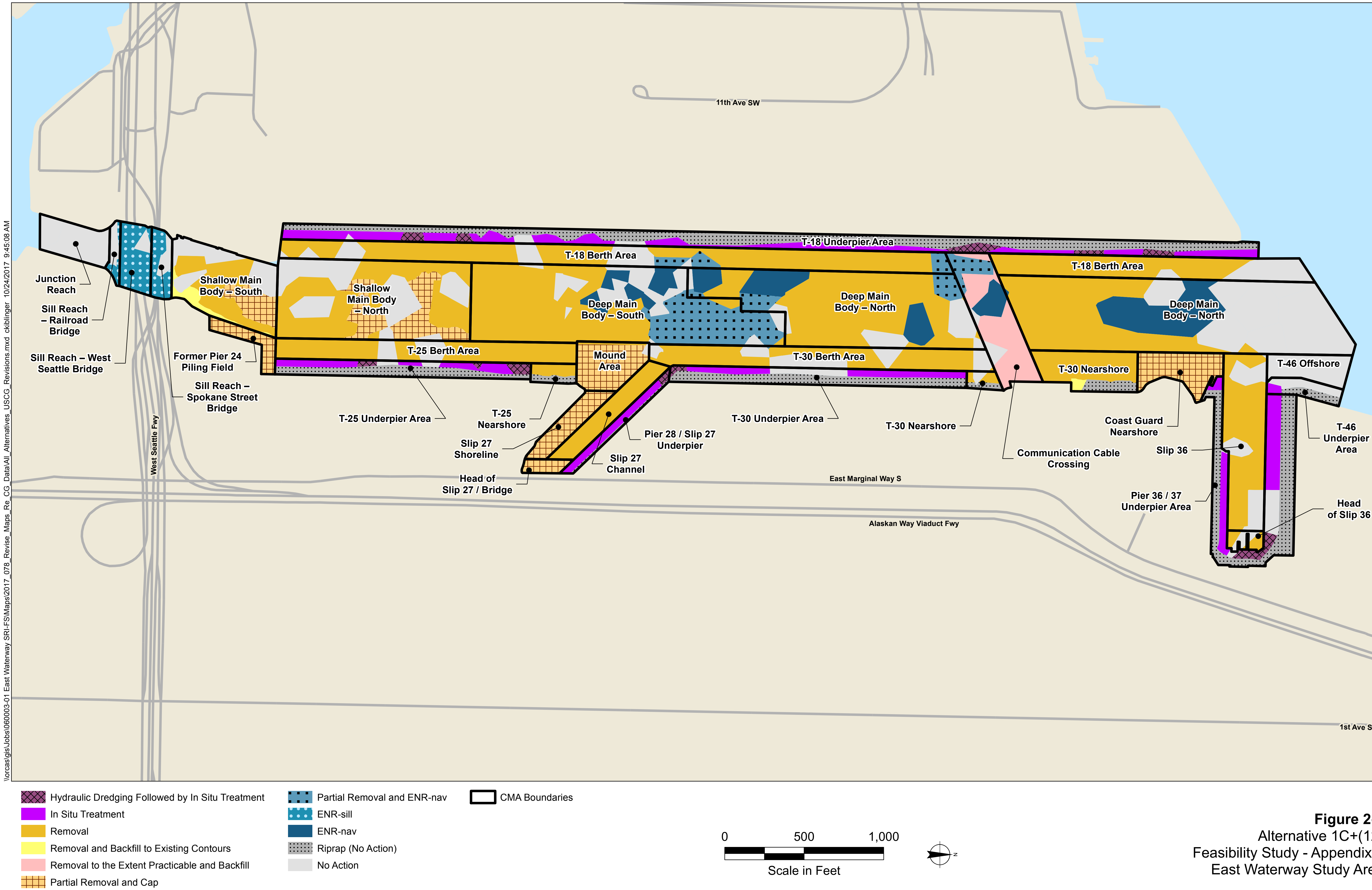

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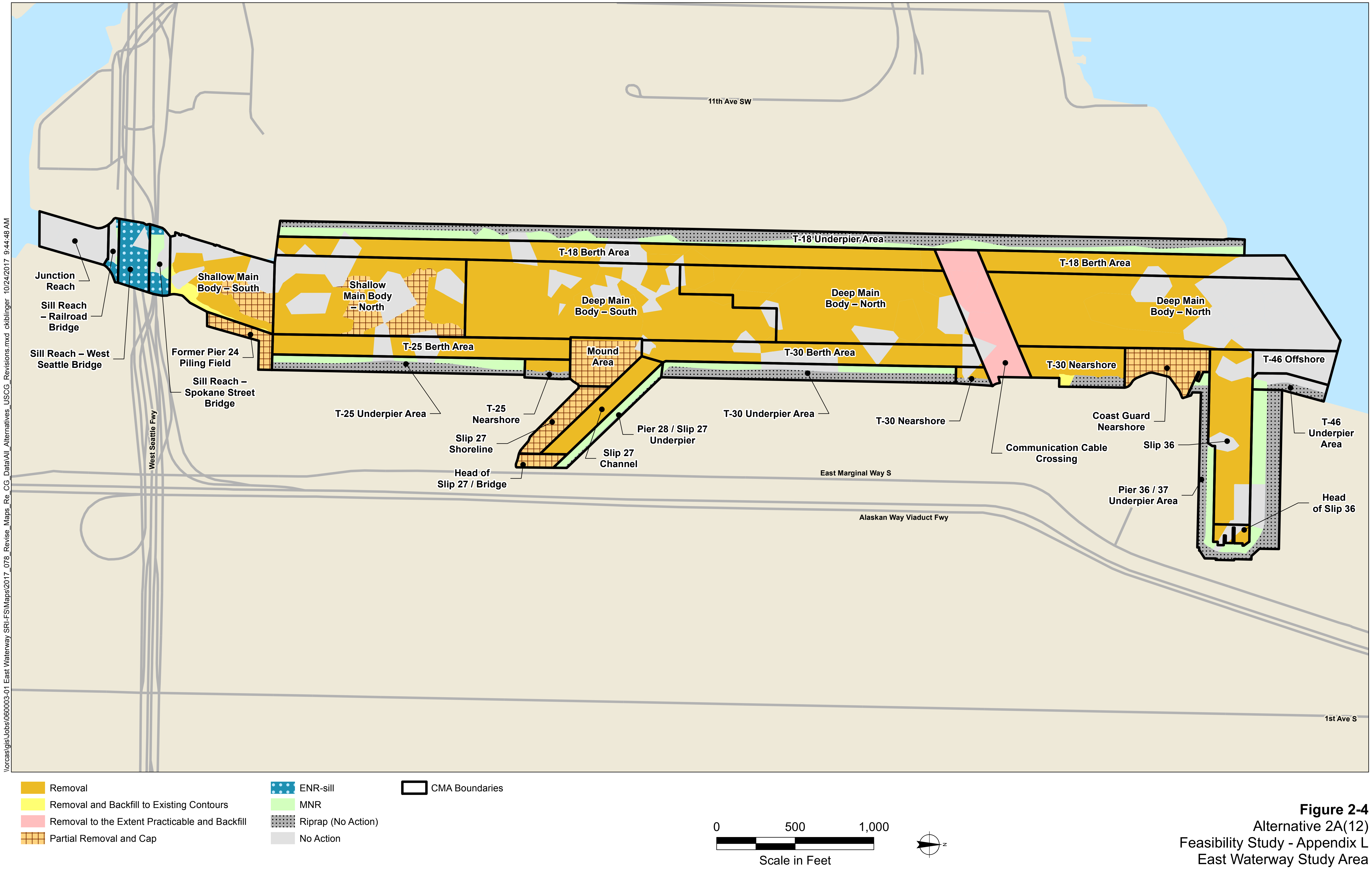
Alternative 1C+(12)
Feasibility Study - Appendix L
East Waterway Study Area



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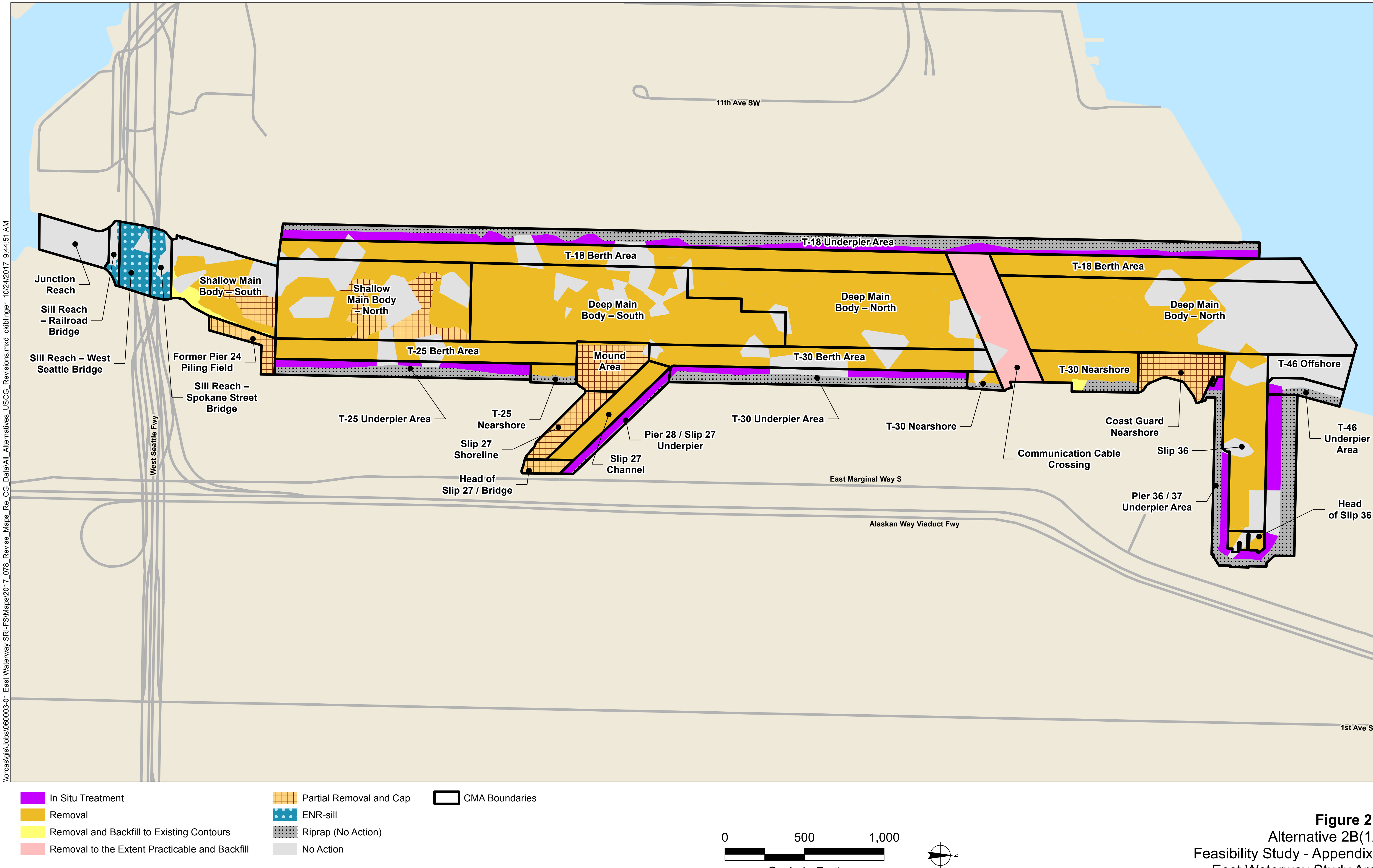

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Alternative 2B(12)
Feasibility Study - Appendix L
East Waterway Study Area

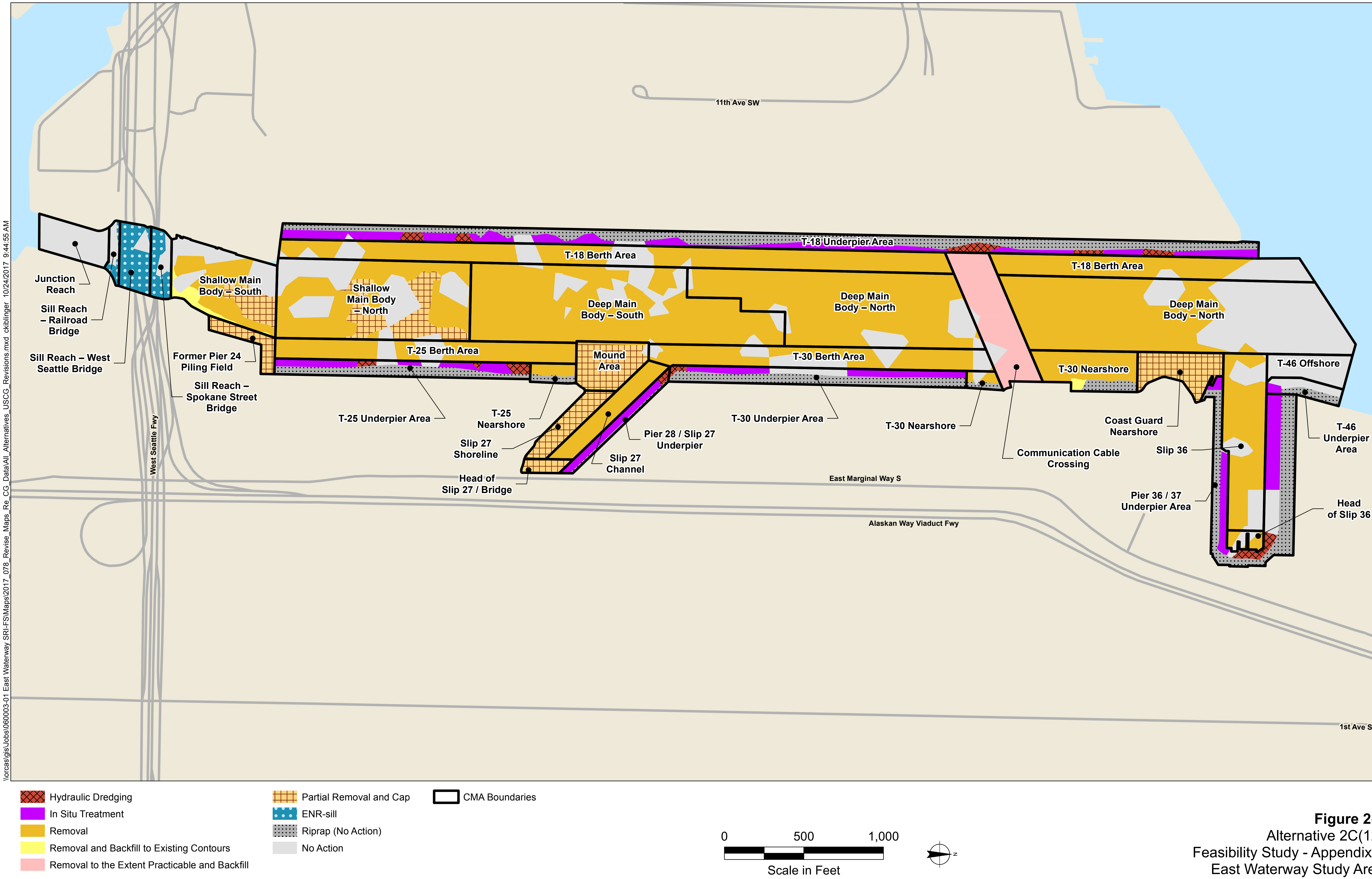

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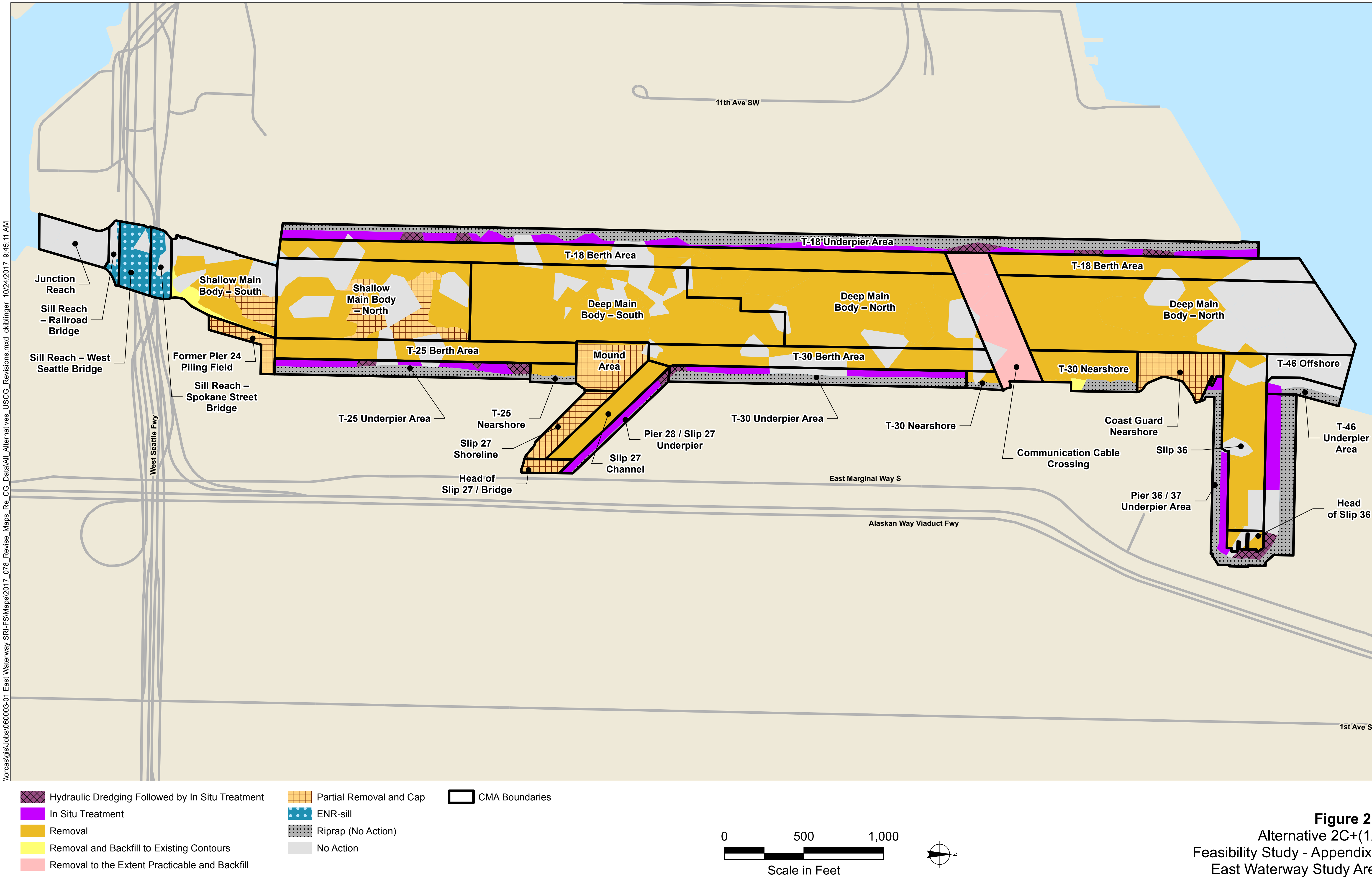
Figure 2-6
Alternative 2C(12)
Feasibility Study - Appendix L
East Waterway Study Area



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Alternative 2C+(12)
Feasibility Study - Appendix L
East Waterway Study Area

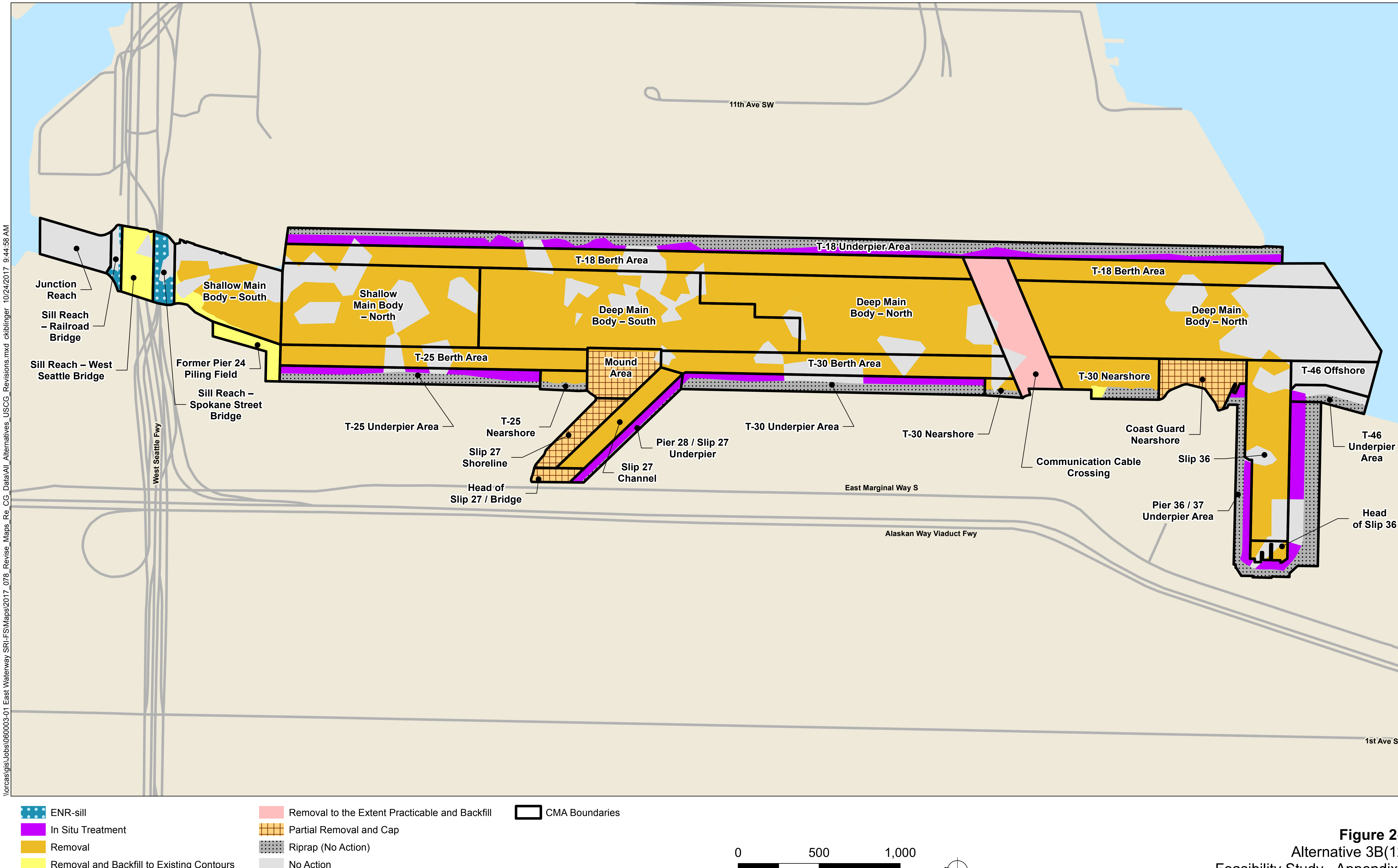
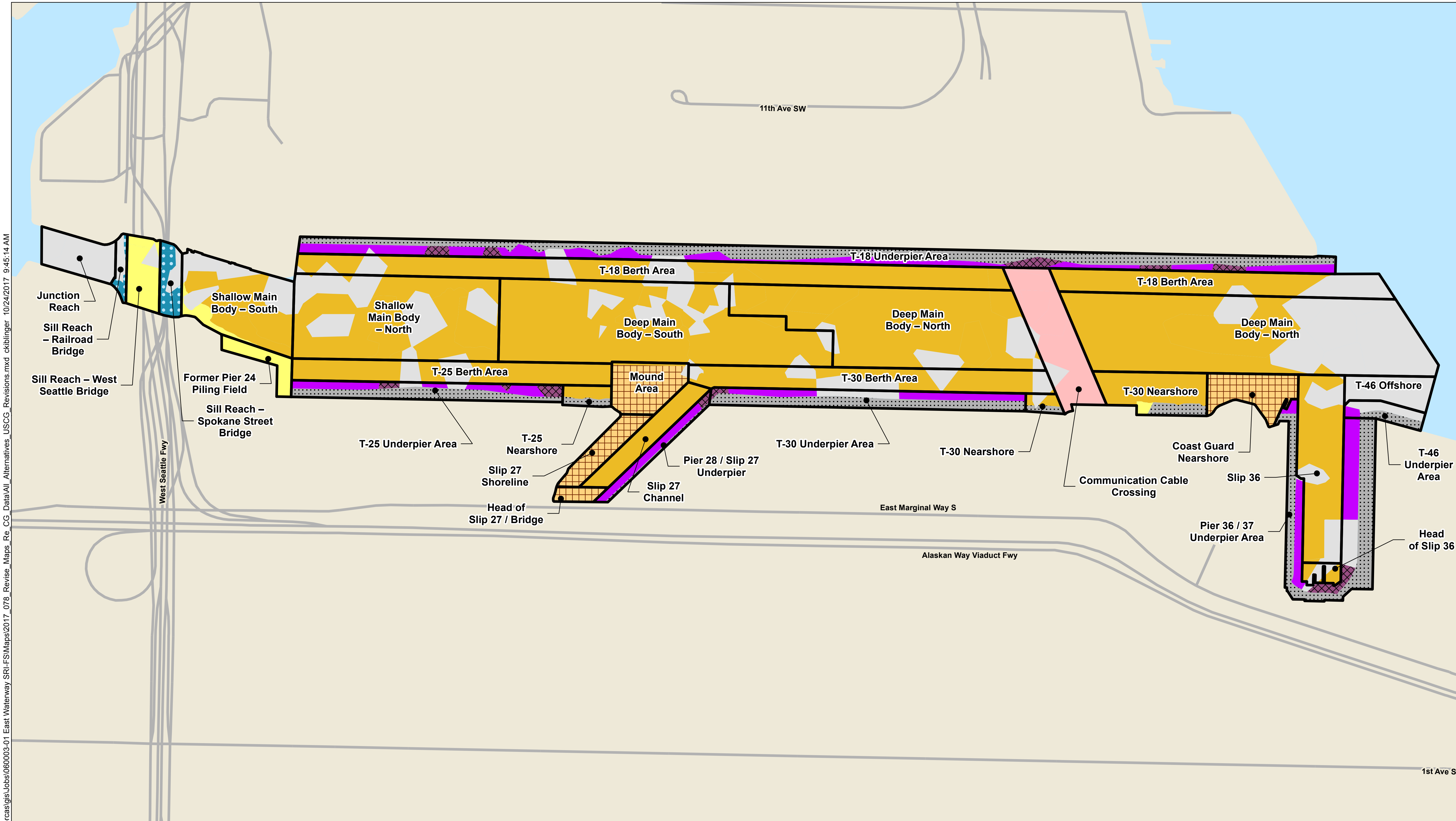


Figure 2-8
Alternative 3B(12)
Feasibility Study - Appendix L
East Waterway Study Area



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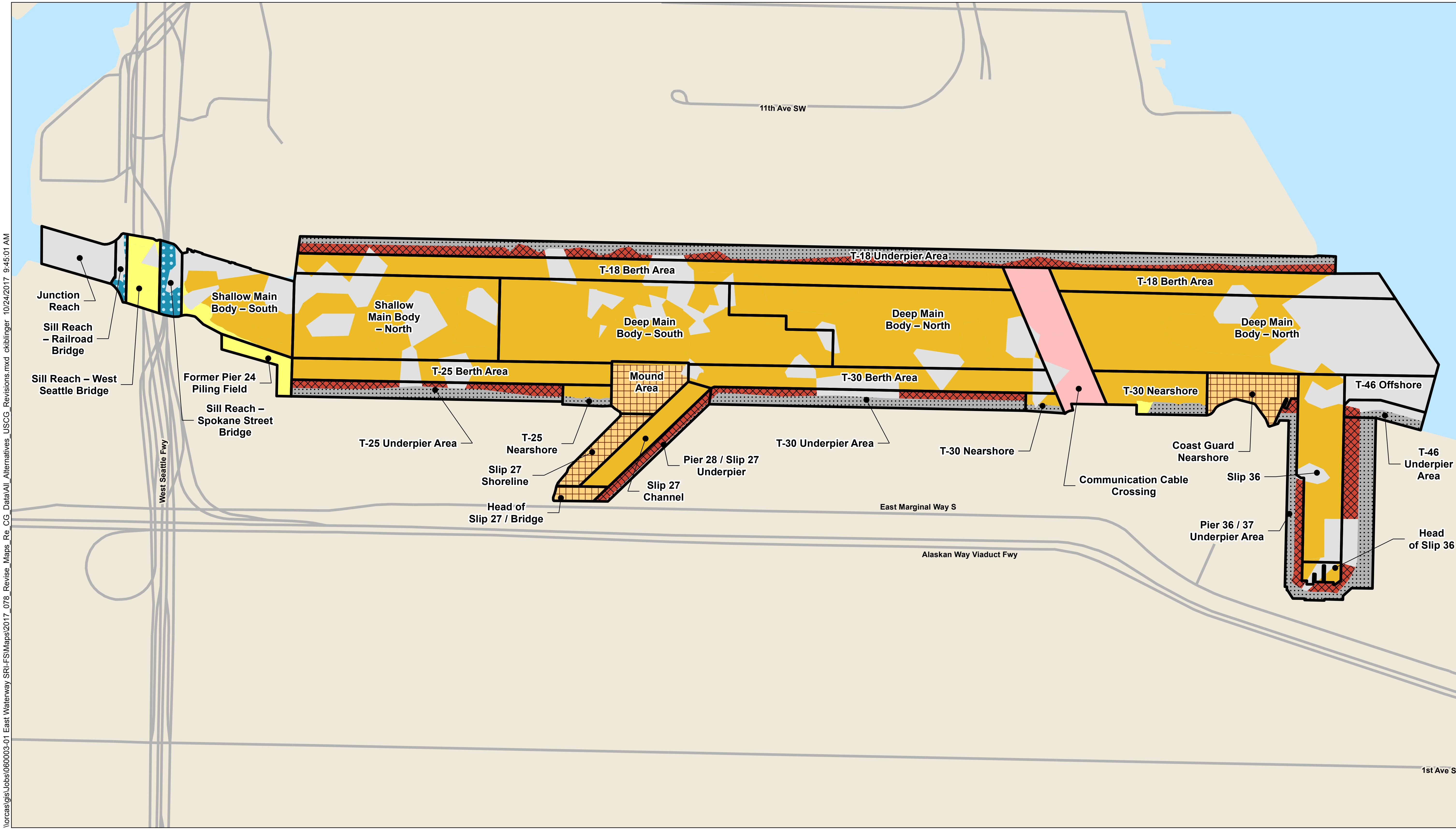
- Hydraulic Dredging Followed by In Situ Treatment
- ENR-sill
- In Situ Treatment
- Removal
- Removal and Backfill to Existing Contours
- Removal to the Extent Practicable and Backfill
- Partial Removal and Cap
- Riprap (No Action)
- No Action
- CMA Boundaries

0 500 1,000
Scale in Feet

Figure 2-9
Alternative 3C+(12)
Feasibility Study - Appendix L
East Waterway Study Area



Hydraulic Dredging
Removal
Removal and Backfill to Existing Contours
Removal to the Extent Practicable and Backfill
Partial Removal and Cap
ENR-sill
Riprap (No Action)
No Action
CMA Boundaries

0 500 1,000
Scale in Feet

Figure 2-10
Alternative 3D(12)
Feasibility Study - Appendix L
East Waterway Study Area

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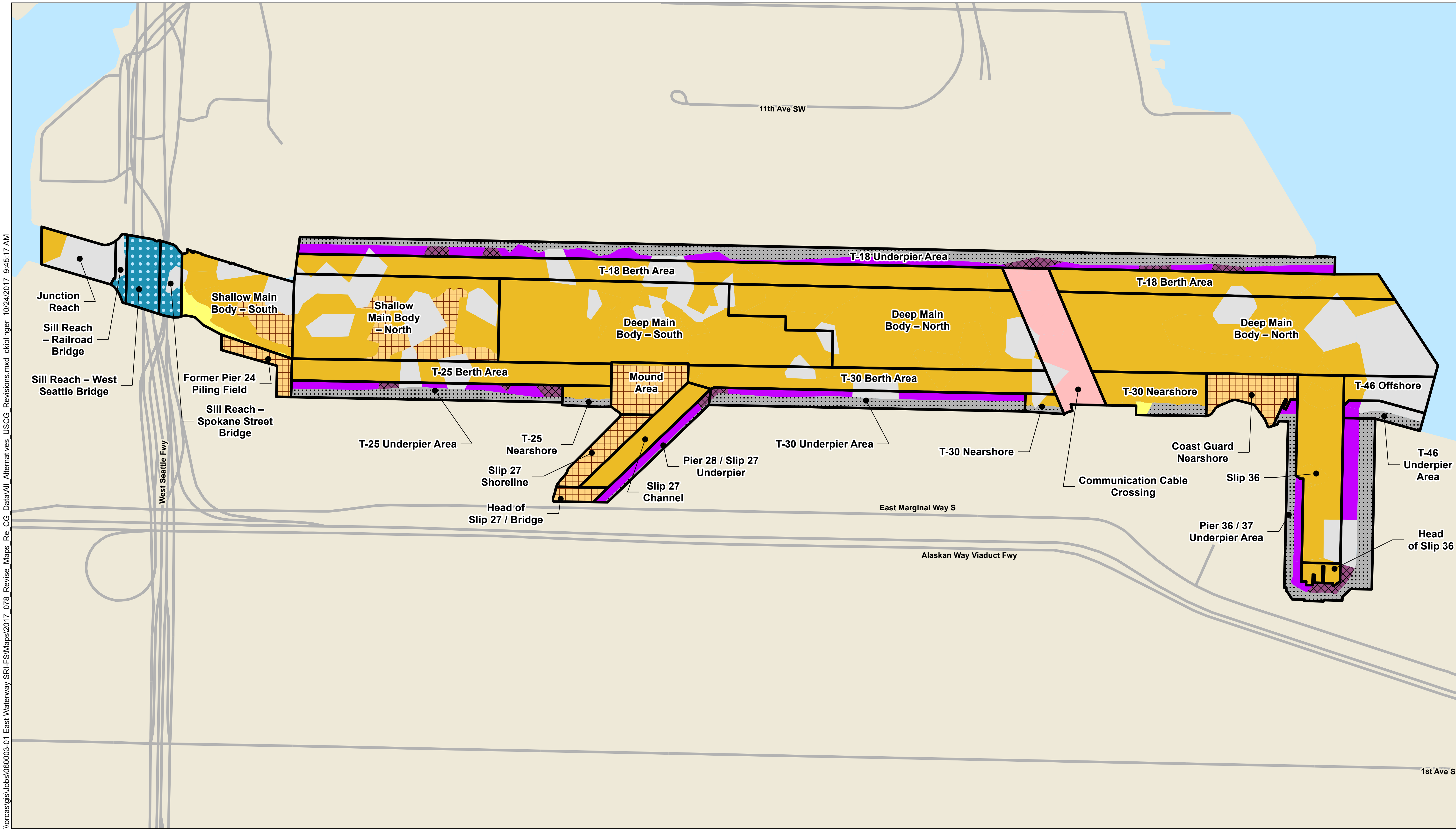


Figure 2-11
Alternative 2C+(7.5)
Feasibility Study - Appendix L
East Waterway Study Area

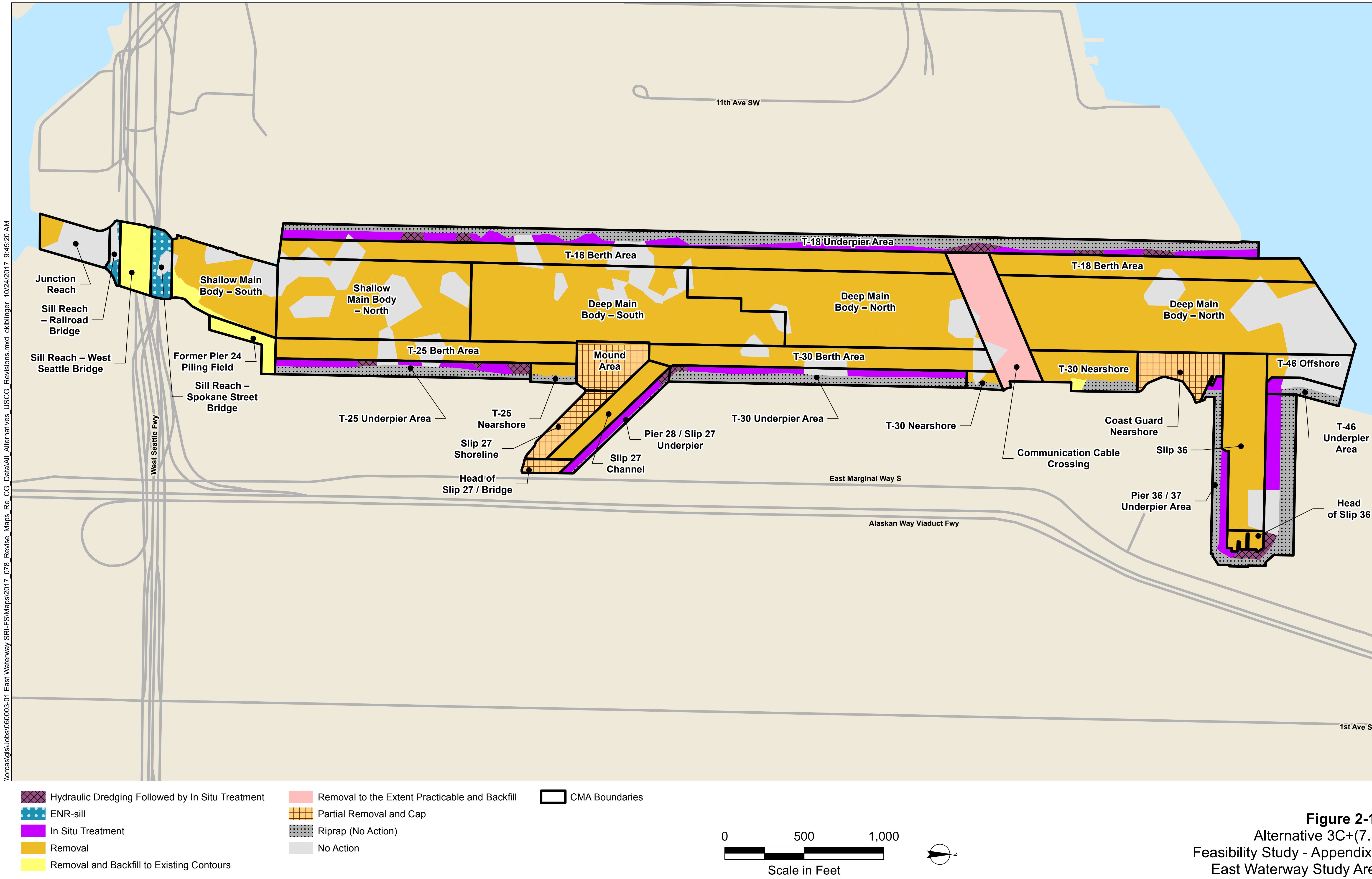


Figure 2-12
Alternative 3C+(7.5)
Feasibility Study - Appendix L
East Waterway Study Area

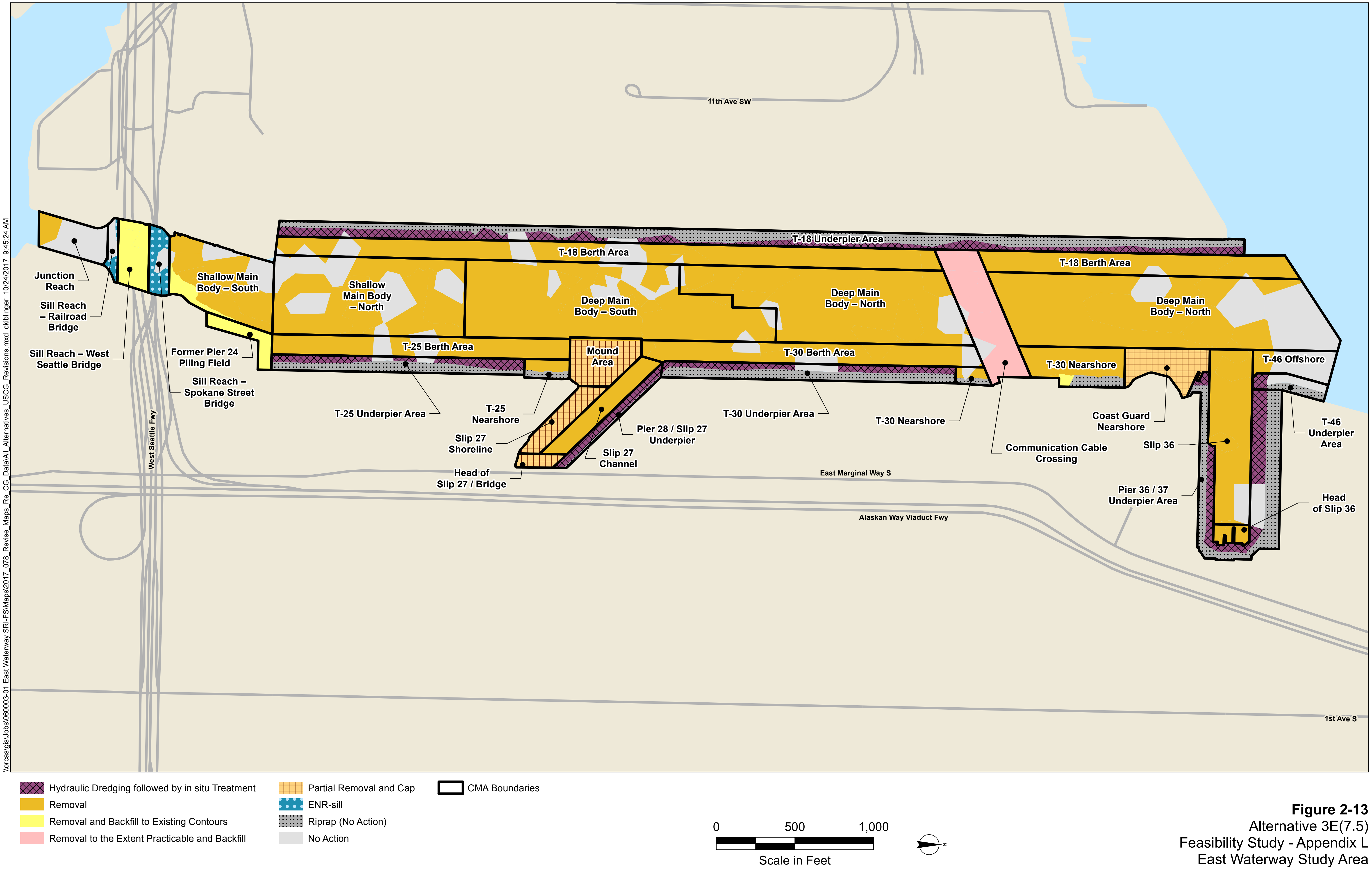
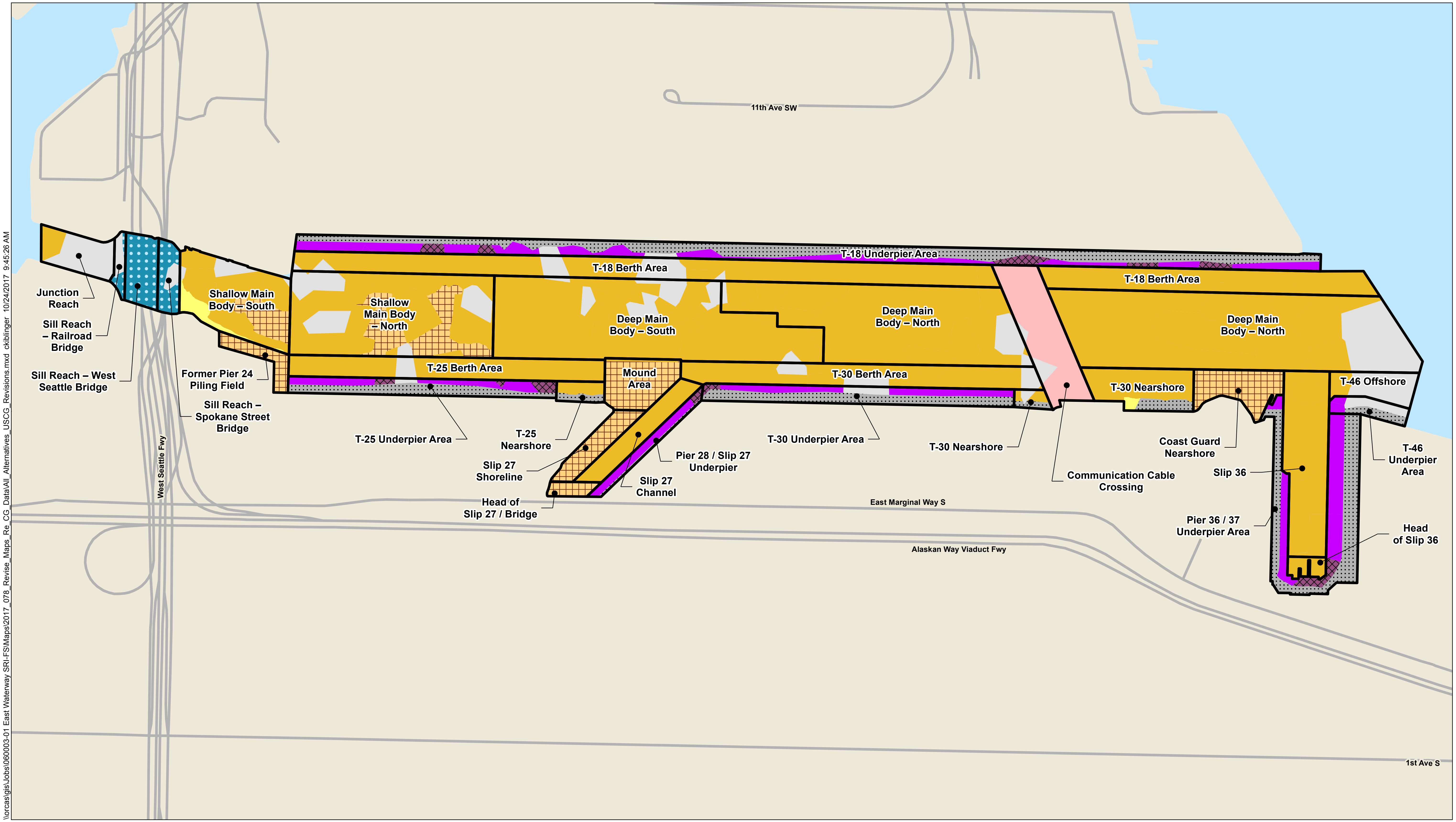


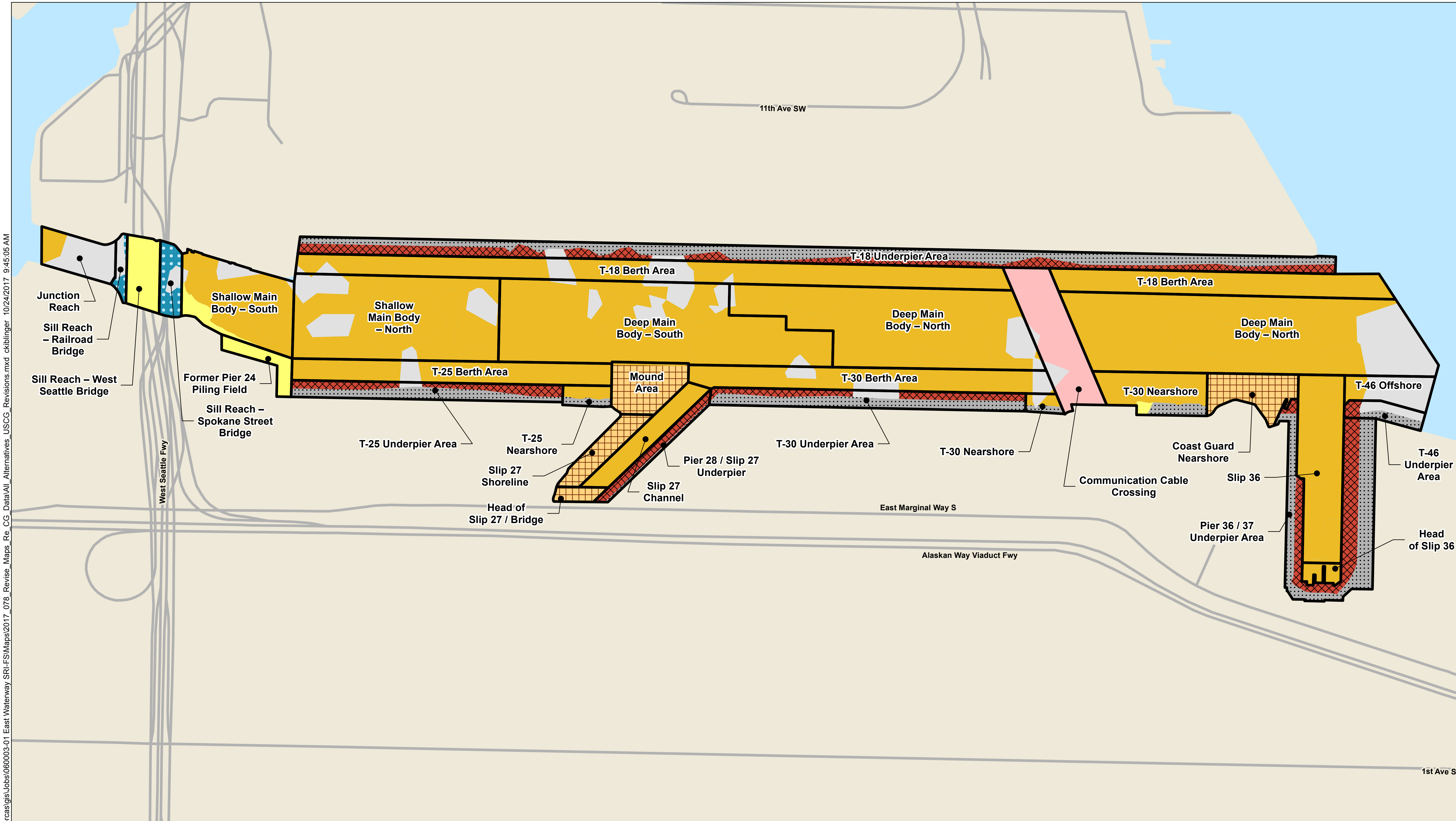
Figure 2-13
Alternative 3E(7.5)
Feasibility Study - Appendix L
East Waterway Study Area



Hydraulic Dredging Followed by In Situ Treatment
In Situ Treatment
Removal
Removal and Backfill to Existing Contours
Removal to the Extent Practicable and Backfill
Partial Removal and Cap
ENR-sill
Riprap (No Action)
No Action
CMA Boundaries

0 500 1,000
Scale in Feet

Figure 2-14
Alternative 2C+(5.0)
Feasibility Study - Appendix L
East Waterway Study Area



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- Hydraulic Dredging
- Removal
- Removal and Backfill to Existing Contours
- Removal to the Extent Practicable and Backfill
- Partial Removal and Cap
- ENR-sill
- Riprap (No Action)
- No Action
- CMA Boundaries

0 500 1,000
Scale in Feet

Figure 2-15
Alternative 3D(5.0)
Feasibility Study - Appendix L
East Waterway Study Area

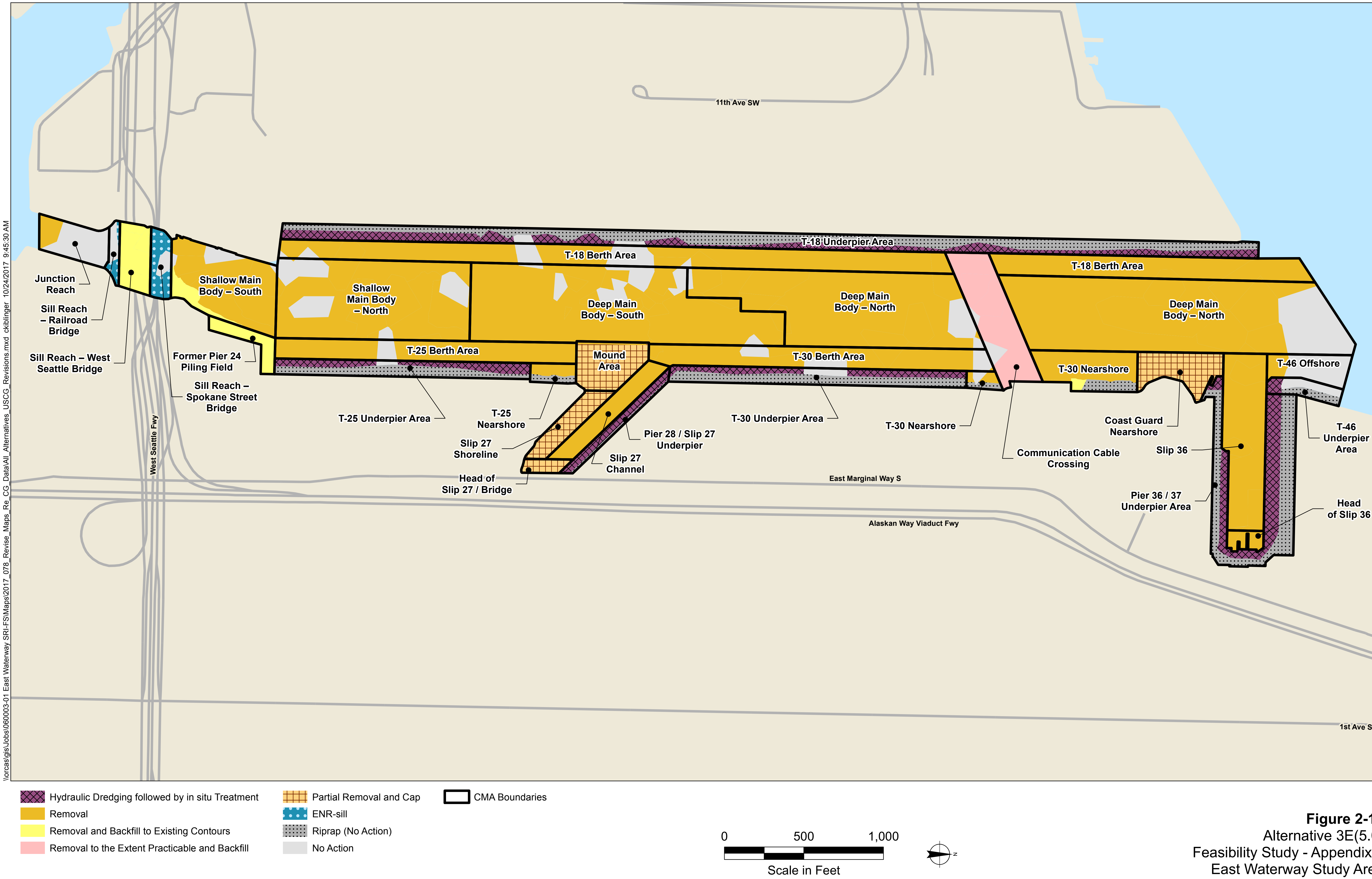
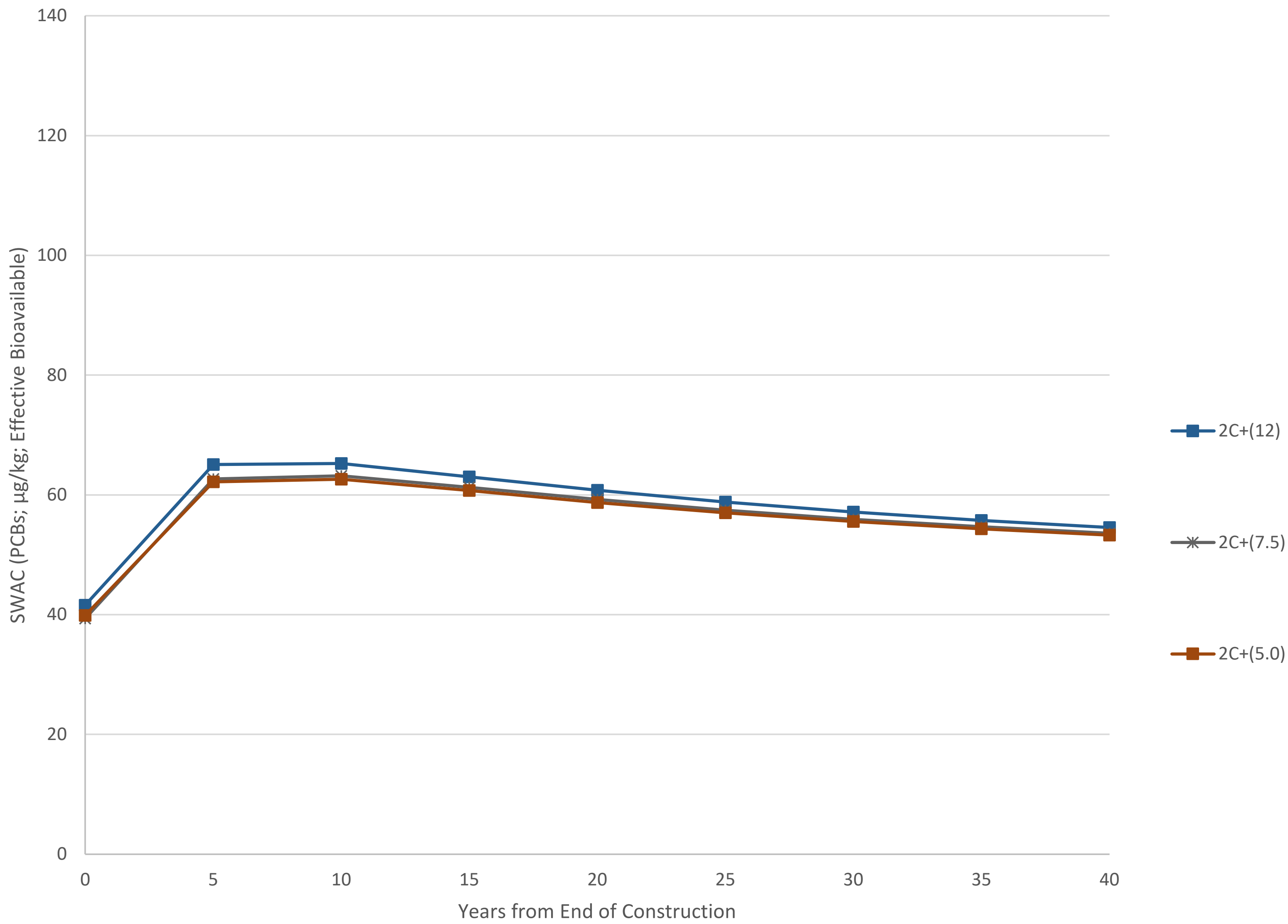
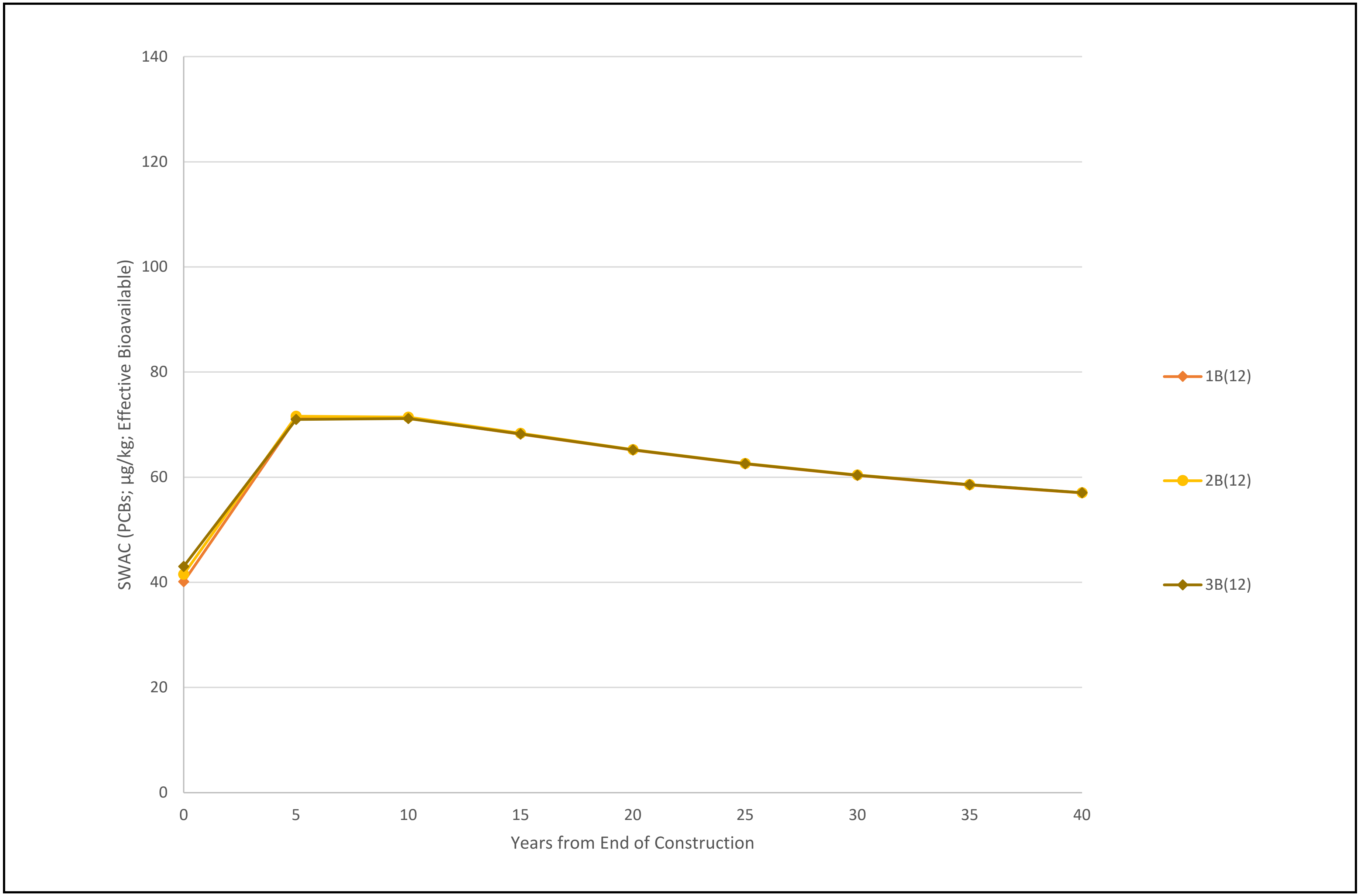


Figure 2-16
Alternative 3E(5.0)
Feasibility Study - Appendix L
East Waterway Study Area



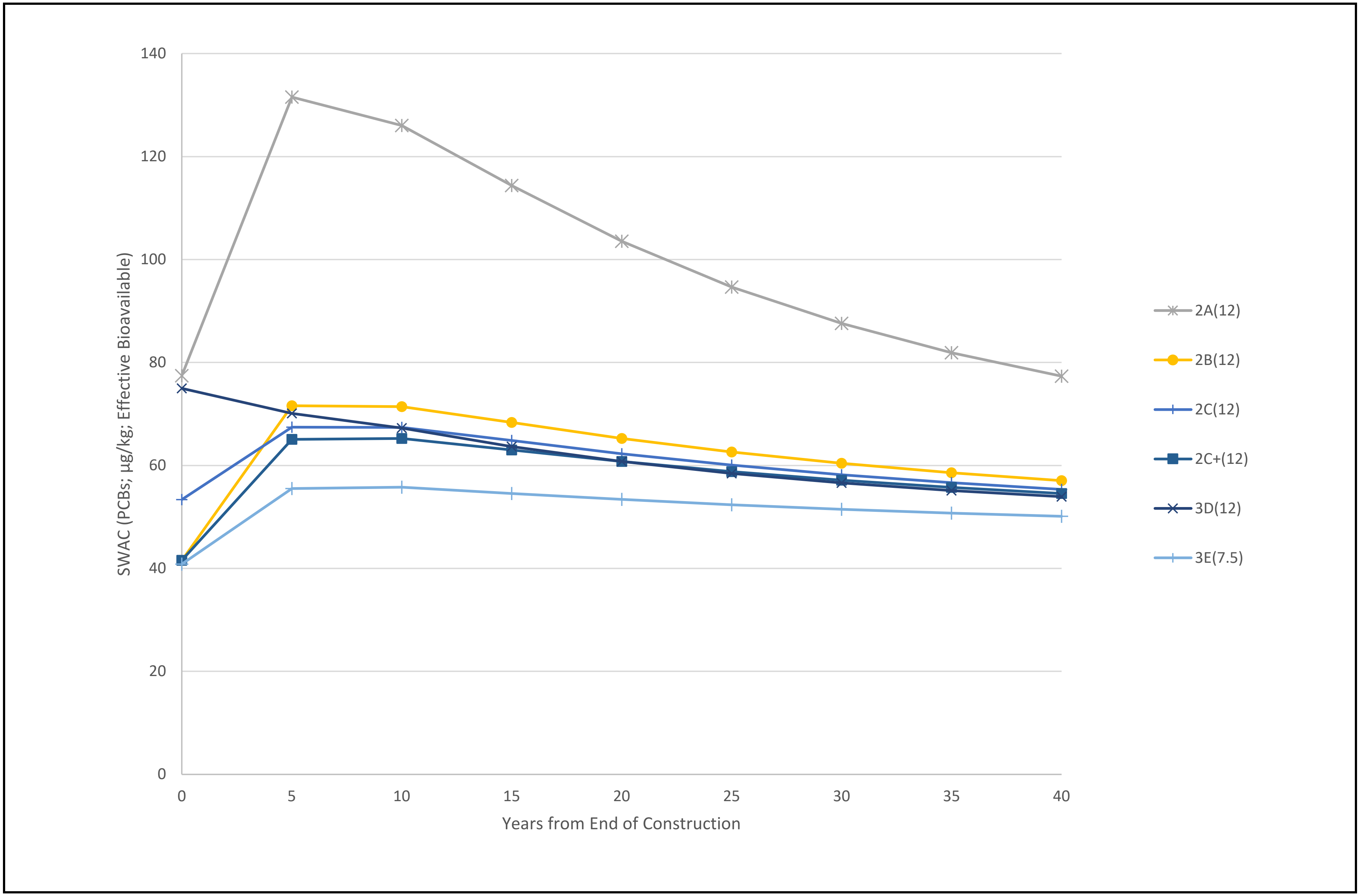
µg/kg = microgram per kilogram
PCB = polychlorinated biphenyl
RAL = remedial action level
SWAC = spatially-weighted average concentration

Figure 3-1
Predicted Site-wide SWAC for Alternatives with Different RALs
Feasibility Study - Appendix L
East Waterway Study Area



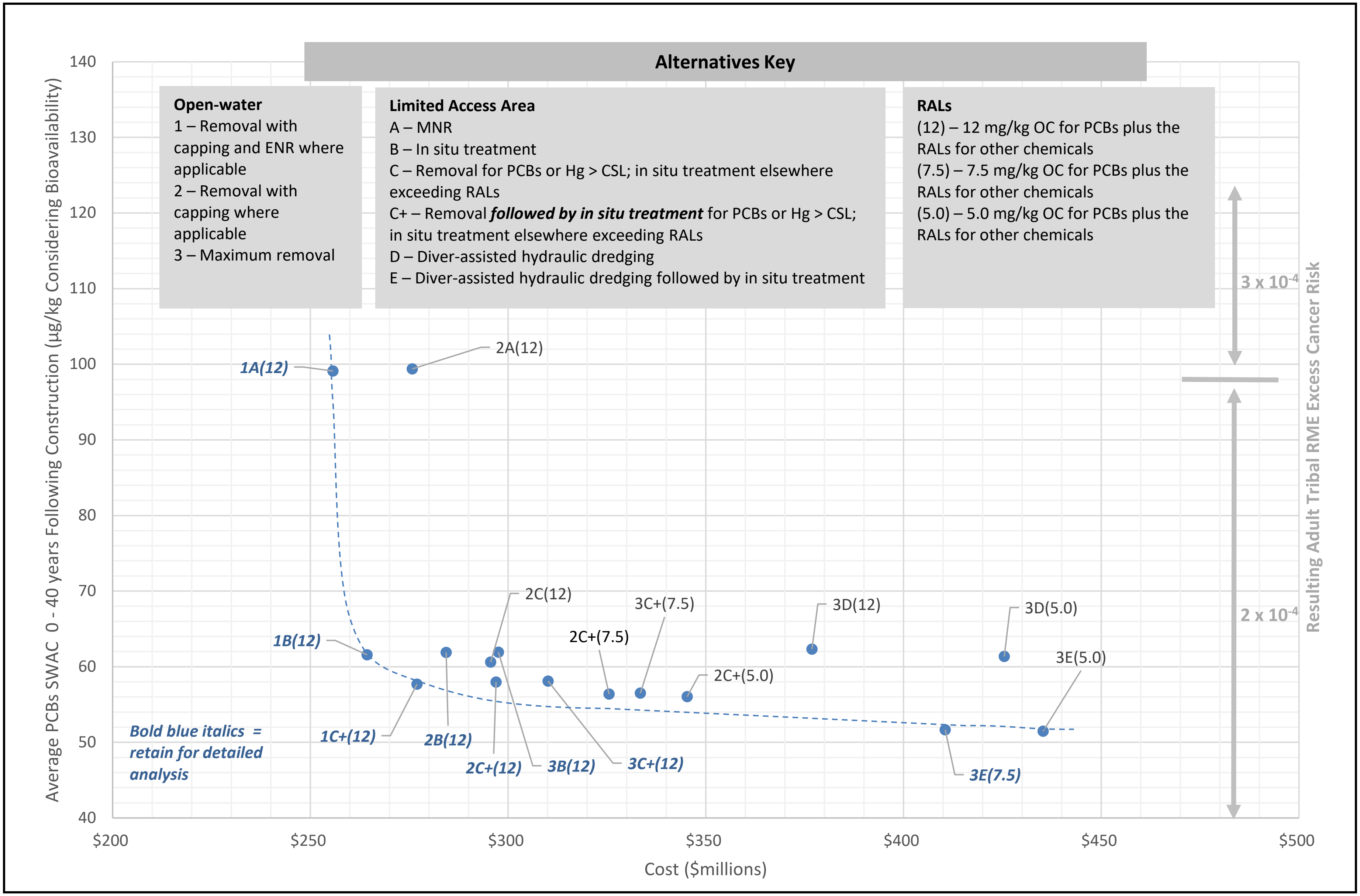
µg/kg = microgram per kilogram
PCB = polychlorinated biphenyl
SWAC = spatially-weighted average concentration

Figure 3-2
Predicted Site-wide SWAC for Alternatives with Different Open-water Technology Options
Feasibility Study - Appendix L
East Waterway Study Area



µg/kg = microgram per kilogram
PCB = polychlorinated biphenyl
SWAC = spatially-weighted average concentration

Figure 3-3
Predicted Site-wide SWAC with Different Underpier Technology Options
Feasibility Study - Appendix L
East Waterway Study Area



µg/kg = microgram per kilogram
CSL = cleanup screening level
ENR = enhanced natural recovery
Hg = mercury
mg/kg = milligram per kilogram
MNR = monitored natural recovery
OC = organic carbon

PCB = polychlorinated biphenyl
RAL = remedial action level
RME = reasonable maximum exposure
SWAC = spatially-weighted average concentration

Figure 4-1
Comparison of Alternatives
Feasibility Study - Appendix L
East Waterway Study Area